MECSERVE

Energy & Sustainability Statement

for

IMPERIAL LONDON HOTELS

64-65 Guilford Street
London Borough of Camden
London
WC1N 1DD

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ISSUE

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CONTENTS

EXECUTIVE SUMMARY

Mecserve Ltd has been appointed by Imperial London Hotels Ltd to prepare an Energy and Sustainability Statement to support the planning application for demolition, renovations and additions to existing properties at 64-65 Guilford Street in the London Borough of Camden.

This Energy Statement has been prepared in line with the Greater London Authority guidance on preparing energy assessments (March 2016) as well as the Camden Planning Guidance 3 on Sustainability (March 2018). The following sections outline the key features and strategies adopted by the development team to enhance the energy and sustainability performance of the proposed development at 64-65 Guilford Street. The building is grade II listed and therefore there are various restrictions applicable to the development, preventing major changes to the building. Sections 2 and 3 review these policies and demonstrate how design meets all relevant planning targets and requirements.

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 64-65 Guilford Street:

- The existing building fabric will be thermally upgraded in line with the Part L standards in terms of U-values to reduce heating demand;
- Where possible, existing single-glazed windows will be replaced with new double-glazed units;
- The new built extensions will be well insulated thus achieving low U-values that exceed the minimum Part L requirements;
- Accredited Construction Details will be used in the extensions to eliminate thermal bridging;
- The new built extension will achieve a low air tightness rate to reduce heat losses further;
- Individual gas-fired condensing combi boilers of high efficiency will provide heating to the new extension;
- Light fittings will be of low energy types i.e. LED lighting will be installed throughout the scheme.

- Installation of CHP or other LZC and renewable technologies solutions has been investigated but were not feasible for this development.

Following the proposed energy strategy, the proposal achieves significant carbon savings that exceed the 35% reduction target over the Baseline Emission Rate set by the London Plan, i.e. CO_2 emissions of the unrefurbished, existing building for the refurbished elements and Part L1A Target Emission Rate (TER) for the extension.

Due to the historic nature of the building (Grade II listed) and its location as well as other restrictions such as area, access and existing site constraints, completing a BREEAM assessment and achieving the relevant rating is too onerous and challenging. However, Camden sustainability policies are addressed within this report where relevant.

Table 1 below demonstrates the overall reduction in the regulated and unregulated carbon emissions of the development after each stage of the London Plan Energy Hierarchy. Estimating reductions in non-regulated carbon dioxide emissions is challenging, as energy consumption will generally be based on the operational regime of the site and users' behaviour. However, by using energy efficiency appliances e.g. A-rated white goods, it is estimated that a reduction of at least 10% can be achieved in unregulated energy use.

Table 1 Total CO_2 emissions from each stage of the Energy Hierarchy

64-65 Guilford Street		Carbon dioxide emissions (Tonnes CO_2 per annum)	
		Regulated	Unregulated
Baseline Emission Rate		34.5	16.5
Be Lean	After energy demand reduction	20.3	14.8
Be Clean	After heat network/CHP	20.3	14.8
Be Green	After renewable energy	20.3	14.8

An overall reduction of 41.2% in regulated carbon emissions can be achieved over the baseline emission rate set by GLA when applying the proposed strategy, which exceeds the 35% reduction required by the London Plan. Table 2 demonstrates the total regulated CO_2 savings from each stage of the Energy Hierarchy.

Table 2 Total CO_2 savings from each stage of the Energy Hierarchy

64-65 Guilford Street	Regulated carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Savings from energy demand reduction	14.2	41.2%
Savings from CHP	0.0	0.0%
Savings from renewable energy	0.0	0.0%
Cumulative on-site savings	**14.2**	41.2%
Total Target Savings	**12.1**	**35.0%**
Annual Surplus	**2.1**	

Figure 1 illustrates the carbon savings achieved for the 64-65 Guilford Street scheme over the Baseline Emission Rate at each stage of the London Plan's Energy Hierarchy. Due to the energy efficiency measures applied to the scheme the achieved reduction exceeds the carbon reduction target as set in the London Plan.

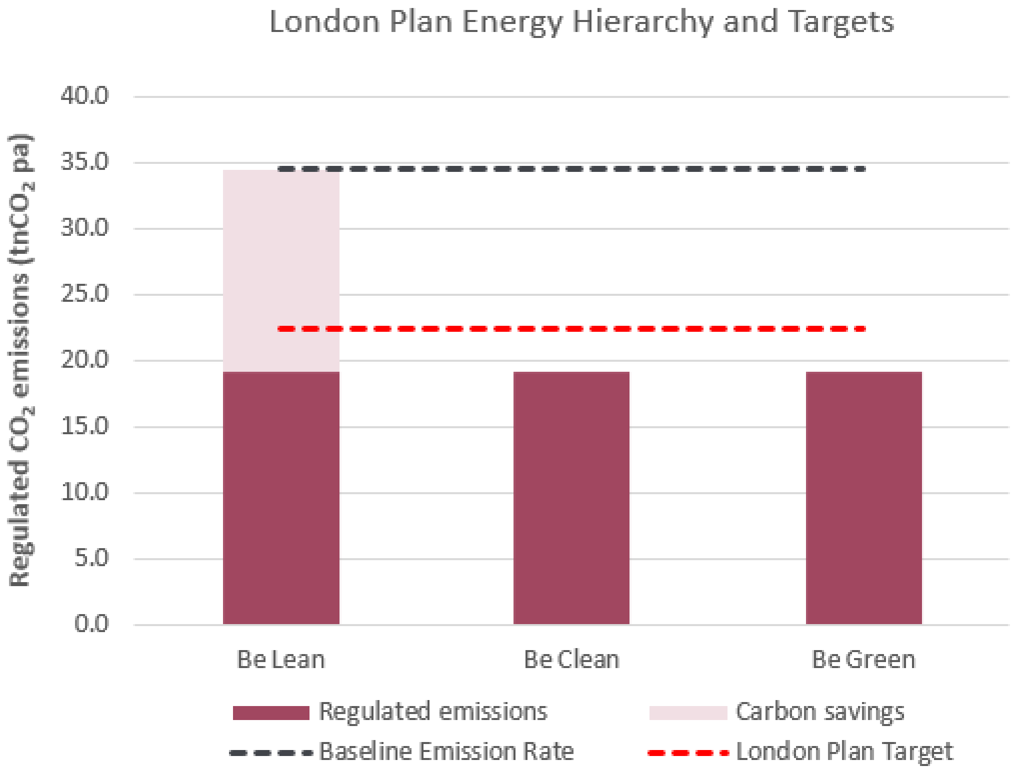

Figure 1 Total carbon savings achieved over Baseline Emissions

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 CO_2 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, consisting of two Grade II listed buildings, is located within the Bloomsbury conservation area in the London Borough of Camden.

The proposals aim to refurbish and revert the existing buildings at 64-65 Guilford Street back to two separate terrace buildings comprising in total 18 No. one-bedroom flats. Building works to be undertaken also include the demolition of the rear closet wings and reconstruction of a three-storey extension as well as provision of a rooftop extension.

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

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[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 64-65 Guilford Street scheme (Front façade – IPA Architects)

2. OVERVIEW OF ENVIRONMENTAL STANDARDS, TARGETS AND POLICIES

2.1 NATIONAL POLICIES

ENERGY WHITE PAPER

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

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

CLIMATE CHANGE ACT 2008

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

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

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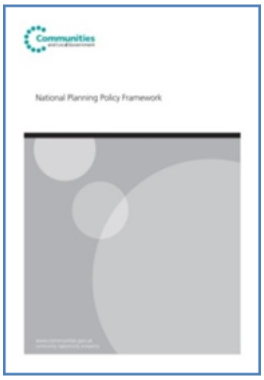
[2] Dti, (2003); Energy White Paper Our Energy Future - Creating a Low Carbon Economy. TSO.

[3] OPSI, (2008); Climate Change Act. HMSO.

NATIONAL PLANNING POLICY FRAMEWORK (NPPF) (MARCH 2012)

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



Communities

National Planning Policy Framework

- 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.

CHAPTER FIVE

LONDON'S RESPONSE TO CLIMATE CHANGE

SUSTAINABLE DESIGN AND CONSTRUCTION

SUPPLEMENTARY PLANNING GUIDANCE

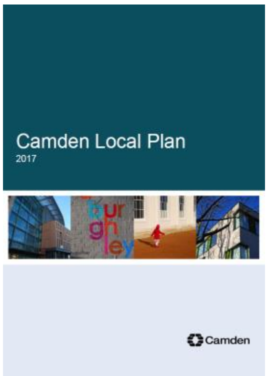
MAYOR OF LONDON

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 (adopted in 2017) sets out the Council's planning policies and replaces the Core Strategy and Development Policies planning documents. The Local Plan, covering the period from 2016-2031, will help deliver the objectives of creating the conditions for harnessing the benefits of economic growth, reducing inequality and securing sustainable neighbourhoods.



Section 8 of the Local Plan sets the Council's targets and objectives with regards to Sustainability and Climate Change for developments to reduce energy use and, therefore, cut carbon emissions.

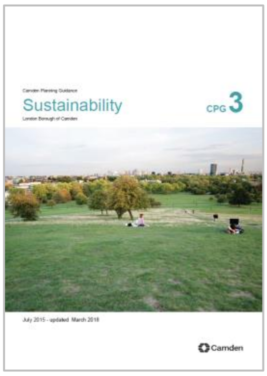
The following section provides review of the London Plan and the Local Plan policies for Climate Change mitigation and Climate Change Adaptation followed by measures implemented in the proposed development to meet the applicable policy requirements.

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 CO_2) 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 the Camden Planning Guidance (CPG 3) on Sustainability (adopted on April 2011 and updated on March 2018), the Council provides information on ways to achieve carbon reductions and more sustainable developments across the borough. It also highlights the Council's requirements and guidelines which support the relevant Local Development Framework (LDF) policies with regards to the following environmental issues:



- Tackling climate change through sustainable construction, energy efficiency, use of renewable energy and retrofitting;
- Adapting to a changing climate, in particular to an increased likelihood of flooding, higher temperatures and the need for cooling and recognising the environmental and social benefits of green infrastructure including living roofs;
- Protecting water resources and making provision for water and sewerage.

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

- Policy 5.2 Minimising carbon dioxide emissions;
- Policy 5.3 Sustainable design and construction;
- Policy 5.6 Decentralised energy in development proposals;
- Policy 5.7 Renewable energy;

CAMDEN’S COUNCIL LOCAL PLAN: DEVELOPMENT MANAGEMENT DPD 2013

- 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

London Plan – Policy 5.2 Minimising Carbon Dioxide Emissions

A. Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:

1. Be lean: use less energy;
2. Be clean: supply energy efficiently;
3. Be green: use renewable energy.

B. The Mayor will work with boroughs and developers to ensure that major developments meet the following targets for carbon dioxide emissions reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) outlined in the national Building Regulations leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019.

Residential buildings:

Year	**Improvement on 2010 Building Regulations**
2010 – 2013	25 per cent
2013 – 2016	40 per cent
2016 – 2031	Zero Carbon[4]

Non-domestic buildings

Year	**Improvement on 2010 Building Regulations**
2010 – 2013	25 per cent
2013 – 2016	40 per cent
2016 – 2019	As per building regulations requirements
2019 – 2031	Zero Carbon

C. Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined above are to be met within the framework of the energy hierarchy.

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

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[4] 'Zero carbon' homes are homes forming part of major development applications where the residential element of the application achieves at least a 35 per cent reduction in regulated carbon dioxide emissions (beyond Part L 2013) on-site. The remaining regulated carbon dioxide emissions, to 100 per cent, are to be off-set through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere (in line with policy 5.2E).

> a. calculation of the energy demand and carbon dioxide emissions covered by Building Regulations and, separately, the energy demand and carbon dioxide emissions from any other part of the development, including plant or equipment, that are not covered by the Building Regulations (see paragraph 5.22) at each stage of the energy hierarchy;
>
> b. proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings and services;
>
> c. proposals to further reduce carbon dioxide emissions through the use of decentralised energy where feasible, such as district heating and cooling and combined heat and power (CHP);
>
> d. proposals to further reduce carbon dioxide emissions through the use of on-site renewable energy technologies.
>
> E. The carbon dioxide reduction targets should be met on-site. Where it is clearly demonstrated that the specific targets cannot be fully achieved on-site, any shortfall may be provided off-site or through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere.

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

The proposed scheme, comprising 19 one-bedroom flats, is classified as a major development according to London Plan. Building works on site include the refurbishment of the existing two Grade II listed buildings and provision of a rear three-storey extension.

The energy strategy proposed follows the London Plan Energy Hierarchy and this report is written in line with GLA guidance on reporting energy assessments (March 2016) and the Camden Council relevant guidance.

Our approach to reducing the energy demand and cut carbon emissions, the following have been considered where technically feasible without compromising the historic character of the buildings:

- The building fabric of the existing buildings will be thermally upgraded and where possible the single glazed windows will be replaced with double glazed units. The new built extensions will also exceed the current building regulations' requirements in terms of U-values;
- Efficient building services and low energy lighting are proposed to reduce energy consumption;
- The design team has carried out a feasibility study to assess the potential of connecting the scheme to a district heating network or provide a Combined Heat and Power to meet heating demand;
- Renewable energy technologies are explored and the most feasible options are proposed the development.

This report also covers the non-regulated energy use due to appliances and cooking and lists a number of strategies in order to reduce this. As a result of the proposed strategy, the scheme achieves an overall reduction in excess of the 35% target set by GLA and the Council. In line with GLA's definition of Zero Carbon homes, the remaining regulated carbon dioxide emissions, to 100 per cent, are to be off-set through a cash in lieu contribution to the borough.

London Plan – 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.

C. Major development proposals should meet the minimum standards outlined in the Mayor's supplementary planning guidance and this should be clearly demonstrated within a design and access statement. The standards include measures to achieve other policies in this Plan and the following sustainable design principles:

  a. minimising carbon dioxide emissions across the site, including the building and services (such as heating and cooling systems)

  b. avoiding internal overheating and contributing to the urban heat island effect

  c. efficient use of natural resources (including water), including making the most of natural systems both within and around buildings

  d. minimising pollution (including noise, air and urban runoff)

  e. minimising the generation of waste and maximising reuse or recycling

  f. avoiding impacts from natural hazards (including flooding)

  g. ensuring developments are comfortable and secure for users, including avoiding the creation of adverse local climatic conditions

  h. securing sustainable procurement of materials, using local supplies where feasible, and

  i. promoting and protecting biodiversity and green infrastructure.

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

As a major development, the scheme achieves a carbon reduction greater than 35% over the Baseline emission rate set by GLA, in accordance with London Plan's Policy 5.2.

The energy section of this report provide details on how significant carbon savings can be achieved across the site and which measures will be considered to tackle overheating. Passive design measures, including building fabric of enhanced thermal performance, double glazed windows, Accredited Construction Details and low air tightness rate for the new extension, will reduce the annual heating demand. Condensing gas-fired boilers of high efficiency and low energy use light fittings of LED lighting will reduce energy use further. Low water use fittings will be installed to minimise water consumption on site, targeting a daily consumption less than 105 litres per person.

The newly created dwellings will rely mainly on natural cross ventilation through fully openable windows to remove excessive solar gains and eliminate the risk of overheating. Materials of low environmental impact, which will be responsibly resourced, will be used for the construction of the new extension. By retaining the majority of the existing building structure and existing construction materials, the overall embodied carbon of the proposed refurbishment will be kept to a minimum in comparison to a newly constructed building.

More information can be found on the Design and Access Statement prepared by IPA Architects.

London Plan – 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:

   1. Connection to existing heating or cooling networks;
   2. Site wide CHP network;
   3. 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 (Figure 4) and Camden’s energy network map (Map 5, Camden Local Plan), there is neither a district heating system currently available in close proximity to the site nor any proposed district heating system in the future. Due to the small number of units (18 No. 1-Bed flats), even if a network is to become available, the cost of connecting to this would be significant, therefore, such a connection would not be considered financially viable. Therefore, given the small scale of the scheme and the current lack of a district heating network in close proximity, it is not feasible or viable to connect to a district heating system.

Given the scale of the proposed scheme, installation of a Combined Heat and Power (CHP) unit is not considered to be feasible either. The heating demand is expected to be low and not constant throughout the year and the hot water demand is not high enough to justify installing a CHP unit.

The CHP unit would need to run continuously for long periods to ensure maximum carbon and cost savings. Therefore, given the low heating load, this would not be feasible. As per GLA guidance on energy assessments, a higher number of residential units is required to justify installation of a CHP unit.

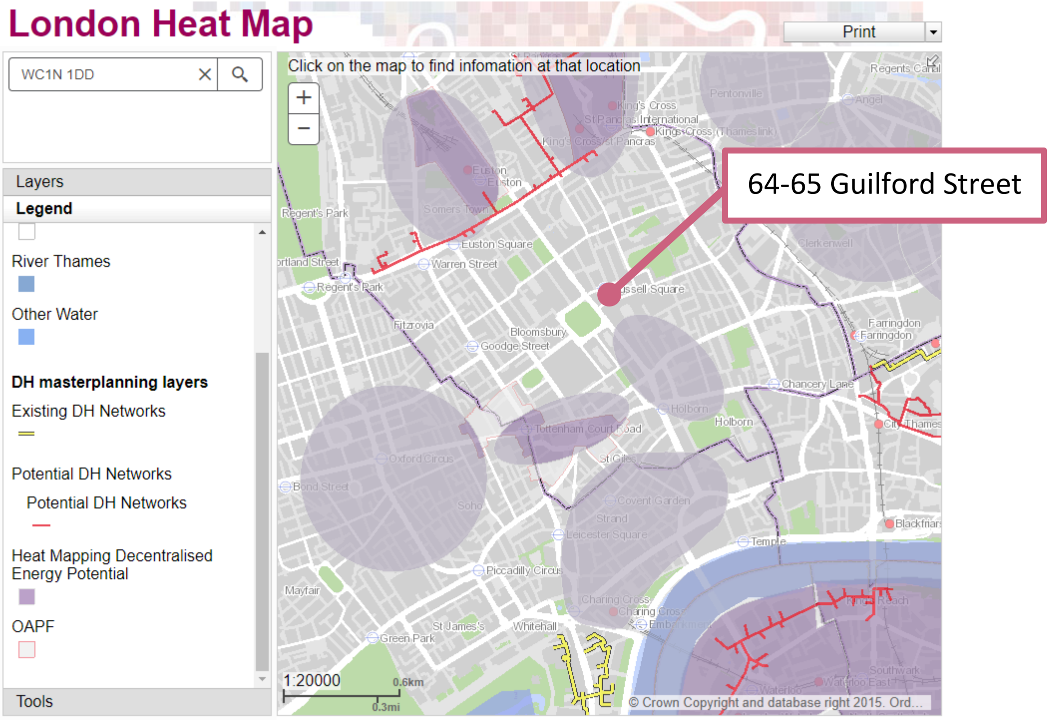

Figure 4 Image of London Heat Map (www.londonheatmap.org.uk)

London Plan – 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 identify those renewable energy technologies that are appropriate for the proposed development.

The most suitable renewable energy technologies for a residential scheme would be photovoltaic or solar thermal panels that would generate electricity on site or provide hot water to the newly created flats.

However, the roof of the new-built extension, where panels could be installed, is heavily overshadowed by the existing buildings located on the south side of the site. In addition, given that the existing buildings are Grade II listed and located within a conservation area, both technologies would have a negative impact on the aesthetics of the surrounding neighbourhood and the historic character of the scheme. Therefore, we would not recommend any renewable energy technology for the proposed scheme.

Section 4.8 summarises the findings of the feasibility study carried out for the above and other renewable energy technologies.

Camden Local Plan – 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

Our response to the London Plan Policies, described above, demonstrates that all the proposed scheme meets all the planning requirements set by the Camden Council.

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

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

CAMDEN'S COUNCIL LOCAL PLAN: DEVELOPMENT MANAGEMENT DPD 2013

- Policy CC2 Adapting to climate change
- Policy CC3 Water and flooding

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

London Plan – 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:

  1. minimise internal heat generation through energy efficient design;
  2. reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls;
  3. manage the heat within the building through exposed internal thermal mass and high ceilings;
  4. passive ventilation;
  5. mechanical ventilation;
  6. 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:

Measures to eliminate the risk of overheating have been considered and integrated in the design of the newly created flats. The following will be applied to ensure comfort during summer within the main living areas of the units:

- Windows can be fully open to allow for cross ventilation, which is the most efficient means of natural ventilation in removing excessive heat that builds up indoors;
- Windows left open at night could benefit of free night time cooling to cool down the structure;

- Internal shading devices of low shading coefficient, e.g. light-coloured curtains will be used for solar control;
- All new double-glazed windows will be of low g-value, compared to the existing single glazed units, to avoid heat transmittance during summer but allow for passive heating in the winter;
- Tenants will be advised to use 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.

London Plan – Policy 5.11 Green roofs and development site environs

A. Major development proposals should be designed to include roof, wall and site planting, especially green roofs and walls where feasible, to deliver as many of the following objectives as possible:
    a. adaptation to climate change (i.e. aiding cooling)
    b. sustainable urban drainage
    c. mitigation of climate change (i.e. aiding energy efficiency)
    d. enhancement of biodiversity
    e. accessible roof space
    f. improvements to appearance and resilience of the building
    g. growing food.

B. Within LDFs boroughs may wish to develop more detailed policies and proposals to support the development of green roofs and the greening of development sites. Boroughs should also promote the use of green roofs in smaller developments, renovations and extensions where feasible.

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

The site is mainly occupied by the existing retained buildings, therefore, there is limited scope for providing green areas. Due to the Grade II listed character of the buildings, it would not possible to install a green wall as this would alter the facades significantly. The existing retained structure would not be able to support the installation of a green roof either. Where possible though, planters will be provided on the ground floor.

Further information with regards to the landscape design can be found in the Design and Access Statement prepared by IPA Architects.

London Plan – Policy 5.12 Flood Risk Management

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 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:

  a. the development will remain safe and operational under flood conditions;

  b. strategy of either safe evacuation and/or safely remaining in the building is followed under flood conditions;

  c. key services including electricity, water etc. will continue to be provided under flood conditions;

  d. 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.

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

The site is located in a low flood risk zone according to the Flood Map for Planning (Figure 5).

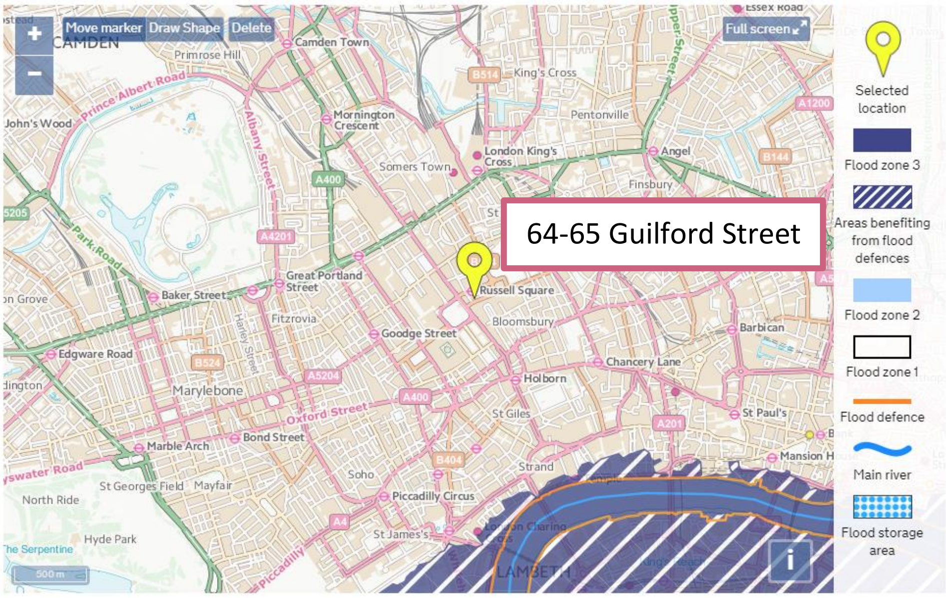

Figure 5 **Flood Map for Planning** (**https://flood-map-for-planning.service.gov.uk/**)

London Plan – Policy 5.13 Sustainable Drainage

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

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

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

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

Given that the existing buildings occupy the majority of the site there is limited opportunity for proposing SUDS techniques to reduce and delay the discharge of rainfall run-off. Where possible use of permeable paving will be used for delaying water at surface before discharging all surface water to ground via soakaways.

London Plan – Policy 5.15 Water Use Supplies

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

a. incorporating water saving measures and equipment;

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

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

All new extension will have low water use fittings to reduce water consumption. Low flow rate showers, taps and dual flush toilets together with smaller baths will mean that all apartments will achieve a daily internal water use lower than 105 litres per person.

Camden Local Plan – 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:

Where technically possible, sustainable development principles have been incorporated into the proposed design. Site ecology will be enhanced where feasible. Measures to eliminate the risk of overheating have been considered and integrated in the design of the new extension. Where possible use of permeable paving will be used for delaying the discharge of surface water run off. Due to the historic nature of the building (Grade II listed) and its location as well as other restrictions such as area, access and existing site constraints, it is too onerous to complete a BREEAM assessment and achieve the relevant ratings. Sustainability measures such as addressing overheating, specifying low embodied materials, providing planters, sourcing materials responsibly and specifying low water use fittings have been incorporated.

Camden Local Plan – 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
f. hierarchy to achieve a greenfield run-off rate where feasible; and
g. 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 located in low flood risk zone. As described previously all apartments will have low water use fittings to reduce water consumption to achieve a daily internal water use lower than 105 litres per person and where possible use of permeable paving will be used for delaying discharge of surface water runoff.

4. ENERGY ASSESSMENT

The energy assessment of the proposed scheme has been assessed following the Standard Assessment Procedure (SAP 2012). This section, prepared in line with the GLA Guidance on preparing energy assessments (March 2016), outlines the energy strategy developed for the scheme and shows how significant carbon savings can be achieved by integrating energy efficiency measures and using LZC technologies on site.

4.1 BUILDING REGULATION COMPLIANCE

Part L (Conservation of Fuel and Power) of the Building Regulations 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.

Part L is split into four sections that cover new and existing domestic and non-domestic buildings. The proposal includes the material change of use and extension of the existing buildings to provide 18 No. 1-Bed flats. Therefore, the scheme needs to comply with the minimum energy efficiency requirements set by the current Building Regulations:

- Approved Document L1A: Conservation of fuel and power in new dwellings (2013 edition inc. 2016 amendments);
- Approved Document L1B: Conservation of fuel and power in existing dwellings (2010 edition inc. 2018 amendments)

The development will comply with all the design limits on building fabric, building services systems and lighting, where feasible and practicable. The rear extension will need to comply with part L1A and the existing buildings with Part L1B. Detailed energy calculations using SAP have been completed to assess the energy performance of the development.

4.2 ENERGY MODELLING

For the purpose of this study, STROMA FSAP 2012 software (version 1.0.4.14), approved by BRE for full implementation of the SAP 2012 has been used to assess the energy performance and annual carbon emissions of the flats after energy efficient measures have been applied. The energy assessment has been completed by Mecserve's energy modelling team who are On Construction Domestic Energy Assessors.

4.3 BASELINE CARBON EMISSION RATE

According to Section 9 of the GLA Guidance on preparing energy assessments (March 2016), for developments consisting of a refurbishment with an extension, the baseline emission rate is the regulated CO_2 emissions of the unrefurbished, existing building for the refurbished elements and the Target Emission Rate set by Part L1A for the extension. Therefore, the target is a combination of both targets on an area-weighted average basis.

The following table presents the Baseline Emission Rate of the scheme as calculated using SAP 2012 for the whole scheme.

Table 3 Baseline Carbon Dioxide emissions

64-65 Guilford Street	Regulated Carbon dioxide emissions (Tonnes CO_2 per annum)
Baseline Emission Rate	34.5

From 6 April 2014, Approved Document L1A has also introduced a Fabric Energy Efficiency Target (TFEE) in addition to the TER. This is the maximum space heating and cooling energy demand for a dwelling. 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 presents the Target Fabric Energy Efficiency (TFEE) calculated by FSAP 2012 software for the extension.

Table 4 Target Fabric Energy Efficiency Rate

64-65 Guilford Street	Fabric Energy Efficiency (kWh per m^2 per annum)
Part L1A Target Fabric Energy Efficiency (TFEE) Rate	68.1

4.4 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 Breen: use renewable energy.

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

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

London Plan sets a zero-carbon target for residential units. 'Zero carbon' homes are homes forming part of major development applications which achieve at least a 35 per cent reduction in regulated carbon dioxide emissions (beyond Part L 2013) on-site. The remaining regulated carbon dioxide emissions, to 100 per cent, are to be off-set through a cash in lieu contribution to the borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere.

The following sections indicate the performance of the extension flats in relation to the London Plan carbon reduction target set by GLA for major developments.

4.5 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 demonstrate how the proposed development will achieve energy and CO_2 emissions reduction over the baseline emissions.

Given that the existing buildings are Grade II listed, only passive design measures, considered technically possible and financial viable without having any negative impact on the historic character of the scheme, are proposed.

PASSIVE DESIGN

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

This will be achieved through:

- **Building Orientation:** The building's orientation is largely dictated by the shape of the site and the location of the existing listed buildings. The main façade of the building is facing south;
- **Passive Solar Design and Daylight:** Internal layouts have been set out to maximise the number of habitable rooms that can take advantage of solar gain and natural light;
- **Thermal performance of the fabric:** the existing building fabric will be thermally upgraded in line with the minimum requirements set in the Part L. The new extension will exceed those standards in terms of U-values thus reducing heating demand;
- **High performance windows:** Where possible, single glazed windows will be replaced with double glazed units. High performance windows of low U-value will be installed in the new extension;
- **Thermal bridging**: Accredited Construction Details will be used in the rear extension to minimise the impact of thermal bridging thus reducing heat losses further;
- **Air-tightness**: Using enhanced construction skills and rigorous detailing to reduce the air permeability of the new extension and, therefore, eliminate heat losses through infiltration.

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

Table 5 Proposed building fabric specifications

Building Fabric	U-value [W/m^{2}K]	Wall	0.18 – New built elements 0.30 – Upgraded existing elements
		Floor	0.15 – New built elements 0.25 – Upgraded existing elements
		Roof	0.15 – New built elements
		Windows	1.60 – Double glazing (g-value: 0.63) 4.80 – Single glazing (g-value: 0.85)
		Doors	1.00 – New fittings
	Air permeability		4 m^3/m^{2}hr @50Pa (New extension only)
	Thermal Bridging		Accredited Construction Details and high-performance lintel (psi-value < 0.05) will be used to eliminate thermal bridging (New extension only)

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.

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 & Hot Water:** Individual gas-fired condensing combi boilers of high efficiency are proposed for each unit;
- **Ventilation:** All residential units will be naturally ventilated with intermittent extract fans in the kitchen and bathroom;
- **Lighting:** All light fittings will be dedicated low energy types i.e. either LED or fluorescent.

Table 6 Proposed building services systems

HVAC Systems	Heating System	All units will feature individual gas-fired condensing combi boilers with automatic ignition of 89.6% efficiency (e.g. Worcester Greenstar 25i)
	Heating Controls	Time and temperature zone control Weather Compensator
	Ventilation	Intermittent extract only fans in kitchens and bathrooms
	Comfort Cooling	Not provided
	Water consumption	Dwellings designed to achieve a water use target less than 105 litres/person/day
Lighting	Installed lighting	All light fittings are dedicated low energy types i.e. LED lighting

After implementing all the passive and active energy efficiency measures listed in the above sections, the regulated carbon dioxide emissions of the proposed scheme are reduced by 41.2% in comparison to the GLA baseline emission rate.

Table 7 Carbon Dioxide emissions (Be Lean stage)

64-65 Guilford Street		Regulated Carbon dioxide emissions (Tonnes CO_2 per annum)
Baseline Emission Rate		34.5
Be Lean	After energy demand reduction	20.3
Carbon savings		14.2
Reduction		41.2%

Subsequently, the reduction in Fabric Energy Efficiency for the new extension is 14.4%, as the following table demonstrates.

Table 8 Fabric Energy Efficiency Rate

64-65 Guilford Street	Fabric Energy Efficiency (kWh per m^2 per annum)
Part L1A Target Fabric Energy Efficiency (TFEE) Rate	68.1
New Extension Dwelling Fabric Energy Efficiency (DFEE) Rate	58.3
Reduction	14.4%

4.6 NON-REGULATED ENERGY USE

The London Plan (March 2016) requires that the energy demand and carbon dioxide emissions of the non-regulated end uses should also be calculated and reported in the energy assessments. In accordance with the BRE calculation procedure for estimating the non-regulated carbon emissions, the carbon emissions from appliances and cooking for all dwellings are approximately 16.5 tonnes per year.

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

- A-rated appliances: 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 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%. However, at this stage, this can only be an assumption as small power consumption depends mainly on occupant’s behaviour.

4.7 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.

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 and Camden Energy Networks Map, there is no district heating network in close proximity available currently. Therefore, given also the size and scale of the proposed scheme, connection to a district energy network is not considered feasible.

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. Given the proposed number of units i.e. 18 No 1-Bed flats, the annual demand for space heating and domestic hot water for the scheme is expected to be low and variable throughout the year.

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

4.8 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.

The following section summarises the findings of the renewable energy feasibility study carried out for the scheme:

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, especially for a listed building located within a conservation area. Therefore, this technology is not suitable for this scheme.

GROUND SOURCE HEAT PUMP

Ground source heat pumps with a closed underground loop borehole system take advantage of the constant temperature of the ground to extract heat during winter and transfer it indoors. However, given that the heating demand for this development is low, the cost of installing a ground source heat pump to an existing building 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. They also have low maintenance costs and they are simple to install compared to a GSHP. However, they tend to drop their efficiencies when ambient air temperature is low during wintertime as there is no heat to absorb. This combined with the fact that they consume electricity which is a more carbon intensive fuel compared to gas, can increase the carbon emissions of the scheme. Finally, the condenser units, which need to be located externally, would have a negative impact on the aesthetics of the building and the surrounding conservation area. For these reasons, we would not recommend ASHPs for this development.

SOLAR THERMAL PANELS/ PHOTOVOLTAIC (PV) PANELS

Both solar thermal panels and photovoltaic panels can work well on residential developments, making use of solar energy to provide hot water or electricity generated on site respectively.

However, given that the existing buildings are Grade II listed and located within a conservation area, both technologies would have a negative impact on the aesthetics of the surrounding neighbourhood and the historic character of the scheme. In addition, the roof of the new-extension, where panels could be installed, is heavily overshadowed by the existing buildings located on the south side of the site. Therefore, we would not recommend any renewable energy technology for the proposed scheme.

5. 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 the London Plan and the London Borough of Camden Climate Change Mitigation and Adaptation Policies.

The following passive and active energy efficiency features have been considered in the proposed strategy for 64-65 Guilford Street:

- The existing building fabric will be thermally upgraded in line with the Part L standards in terms of U-values to reduce heating demand;
- The new built extensions will be well insulated thus achieving low U-values that exceed the minimum Part L requirements;
- Accredited Construction Details will be used in the extension to eliminate thermal bridging and a low air tightness rate will be achieved to reduce heat losses further;
- Individual gas-fired condensing combi boilers of high efficiency will provide heating to the new extension
- Light fittings will be of low energy types i.e. LED lighting will be installed throughout the scheme.

Installation of CHP or other LZC and renewable technologies solutions has been investigated but were not feasible for this development.

Following the proposed energy strategy, the proposal achieves significant carbon savings that exceed the 35% reduction target over the Baseline Emission Rate set by the London Plan, i.e. CO_2 emissions of the un refurbished, existing building for the refurbished elements and Part L1A Target Emission Rate (TER) for the new build elements.

Due to the historic nature of the building (Grade II listed) and location and other restrictions such as area, access and existing site constraints, it is too onerous to complete a BREEAM assessment and achieve the relevant ratings. Sustainability measures such as addressing overheating, specifying low embodied materials, sourcing materials responsibly and specifying low water use fittings have been incorporated as far as feasible as described in section 3.4.

Table 9 below demonstrates the overall reduction in the regulated and unregulated carbon emissions of the development after each stage of the London Plan Energy Hierarchy.

Table 9 Total CO_2 emissions from each stage of the Energy Hierarchy

64-65 Guilford Street		Carbon dioxide emissions (Tonnes CO_2 per annum)	
		Regulated	Unregulated
Baseline Emission Rate		34.5	16.5
Be Lean	After energy demand reduction	20.3	14.8
Be Clean	After heat network/CHP	20.3	14.8
Be Green	After renewable energy	20.3	14.8

Table 10 demonstrates the total regulated CO_2 savings from each stage of the Energy Hierarchy. An overall reduction of 41.2% in regulated carbon emissions can be achieved over the baseline emission rate set by GLA when applying the proposed strategy, which exceeds the 35% reduction required by the London Plan.

Table 10 Total CO_2 savings from each stage of the Energy Hierarchy

64-65 Guilford Street	Regulated carbon dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Savings from energy demand reduction	14.2	41.2%
Savings from CHP	0.0	0.0%
Savings from renewable energy	0.0	0.0%
Cumulative on-site savings	**14.2**	41.2%
Total Target Savings	**12.1**	**35.0%**
Annual Surplus	**2.1**	

Figure 6 illustrates the carbon savings achieved for the 64-65 Guilford Street scheme over the Baseline Emission Rate at each stage of the London Plan's Energy Hierarchy. Due to the energy efficiency measures applied to the scheme the achieved reduction exceeds the carbon reduction target as set in the London Plan.

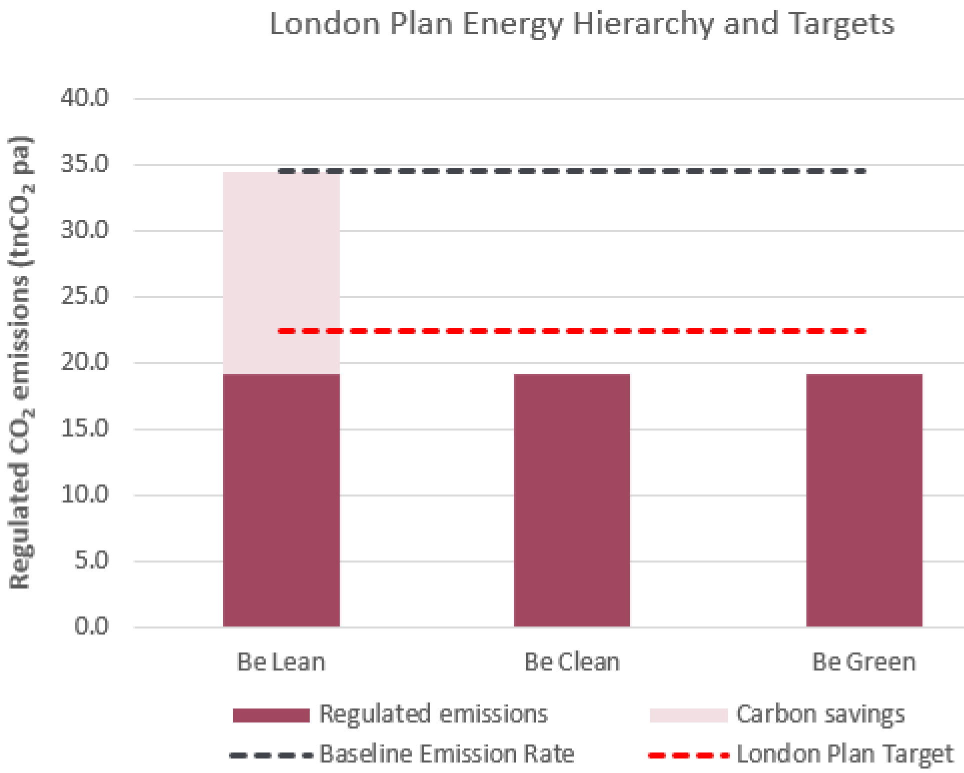

Figure 6 Total carbon savings achieved over Baseline Emissions

APPENDIX A DER WORKSHEET OF TYPICAL EXISTING UNIT

User Details:

Assessor Name: Panagiotis Dalapas
Stroma Number: STRO030082
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.4.14

Property Address: No 65-Plot 7-Existing

Address : Plot 7, 65 Guilford Street, WC1N 1DD

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	40.26	(1a)	x	2.61	(2a)	=	105.08	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	40.26	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	105.08	(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							2	x 10 =	20	(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) =	20	÷ (5) =	0.19	(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		15	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.94	(18)

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

Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.73	(21)

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

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

Wind Factor (22a)m = (22)m ÷ 4

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

DER WorkSheet: New dwelling created by change of use

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

0.93	0.91	0.89	0.8	0.78	0.69	0.69	0.67	0.73	0.78	0.82	0.86

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=	0.93	0.91	0.9	0.82	0.81	0.74	0.74	0.73	0.77	0.81	0.84	0.87	(24d)

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

(25)m=	0.93	0.91	0.9	0.82	0.81	0.74	0.74	0.73	0.77	0.81	0.84	0.87	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2	x	3	=	6			(26)
Windows Type 1			1.67	x1/[1/(4.8)+ 0.04]		=	6.72			(27)
Windows Type 2			2.51	x1/[1/(4.8)+ 0.04]		=	10.11			(27)
Walls Type1	25.13	7.52	17.61	x	2.1	=	36.98			(29)
Walls Type2	19.5	2	17.5	x	1.23	=	21.44			(29)
Total area of elements, m²			44.63							(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) =	94.7	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	315.99	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	Indicative Value: Medium	250	(35)

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

Thermal bridges : S (L x Y) calculated using Appendix K		6.69	(36)

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

Total fabric heat loss	(33) + (36) =	101.4	(37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	32.31	31.73	31.16	28.48	27.98	25.65	25.65	25.22	26.55	27.98	28.99	30.05	(38)

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

(39)m=	133.71	133.12	132.55	129.88	129.38	127.05	127.05	126.62	127.94	129.38	130.39	131.45	

Average = Sum(39)$_{1…12}$ /12= 129.88 (39)

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

(40)m=	3.32	3.31	3.29	3.23	3.21	3.16	3.16	3.14	3.18	3.21	3.24	3.27	

Average = Sum(40)$_{1…12}$ /12= 3.23 (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 1.41 (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 71.33 (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=	78.46	75.61	72.76	69.9	67.05	64.2	64.2	67.05	69.9	72.76	75.61	78.46	

Total = Sum(44)$_{1…12}$ = 855.98 (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=	116.36	101.77	105.02	91.56	87.85	75.81	70.25	80.61	81.57	95.07	103.77	112.69	

Total = Sum(45)$_{1…12}$ = 1122.32 (45)

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

(46)m=	17.45	15.27	15.75	13.73	13.18	11.37	10.54	12.09	12.24	14.26	15.57	16.9	(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)

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=	39.98	34.8	37.08	34.47	34.17	31.66	32.71	34.17	34.47	37.08	37.29	39.98	(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=	156.35	136.57	142.09	126.03	122.02	107.47	102.96	114.78	116.05	132.14	141.06	152.67	(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=	156.35	136.57	142.09	126.03	122.02	107.47	102.96	114.78	116.05	132.14	141.06	152.67	

Output from water heater (annual)$_{1…12}$	1550.2	(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=	48.69	42.54	44.19	39.06	37.75	33.12	31.54	35.35	35.74	40.88	43.83	47.47	(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=	70.66	70.66	70.66	70.66	70.66	70.66	70.66	70.66	70.66	70.66	70.66	70.66	(66)

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

(67)m=	16.86	14.97	12.18	9.22	6.89	5.82	6.29	8.17	10.97	13.93	16.25	17.33	(67)

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

(68)m=	122.19	123.46	120.26	113.46	104.87	96.8	91.41	90.14	93.34	100.14	108.73	116.8	(68)

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

(69)m=	30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	(69)

Pumps and fans gains (Table 5a)

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

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

(71)m=	-56.53	-56.53	-56.53	-56.53	-56.53	-56.53	-56.53	-56.53	-56.53	-56.53	-56.53	-56.53	(71)

Water heating gains (Table 5)

(72)m=	65.44	63.3	59.39	54.25	50.74	46	42.39	47.51	49.64	54.94	60.87	63.8	(72)

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

(73)m=	258.68	255.93	246.03	231.13	216.71	202.82	194.28	200.02	208.15	223.21	240.05	252.12	(73)

6. Solar gains:

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

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
North	0.9x	0.54	x	2.51	x	10.63	x	0.85	x	0.7	=	7.72	(74)
North	0.9x	0.54	x	2.51	x	20.32	x	0.85	x	0.7	=	14.75	(74)
North	0.9x	0.54	x	2.51	x	34.53	x	0.85	x	0.7	=	25.06	(74)
North	0.9x	0.54	x	2.51	x	55.46	x	0.85	x	0.7	=	40.26	(74)
North	0.9x	0.54	x	2.51	x	74.72	x	0.85	x	0.7	=	54.23	(74)

North	0.9x	0.54	x	2.51	x	79.99	x	0.85	x	0.7	=	58.05	(74)
North	0.9x	0.54	x	2.51	x	74.68	x	0.85	x	0.7	=	54.2	(74)
North	0.9x	0.54	x	2.51	x	59.25	x	0.85	x	0.7	=	43	(74)
North	0.9x	0.54	x	2.51	x	41.52	x	0.85	x	0.7	=	30.13	(74)
North	0.9x	0.54	x	2.51	x	24.19	x	0.85	x	0.7	=	17.56	(74)
North	0.9x	0.54	x	2.51	x	13.12	x	0.85	x	0.7	=	9.52	(74)
North	0.9x	0.54	x	2.51	x	8.86	x	0.85	x	0.7	=	6.43	(74)
South	0.9x	0.54	x	1.67	x	46.75	x	0.85	x	0.7	=	67.73	(78)
South	0.9x	0.54	x	1.67	x	76.57	x	0.85	x	0.7	=	110.93	(78)
South	0.9x	0.54	x	1.67	x	97.53	x	0.85	x	0.7	=	141.3	(78)
South	0.9x	0.54	x	1.67	x	110.23	x	0.85	x	0.7	=	159.7	(78)
South	0.9x	0.54	x	1.67	x	114.87	x	0.85	x	0.7	=	166.42	(78)
South	0.9x	0.54	x	1.67	x	110.55	x	0.85	x	0.7	=	160.16	(78)
South	0.9x	0.54	x	1.67	x	108.01	x	0.85	x	0.7	=	156.48	(78)
South	0.9x	0.54	x	1.67	x	104.89	x	0.85	x	0.7	=	151.97	(78)
South	0.9x	0.54	x	1.67	x	101.89	x	0.85	x	0.7	=	147.61	(78)
South	0.9x	0.54	x	1.67	x	82.59	x	0.85	x	0.7	=	119.65	(78)
South	0.9x	0.54	x	1.67	x	55.42	x	0.85	x	0.7	=	80.29	(78)
South	0.9x	0.54	x	1.67	x	40.4	x	0.85	x	0.7	=	58.53	(78)

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

(83)m=	75.45	125.68	166.36	199.96	220.65	218.21	210.68	194.97	177.74	137.2	89.81	64.96	(83)

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

(84)m=	334.13	381.61	412.39	431.09	437.35	421.03	404.97	394.99	385.89	360.41	329.86	317.08	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.99	0.98	0.97	0.94	0.89	0.82	0.83	0.92	0.97	0.99	0.99	(86)

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

(87)m=	17.82	18.04	18.45	19.05	19.66	20.25	20.61	20.57	20.1	19.31	18.49	17.81	(87)

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

(88)m=	19.34	19.35	19.35	19.39	19.39	19.42	19.42	19.43	19.41	19.39	19.38	19.37	(88)

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

(89)m=	0.99	0.98	0.97	0.96	0.92	0.83	0.67	0.7	0.87	0.96	0.98	0.99	(89)

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

(90)m=	16.53	16.75	17.17	17.78	18.39	18.97	19.27	19.25	18.83	18.05	17.22	16.54	(90)

fLA = Living area ÷ (4) = 0.52 (91)

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

(92)m=	17.2	17.43	17.84	18.44	19.05	19.64	19.97	19.94	19.49	18.71	17.88	17.2	(92)

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

(93)m=	17.2	17.43	17.84	18.44	19.05	19.64	19.97	19.94	19.49	18.71	17.88	17.2	(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=	0.98	0.98	0.97	0.95	0.91	0.84	0.73	0.76	0.88	0.95	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	328.82	373.01	398.91	409.02	399.27	354.2	296.09	298.26	338.8	342.52	322.35	312.67	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	1725.46	1667.65	1503.26	1239.35	951.33	640.62	428.22	447.76	690.18	1049.18	1406.11	1709.35	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	1039.1	870	821.64	597.84	410.74	0	0	0	0	525.76	780.31	1039.13	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 6084.5 (98)

Space heating requirement in kWh/m²/year 151.13 (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		84	(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)													
	1039.1	870	821.64	597.84	410.74	0	0	0	0	525.76	780.31	1039.13	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	1237.03	1035.71	978.14	711.71	488.97	0	0	0	0	625.9	928.94	1237.06	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 7243.46 (211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] } x 100 ÷ (208)

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

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

Water heating

Output from water heater (calculated above)													
	156.35	136.57	142.09	126.03	122.02	107.47	102.96	114.78	116.05	132.14	141.06	152.67	
Efficiency of water heater												75	(216)
(217)m=	82.7	82.65	82.54	82.28	81.75	75	75	75	75	82.02	82.48	82.73	(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m													
(219)m=	189.05	165.23	172.15	153.17	149.25	143.29	137.28	153.04	154.73	161.1	171.01	184.55	

Total = Sum(219a)$_{1...12}$ = 1933.87 (219)

Annual totals	kWh/year	kWh/year
Space heating fuel used, main system 1		7243.46

Water heating fuel used		1933.87	
Electricity for pumps, fans and electric keep-hot			
central heating pump:	120		(230c)
boiler with a fan-assisted flue	45		(230e)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =	165	(231)
Electricity for lighting		297.73	(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	=	1564.59	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	417.72	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1982.3	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	85.64	(267)
Electricity for lighting	(232)	x	0.519	=	154.52	(268)
Total CO2, kg/year			sum of (265)…(271) =		2222.46	(272)
Dwelling CO2 Emission Rate			(272) ÷ (4) =		55.2	(273)
EI rating (section 14)					65	(274)

APPENDIX B DER WORKSHEET OF TYPICAL REFURBISHED UNIT

DER WorkSheet: New dwelling created by change of use

User Details:

Assessor Name: Panagiotis Dalapas
Stroma Number: STRO030082
Software Name: Stroma FSAP 2012
Software Version: Version: 1.0.4.14

Property Address: No 65-Plot 7-Proposed DG

Address : Plot 7, 65 Guilford Street, WC1N 1DD

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	40.26	(1a)	x	2.61	(2a)	=	105.08	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	40.26	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	105.08	(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							2	x 10 =	20	(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) =	20	÷ (5) =	0.19	(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		15	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.94	(18)

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

Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.73	(21)

Infiltration rate modified for monthly wind speed

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

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

0.93	0.91	0.89	0.8	0.78	0.69	0.69	0.67	0.73	0.78	0.82	0.86

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=	0.93	0.91	0.9	0.82	0.81	0.74	0.74	0.73	0.77	0.81	0.84	0.87	(24d)

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

(25)m=	0.93	0.91	0.9	0.82	0.81	0.74	0.74	0.73	0.77	0.81	0.84	0.87	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2	x	1	=	2			(26)
Windows Type 1			1.67	x1/[1/(1.6)+ 0.04]		=	2.51			(27)
Windows Type 2			2.51	x1/[1/(4.8)+ 0.04]		=	10.11			(27)
Walls Type1	25.13	7.52	17.61	x	0.3	=	5.28			(29)
Walls Type2	19.5	2	17.5	x	0.27	=	4.76			(29)
Total area of elements, m²			44.63							(31)

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

Fabric heat loss, W/K = S (A x U)	(26)…(30) + (32) =	29.69	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	315.99	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	Indicative Value: Low	100	(35)

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

Thermal bridges : S (L x Y) calculated using Appendix K		6.69	(36)

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

Total fabric heat loss	(33) + (36) =	36.38	(37)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m=	32.31	31.73	31.16	28.48	27.98	25.65	25.65	25.22	26.55	27.98	28.99	30.05	(38)

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

(39)m=	68.69	68.11	67.54	64.86	64.36	62.03	62.03	61.6	62.93	64.36	65.37	66.43	

Average = Sum(39)$_{1…12}$ /12= 64.86 (39)

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

(40)m=	1.71	1.69	1.68	1.61	1.6	1.54	1.54	1.53	1.56	1.6	1.62	1.65

Average = Sum(40)$_{1\ldots12}$ /12= 1.61 (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 1.41 (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 67.77 (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=	74.54	71.83	69.12	66.41	63.7	60.99	60.99	63.7	66.41	69.12	71.83	74.54

Total = Sum(44)$_{1\ldots12}$ = 813.18 (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=	110.54	96.68	99.77	86.98	83.46	72.02	66.74	76.58	77.49	90.31	98.58	107.05

Total = Sum(45)$_{1\ldots12}$ = 1066.21 (45)

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

(46)m=	16.58	14.5	14.97	13.05	12.52	10.8	10.01	11.49	11.62	13.55	14.79	16.06	(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)

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=	32.89	29.7	32.86	31.79	32.84	31.77	32.82	32.83	31.78	32.85	31.81	32.88	(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=	143.43	126.38	132.63	118.77	116.3	103.79	99.55	109.41	109.27	123.17	130.39	139.94	(62)

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

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

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

Output from water heater

(64)m=	143.43	126.38	132.63	118.77	116.3	103.79	99.55	109.41	109.27	123.17	130.39	139.94	

Output from water heater (annual)$_{1...12}$ 1453.03 (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=	44.98	39.57	41.39	36.87	35.96	31.89	30.39	33.67	33.71	38.24	40.73	43.82	(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=	70.66	70.66	70.66	70.66	70.66	70.66	70.66	70.66	70.66	70.66	70.66	70.66	(66)

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

(67)m=	11.41	10.13	8.24	6.24	4.66	3.94	4.25	5.53	7.42	9.42	11	11.72	(67)

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

(68)m=	122.19	123.46	120.26	113.46	104.87	96.8	91.41	90.14	93.34	100.14	108.73	116.8	(68)

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

(69)m=	30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	30.07	(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=	-56.53	-56.53	-56.53	-56.53	-56.53	-56.53	-56.53	-56.53	-56.53	-56.53	-56.53	-56.53	(71)

Water heating gains (Table 5)

(72)m=	60.45	58.88	55.63	51.21	48.33	44.29	40.85	45.26	46.82	51.4	56.57	58.89	(72)

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

(73)m=	241.25	239.67	231.33	218.1	205.07	192.23	183.72	188.13	194.78	208.16	223.49	234.61	(73)

6. Solar gains:

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

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
North	0.9x	0.54	x	2.51	x	10.63	x	0.85	x	0.7	=	7.72	(74)
North	0.9x	0.54	x	2.51	x	20.32	x	0.85	x	0.7	=	14.75	(74)
North	0.9x	0.54	x	2.51	x	34.53	x	0.85	x	0.7	=	25.06	(74)
North	0.9x	0.54	x	2.51	x	55.46	x	0.85	x	0.7	=	40.26	(74)
North	0.9x	0.54	x	2.51	x	74.72	x	0.85	x	0.7	=	54.23	(74)

DER WorkSheet: New dwelling created by change of use

North	0.9x	0.54	x	2.51	x	79.99	x	0.85	x	0.7	=	58.05	(74)
North	0.9x	0.54	x	2.51	x	74.68	x	0.85	x	0.7	=	54.2	(74)
North	0.9x	0.54	x	2.51	x	59.25	x	0.85	x	0.7	=	43	(74)
North	0.9x	0.54	x	2.51	x	41.52	x	0.85	x	0.7	=	30.13	(74)
North	0.9x	0.54	x	2.51	x	24.19	x	0.85	x	0.7	=	17.56	(74)
North	0.9x	0.54	x	2.51	x	13.12	x	0.85	x	0.7	=	9.52	(74)
North	0.9x	0.54	x	2.51	x	8.86	x	0.85	x	0.7	=	6.43	(74)
South	0.9x	0.54	x	1.67	x	46.75	x	0.63	x	0.7	=	50.2	(78)
South	0.9x	0.54	x	1.67	x	76.57	x	0.63	x	0.7	=	82.22	(78)
South	0.9x	0.54	x	1.67	x	97.53	x	0.63	x	0.7	=	104.73	(78)
South	0.9x	0.54	x	1.67	x	110.23	x	0.63	x	0.7	=	118.37	(78)
South	0.9x	0.54	x	1.67	x	114.87	x	0.63	x	0.7	=	123.35	(78)
South	0.9x	0.54	x	1.67	x	110.55	x	0.63	x	0.7	=	118.7	(78)
South	0.9x	0.54	x	1.67	x	108.01	x	0.63	x	0.7	=	115.98	(78)
South	0.9x	0.54	x	1.67	x	104.89	x	0.63	x	0.7	=	112.63	(78)
South	0.9x	0.54	x	1.67	x	101.89	x	0.63	x	0.7	=	109.4	(78)
South	0.9x	0.54	x	1.67	x	82.59	x	0.63	x	0.7	=	88.68	(78)
South	0.9x	0.54	x	1.67	x	55.42	x	0.63	x	0.7	=	59.51	(78)
South	0.9x	0.54	x	1.67	x	40.4	x	0.63	x	0.7	=	43.38	(78)

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

(83)m=	57.92	96.97	129.79	158.62	177.58	176.76	170.18	155.63	139.54	106.24	69.03	49.81	(83)

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

(84)m=	299.17	336.64	361.12	376.72	382.64	368.98	353.9	343.76	334.32	314.4	292.52	284.42	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.95	0.94	0.92	0.88	0.82	0.71	0.59	0.62	0.77	0.89	0.94	0.96	(86)

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

(87)m=	17.79	18.09	18.57	19.27	19.9	20.48	20.76	20.72	20.31	19.5	18.58	17.81	(87)

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

(88)m=	19.54	19.55	19.56	19.61	19.61	19.66	19.66	19.67	19.64	19.61	19.6	19.58	(88)

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

(89)m=	0.95	0.93	0.9	0.86	0.77	0.63	0.46	0.49	0.7	0.86	0.93	0.95	(89)

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

(90)m=	15.4	15.82	16.52	17.53	18.42	19.19	19.51	19.49	18.99	17.87	16.56	15.43	(90)

fLA = Living area ÷ (4) = 0.52 (91)

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

(92)m=	16.65	17	17.59	18.44	19.2	19.86	20.16	20.13	19.68	18.72	17.62	16.68	(92)

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

(93)m=	16.65	17	17.59	18.44	19.2	19.86	20.16	20.13	19.68	18.72	17.62	16.68	(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=	0.92	0.9	0.88	0.83	0.76	0.64	0.52	0.54	0.7	0.83	0.9	0.93		(94)
Useful gains, hmGm , W = (94)m x (84)m														
(95)m=	276.22	304.09	316.16	312.53	290.17	237.9	183.15	186.8	234.97	262.08	263.56	264.41		(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=	848.48	824.44	749.16	618.6	482.43	326.53	220.92	230.01	351.3	522.78	687.51	828.86		(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m														
(98)m=	425.76	349.67	322.15	220.37	143.05	0	0	0	0	193.96	305.25	419.95		
										Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ =			2380.16	(98)
Space heating requirement in kWh/m²/year													59.12	(99)

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

Space heating:

Fraction of space heat from secondary/supplementary system		0	(201)
Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)														
	425.76	349.67	322.15	220.37	143.05	0	0	0	0	193.96	305.25	419.95		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)														(211)
	455.36	373.98	344.54	235.69	152.99	0	0	0	0	207.45	326.47	449.14		
										Total (kWh/year) =Sum(211)$_{1...5,10....12}$=			2545.62	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208)														
(215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
										Total (kWh/year) =Sum(215)$_{1...5,10....12}$=			0	(215)

Water heating

Output from water heater (calculated above)														
	143.43	126.38	132.63	118.77	116.3	103.79	99.55	109.41	109.27	123.17	130.39	139.94		
Efficiency of water heater													86.6	(216)
(217)m=	89.48	89.43	89.33	89.09	88.71	86.6	86.6	86.6	86.6	88.94	89.3	89.49		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m														
(219)m=	160.28	141.31	148.48	133.31	131.1	119.85	114.96	126.34	126.18	138.48	146.02	156.37		
										Total = Sum(219a)$_{1...12}$ =			1642.68	(219)

Annual totals	**kWh/year**	**kWh/year**
Space heating fuel used, main system 1		2545.62

Water heating fuel used			1642.68	
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			201.44	(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	=	549.85	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	354.82	(264)
Space and water heating	(261) + (262) + (263) + (264) =				904.67	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	104.55	(268)
Total CO2, kg/year			sum of (265)…(271) =		1048.15	(272)
Dwelling CO2 Emission Rate			(272) ÷ (4) =		26.03	(273)
EI rating (section 14)					84	(274)

APPENDIX C TER WORKSHEET OF TYPICAL NEW-EXTENSION (BE LEAN)

TER WorkSheet: New dwelling as built

User Details:

Assessor Name:	Panagiotis Dalapas	**Stroma Number:**	STRO030082
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.14

Property Address: No 65-Plot 4-Proposed

Address : Plot 4, 65 Guilford Street, WC1N 1DD

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Ground floor	51.22	(1a) x	2.55	(2a) =	130.61	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	51.22	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	130.61	(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							2	x 10 =	20	(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) = 20 ÷ (5) = 0.15 (8)

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

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

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

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.4	(18)

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

Number of sides sheltered		4	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.28	(21)

Infiltration rate modified for monthly wind speed

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

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

0.36	0.35	0.35	0.31	0.3	0.27	0.27	0.26	0.28	0.3	0.32	0.33

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

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

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

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

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

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

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2	x	1	=	2			(26)
Windows Type 1			1.89	x1/[1/(1.4)+ 0.04]		=	2.51			(27)
Windows Type 2			0.92	x1/[1/(1.4)+ 0.04]		=	1.22			(27)
Windows Type 3			3.84	x1/[1/(1.4)+ 0.04]		=	5.09			(27)
Windows Type 4			1.23	x1/[1/(1.4)+ 0.04]		=	1.63			(27)
Walls Type1	80.78	9.88	70.9	x	0.18	=	12.76			(29)
Walls Type2	5.89	0	5.89	x	0.18	=	1.06			(29)
Roof	12.86	0	12.86	x	0.13	=	1.67			(30)
Total area of elements, m²			99.53							(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) = 27.94 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 4723.14 (34)

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 7.25 (36)

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

Total fabric heat loss (33) + (36) = 35.19 (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=	24.34	24.23	24.13	23.63	23.53	23.1	23.1	23.02	23.27	23.53	23.72	23.92	(38)

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

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

(40)m=	1.16	1.16	1.16	1.15	1.15	1.14	1.14	1.14	1.14	1.15	1.15	1.15

Average = Sum(40)$_{1…12}$ /12= 1.15 (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 1.73 (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 75.19 (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=	82.71	79.71	76.7	73.69	70.68	67.67	67.67	70.68	73.69	76.7	79.71	82.71	
									Total = Sum(44)$_{1…12}$ =			902.33	(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=	122.66	107.28	110.7	96.51	92.61	79.91	74.05	84.98	85.99	100.21	109.39	118.79	
									Total = Sum(45)$_{1…12}$ =			1183.09	(45)
If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)													
(46)m=	18.4	16.09	16.61	14.48	13.89	11.99	11.11	12.75	12.9	15.03	16.41	17.82	(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)

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=	42.15	36.69	39.08	36.34	36.02	33.37	34.49	36.02	36.34	39.08	39.31	42.15	(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=	164.81	143.97	149.79	132.85	128.63	113.29	108.54	120.99	122.33	139.3	148.7	160.94	(62)

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

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

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

Output from water heater

(64)m=	164.81	143.97	149.79	132.85	128.63	113.29	108.54	120.99	122.33	139.3	148.7	160.94	

Output from water heater (annual)$_{1\ldots12}$ 1634.13 (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=	51.32	44.84	46.58	41.18	39.8	34.91	33.24	37.26	37.68	43.09	46.2	50.04	(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=	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	(66)

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

(67)m=	14.77	13.12	10.67	8.08	6.04	5.1	5.51	7.16	9.61	12.2	14.24	15.18	(67)

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

(68)m=	150.4	151.96	148.03	139.66	129.09	119.15	112.52	110.96	114.89	123.26	133.83	143.77	(68)

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

(69)m=	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	(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=	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	(71)

Water heating gains (Table 5)

(72)m=	68.98	66.73	62.61	57.19	53.49	48.49	44.68	50.08	52.33	57.92	64.17	67.25	(72)

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

(73)m=	286.04	283.7	273.2	256.81	240.51	224.64	214.6	220.09	228.72	245.27	264.13	278.09	(73)

6. Solar gains:

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

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
East	0.9x	1	x	1.89	x	19.64	x	0.63	x	0.7	=	7.96	(76)
East	0.9x	1	x	0.92	x	19.64	x	0.63	x	0.7	=	3.87	(76)
East	0.9x	1	x	3.84	x	19.64	x	0.63	x	0.7	=	16.16	(76)
East	0.9x	1	x	1.23	x	19.64	x	0.63	x	0.7	=	5.18	(76)
East	0.9x	1	x	1.89	x	38.42	x	0.63	x	0.7	=	15.56	(76)

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East	0.9x	1	x	0.92	x	38.42	x	0.63	x	0.7	=	7.58	(76)
East	0.9x	1	x	3.84	x	38.42	x	0.63	x	0.7	=	31.62	(76)
East	0.9x	1	x	1.23	x	38.42	x	0.63	x	0.7	=	10.13	(76)
East	0.9x	1	x	1.89	x	63.27	x	0.63	x	0.7	=	25.63	(76)
East	0.9x	1	x	0.92	x	63.27	x	0.63	x	0.7	=	12.48	(76)
East	0.9x	1	x	3.84	x	63.27	x	0.63	x	0.7	=	52.07	(76)
East	0.9x	1	x	1.23	x	63.27	x	0.63	x	0.7	=	16.68	(76)
East	0.9x	1	x	1.89	x	92.28	x	0.63	x	0.7	=	37.38	(76)
East	0.9x	1	x	0.92	x	92.28	x	0.63	x	0.7	=	18.2	(76)
East	0.9x	1	x	3.84	x	92.28	x	0.63	x	0.7	=	75.95	(76)
East	0.9x	1	x	1.23	x	92.28	x	0.63	x	0.7	=	24.33	(76)
East	0.9x	1	x	1.89	x	113.09	x	0.63	x	0.7	=	45.81	(76)
East	0.9x	1	x	0.92	x	113.09	x	0.63	x	0.7	=	22.3	(76)
East	0.9x	1	x	3.84	x	113.09	x	0.63	x	0.7	=	93.08	(76)
East	0.9x	1	x	1.23	x	113.09	x	0.63	x	0.7	=	29.81	(76)
East	0.9x	1	x	1.89	x	115.77	x	0.63	x	0.7	=	46.9	(76)
East	0.9x	1	x	0.92	x	115.77	x	0.63	x	0.7	=	22.83	(76)
East	0.9x	1	x	3.84	x	115.77	x	0.63	x	0.7	=	95.28	(76)
East	0.9x	1	x	1.23	x	115.77	x	0.63	x	0.7	=	30.52	(76)
East	0.9x	1	x	1.89	x	110.22	x	0.63	x	0.7	=	44.65	(76)
East	0.9x	1	x	0.92	x	110.22	x	0.63	x	0.7	=	21.73	(76)
East	0.9x	1	x	3.84	x	110.22	x	0.63	x	0.7	=	90.71	(76)
East	0.9x	1	x	1.23	x	110.22	x	0.63	x	0.7	=	29.06	(76)
East	0.9x	1	x	1.89	x	94.68	x	0.63	x	0.7	=	38.35	(76)
East	0.9x	1	x	0.92	x	94.68	x	0.63	x	0.7	=	18.67	(76)
East	0.9x	1	x	3.84	x	94.68	x	0.63	x	0.7	=	77.92	(76)
East	0.9x	1	x	1.23	x	94.68	x	0.63	x	0.7	=	24.96	(76)
East	0.9x	1	x	1.89	x	73.59	x	0.63	x	0.7	=	29.81	(76)
East	0.9x	1	x	0.92	x	73.59	x	0.63	x	0.7	=	14.51	(76)
East	0.9x	1	x	3.84	x	73.59	x	0.63	x	0.7	=	60.56	(76)
East	0.9x	1	x	1.23	x	73.59	x	0.63	x	0.7	=	19.4	(76)
East	0.9x	1	x	1.89	x	45.59	x	0.63	x	0.7	=	18.47	(76)
East	0.9x	1	x	0.92	x	45.59	x	0.63	x	0.7	=	8.99	(76)
East	0.9x	1	x	3.84	x	45.59	x	0.63	x	0.7	=	37.52	(76)
East	0.9x	1	x	1.23	x	45.59	x	0.63	x	0.7	=	12.02	(76)
East	0.9x	1	x	1.89	x	24.49	x	0.63	x	0.7	=	9.92	(76)
East	0.9x	1	x	0.92	x	24.49	x	0.63	x	0.7	=	4.83	(76)
East	0.9x	1	x	3.84	x	24.49	x	0.63	x	0.7	=	20.15	(76)
East	0.9x	1	x	1.23	x	24.49	x	0.63	x	0.7	=	6.46	(76)
East	0.9x	1	x	1.89	x	16.15	x	0.63	x	0.7	=	6.54	(76)
East	0.9x	1	x	0.92	x	16.15	x	0.63	x	0.7	=	3.18	(76)

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East	0.9x	1	x	3.84	x	16.15	x	0.63	x	0.7	=	13.29	(76)
East	0.9x	1	x	1.23	x	16.15	x	0.63	x	0.7	=	4.26	(76)

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

(83)m=	33.17	64.89	106.86	155.85	191	195.52	186.15	159.9	124.28	77	41.36	27.28	(83)

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

(84)m=	319.21	348.59	380.06	412.66	431.51	420.16	400.75	379.98	353	322.27	305.49	305.37	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	1	0.99	0.97	0.92	0.78	0.61	0.66	0.89	0.98	1	1	(86)

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

(87)m=	19.76	19.88	20.11	20.43	20.72	20.92	20.98	20.97	20.83	20.46	20.06	19.74	(87)

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

(88)m=	19.95	19.95	19.95	19.96	19.96	19.97	19.97	19.97	19.97	19.96	19.96	19.96	(88)

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

(89)m=	1	0.99	0.99	0.96	0.88	0.69	0.48	0.54	0.82	0.97	0.99	1	(89)

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

(90)m=	18.31	18.48	18.82	19.28	19.68	19.91	19.96	19.96	19.83	19.33	18.74	18.27	(90)

fLA = Living area ÷ (4) = 0.46 (91)

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

(92)m=	18.97	19.12	19.41	19.8	20.16	20.37	20.43	20.42	20.29	19.84	19.34	18.94	(92)

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

(93)m=	18.97	19.12	19.41	19.8	20.16	20.37	20.43	20.42	20.29	19.84	19.34	18.94	(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	0.96	0.89	0.73	0.54	0.59	0.84	0.97	0.99	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	317.87	346.11	374.2	395.46	382.76	307.06	217.88	225.97	298.21	312.38	303.12	304.33	(95)
Monthly average external temperature from Table 8													
(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]													
(97)m=	873.44	845.19	765.83	641.38	496.54	336.42	223.11	234.1	361.61	542.83	721.18	871.5	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	413.34	335.38	291.38	177.06	84.65	0	0	0	0	171.46	301	421.97	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2196.25 (98)

Space heating requirement in kWh/m²/year 42.88 (99)

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

Space heating:

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

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Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		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)	413.34	335.38	291.38	177.06	84.65	0	0	0	0	171.46	301	421.97	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	442.55	359.08	311.97	189.57	90.64	0	0	0	0	183.57	322.27	451.79	(211)

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 2351.44 (211)

Space heating fuel (secondary), kWh/month

= {[(98)m x (201)] } x 100 ÷ (208)

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

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

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Output from water heater (calculated above)	164.81	143.97	149.79	132.85	128.63	113.29	108.54	120.99	122.33	139.3	148.7	160.94

Efficiency of water heater 80.3 (216)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(217)m=	87.27	87.11	86.7	85.78	84.03	80.3	80.3	80.3	80.3	85.58	86.79	87.37	(217)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(219)m=	188.85	165.27	172.77	154.89	153.08	141.08	135.17	150.68	152.34	162.78	171.33	184.21

Total = Sum(219a)$_{1...12}$ = 1932.45 (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			2351.44	
Water heating fuel used			1932.45	
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			260.84	(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	=	507.91	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	417.41	(264)
Space and water heating	(261) + (262) + (263) + (264) =				925.32	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	135.38	(268)

TER WorkSheet: New dwelling as built

Total CO2, kg/year	sum of (265)…(271) =	1099.62	(272)
TER =		21.47	(273)

APPENDIX D DER WORKSHEET OF TYPICAL NEW-EXTENSION (BE LEAN)

Target Fabric Energy Efficiency WorkSheet: New dwelling as built

User Details:

Assessor Name:	Panagiotis Dalapas	**Stroma Number:**	STRO030082
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.14

Property Address: No 65-Plot 4-Proposed

Address : Plot 4, 65 Guilford Street, WC1N 1DD

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	51.22	(1a)	x	2.55	(2a)	=	130.61	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	51.22	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	130.61	(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							2	x 10 =	20	(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) =	20	÷ (5) =	0.15	(8)

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.4	(18)
Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used			
Number of sides sheltered		4	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.7	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.28	(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

Target Fabric Energy Efficiency WorkSheet: New dwelling as built

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

0.36	0.35	0.35	0.31	0.3	0.27	0.27	0.26	0.28	0.3	0.32	0.33

Calculate effective air change rate for the applicable case

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

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

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

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

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

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

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

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

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

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2	x	1	=	2			(26)
Windows Type 1			1.89	x1/[1/(1.4)+ 0.04]		=	2.51			(27)
Windows Type 2			0.92	x1/[1/(1.4)+ 0.04]		=	1.22			(27)
Windows Type 3			3.84	x1/[1/(1.4)+ 0.04]		=	5.09			(27)
Windows Type 4			1.23	x1/[1/(1.4)+ 0.04]		=	1.63			(27)
Walls Type1	80.78	9.88	70.9	x	0.18	=	12.76			(29)
Walls Type2	5.89	0	5.89	x	0.18	=	1.06			(29)
Roof	12.86	0	12.86	x	0.13	=	1.67			(30)
Total area of elements, m²			99.53							(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) =	27.94	(33)
Heat capacity Cm = S(A x k)	((28)…(30) + (32) + (32a)…(32e) =	4723.14	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	Indicative Value: Medium	250	(35)

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

Thermal bridges : S (L x Y) calculated using Appendix K		7.25	(36)

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

Total fabric heat loss	(33) + (36) =	35.19	(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=	24.34	24.23	24.13	23.63	23.53	23.1	23.1	23.02	23.27	23.53	23.72	23.92	(38)

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

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

(40)m=	1.16	1.16	1.16	1.15	1.15	1.14	1.14	1.14	1.14	1.15	1.15	1.15	

Average = Sum(40)$_{1…12}$ /12= 1.15 (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 1.73 (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 75.19 (43)

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m=	82.71	79.71	76.7	73.69	70.68	67.67	67.67	70.68	73.69	76.7	79.71	82.71

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

Total = Sum(44)$_{1…12}$ = 902.33 (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=	122.66	107.28	110.7	96.51	92.61	79.91	74.05	84.98	85.99	100.21	109.39	118.79

Total = Sum(45)$_{1…12}$ = 1183.09 (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)

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=	104.26	91.19	94.1	82.04	78.72	67.93	62.94	72.23	73.09	85.18	92.98	100.97	(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=	104.26	91.19	94.1	82.04	78.72	67.93	62.94	72.23	73.09	85.18	92.98	100.97	

Output from water heater (annual)$_{1...12}$ 1005.63 (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=	26.07	22.8	23.52	20.51	19.68	16.98	15.74	18.06	18.27	21.3	23.25	25.24	(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=	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	(66)

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

(67)m=	14.77	13.12	10.67	8.08	6.04	5.1	5.51	7.16	9.61	12.2	14.24	15.18	(67)

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

(68)m=	150.4	151.96	148.03	139.66	129.09	119.15	112.52	110.96	114.89	123.26	133.83	143.77	(68)

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

(69)m=	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	(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=	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	(71)

Water heating gains (Table 5)

(72)m=	35.03	33.92	31.62	28.49	26.45	23.59	21.15	24.27	25.38	28.62	32.29	33.93	(72)

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

(73)m=	249.1	247.9	239.21	225.11	210.47	196.73	188.07	191.28	198.77	212.98	229.25	241.77	(73)

6. Solar gains:

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

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
East	0.9x	1	x	1.89	x	19.64	x	0.63	x	0.7	=	7.96	(76)
East	0.9x	1	x	0.92	x	19.64	x	0.63	x	0.7	=	3.87	(76)
East	0.9x	1	x	3.84	x	19.64	x	0.63	x	0.7	=	16.16	(76)
East	0.9x	1	x	1.23	x	19.64	x	0.63	x	0.7	=	5.18	(76)
East	0.9x	1	x	1.89	x	38.42	x	0.63	x	0.7	=	15.56	(76)

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East	0.9x	1	x	0.92	x	38.42	x	0.63	x	0.7	=	7.58	(76)
East	0.9x	1	x	3.84	x	38.42	x	0.63	x	0.7	=	31.62	(76)
East	0.9x	1	x	1.23	x	38.42	x	0.63	x	0.7	=	10.13	(76)
East	0.9x	1	x	1.89	x	63.27	x	0.63	x	0.7	=	25.63	(76)
East	0.9x	1	x	0.92	x	63.27	x	0.63	x	0.7	=	12.48	(76)
East	0.9x	1	x	3.84	x	63.27	x	0.63	x	0.7	=	52.07	(76)
East	0.9x	1	x	1.23	x	63.27	x	0.63	x	0.7	=	16.68	(76)
East	0.9x	1	x	1.89	x	92.28	x	0.63	x	0.7	=	37.38	(76)
East	0.9x	1	x	0.92	x	92.28	x	0.63	x	0.7	=	18.2	(76)
East	0.9x	1	x	3.84	x	92.28	x	0.63	x	0.7	=	75.95	(76)
East	0.9x	1	x	1.23	x	92.28	x	0.63	x	0.7	=	24.33	(76)
East	0.9x	1	x	1.89	x	113.09	x	0.63	x	0.7	=	45.81	(76)
East	0.9x	1	x	0.92	x	113.09	x	0.63	x	0.7	=	22.3	(76)
East	0.9x	1	x	3.84	x	113.09	x	0.63	x	0.7	=	93.08	(76)
East	0.9x	1	x	1.23	x	113.09	x	0.63	x	0.7	=	29.81	(76)
East	0.9x	1	x	1.89	x	115.77	x	0.63	x	0.7	=	46.9	(76)
East	0.9x	1	x	0.92	x	115.77	x	0.63	x	0.7	=	22.83	(76)
East	0.9x	1	x	3.84	x	115.77	x	0.63	x	0.7	=	95.28	(76)
East	0.9x	1	x	1.23	x	115.77	x	0.63	x	0.7	=	30.52	(76)
East	0.9x	1	x	1.89	x	110.22	x	0.63	x	0.7	=	44.65	(76)
East	0.9x	1	x	0.92	x	110.22	x	0.63	x	0.7	=	21.73	(76)
East	0.9x	1	x	3.84	x	110.22	x	0.63	x	0.7	=	90.71	(76)
East	0.9x	1	x	1.23	x	110.22	x	0.63	x	0.7	=	29.06	(76)
East	0.9x	1	x	1.89	x	94.68	x	0.63	x	0.7	=	38.35	(76)
East	0.9x	1	x	0.92	x	94.68	x	0.63	x	0.7	=	18.67	(76)
East	0.9x	1	x	3.84	x	94.68	x	0.63	x	0.7	=	77.92	(76)
East	0.9x	1	x	1.23	x	94.68	x	0.63	x	0.7	=	24.96	(76)
East	0.9x	1	x	1.89	x	73.59	x	0.63	x	0.7	=	29.81	(76)
East	0.9x	1	x	0.92	x	73.59	x	0.63	x	0.7	=	14.51	(76)
East	0.9x	1	x	3.84	x	73.59	x	0.63	x	0.7	=	60.56	(76)
East	0.9x	1	x	1.23	x	73.59	x	0.63	x	0.7	=	19.4	(76)
East	0.9x	1	x	1.89	x	45.59	x	0.63	x	0.7	=	18.47	(76)
East	0.9x	1	x	0.92	x	45.59	x	0.63	x	0.7	=	8.99	(76)
East	0.9x	1	x	3.84	x	45.59	x	0.63	x	0.7	=	37.52	(76)
East	0.9x	1	x	1.23	x	45.59	x	0.63	x	0.7	=	12.02	(76)
East	0.9x	1	x	1.89	x	24.49	x	0.63	x	0.7	=	9.92	(76)
East	0.9x	1	x	0.92	x	24.49	x	0.63	x	0.7	=	4.83	(76)
East	0.9x	1	x	3.84	x	24.49	x	0.63	x	0.7	=	20.15	(76)
East	0.9x	1	x	1.23	x	24.49	x	0.63	x	0.7	=	6.46	(76)
East	0.9x	1	x	1.89	x	16.15	x	0.63	x	0.7	=	6.54	(76)
East	0.9x	1	x	0.92	x	16.15	x	0.63	x	0.7	=	3.18	(76)

East	0.9x	1	x	3.84	x	16.15	x	0.63	x	0.7	=	13.29	(76)
East	0.9x	1	x	1.23	x	16.15	x	0.63	x	0.7	=	4.26	(76)

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

(83)m=	33.17	64.89	106.86	155.85	191	195.52	186.15	159.9	124.28	77	41.36	27.28	(83)

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

(84)m=	282.27	312.78	346.07	380.96	401.47	392.25	374.21	351.18	323.05	289.97	270.61	269.04	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	1	0.99	0.98	0.93	0.81	0.65	0.71	0.91	0.99	1	1	(86)

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

(87)m=	19.7	19.82	20.05	20.38	20.69	20.9	20.98	20.96	20.8	20.4	19.99	19.67	(87)

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

(88)m=	19.95	19.95	19.95	19.96	19.96	19.97	19.97	19.97	19.97	19.96	19.96	19.96	(88)

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

(89)m=	1	1	0.99	0.97	0.9	0.73	0.52	0.57	0.86	0.98	1	1	(89)

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

(90)m=	18.76	18.89	19.12	19.45	19.74	19.92	19.96	19.96	19.85	19.48	19.07	18.74	(90)

fLA = Living area ÷ (4) = 0.46 (91)

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

(92)m=	19.19	19.31	19.55	19.87	20.17	20.37	20.43	20.42	20.28	19.9	19.49	19.17	(92)

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

(93)m=	19.19	19.31	19.55	19.87	20.17	20.37	20.43	20.42	20.28	19.9	19.49	19.17	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	1	0.99	0.97	0.91	0.76	0.58	0.64	0.88	0.98	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	281.62	311.48	342.62	369.48	365.22	300.03	216.16	223.04	283.63	284.25	269.44	268.56	(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=	886.33	856.42	773.92	645.37	497.42	336.22	222.99	233.89	361.41	546.15	729.89	884.74	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	449.9	366.2	320.89	198.64	98.36	0	0	0	0	194.86	331.52	458.43	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2418.8 (98)

Space heating requirement in kWh/m^2/year 47.22 (99)

8c. Space cooling requirement

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

Target Fabric Energy Efficiency WorkSheet: New dwelling as built

	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	547.93	431.35	442.39	0	0	0	0	(100)
Utilisation factor for loss hm													
(101)m=	0	0	0	0	0	0.84	0.91	0.88	0	0	0	0	(101)
Useful loss, hmLm (Watts) = (100)m x (101)m													
(102)m=	0	0	0	0	0	458.17	390.72	389.15	0	0	0	0	(102)
Gains (solar gains calculated for applicable weather region, see Table 10)													
(103)m=	0	0	0	0	0	549.23	525.76	496.65	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	65.56	100.47	79.98	0	0	0	0	

Total = Sum(104)$_{6...8}$ = 246.01 (104)

Cooled fraction f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(106)m=	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(107)m=	0	0	0	0	0	16.39	25.12	19.99	0	0	0	0

Total = Sum(107)$_{6...8}$ = 61.5 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 1.2 (108)

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

Fabric Energy Efficiency (99) + (108) = 48.42 (109)

Target Fabric Energy Efficiency (TFEE) 55.69 (109)

APPENDIX E TFEE WORKSHEET OF TYPICAL NEW-EXTENSION

DER WorkSheet: New dwelling as built

User Details:

Assessor Name:	Panagiotis Dalapas	**Stroma Number:**	STRO030082
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.14

Property Address: No 65-Plot 4-Proposed

Address : Plot 4, 65 Guilford Street, WC1N 1DD

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	51.22	(1a)	x	2.55	(2a)	=	130.61	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	51.22	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	130.61	(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							2	x 10 =	20	(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) =	20	÷ (5) =	0.15	(8)

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

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

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

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		4	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.35	(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) =	0.25	(21)

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

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

Wind Factor (22a)m = (22)m ÷ 4

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

DER WorkSheet: New dwelling as built

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

0.32	0.31	0.3	0.27	0.27	0.23	0.23	0.23	0.25	0.27	0.28	0.29

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

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

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

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

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

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

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Doors			2	x	1	=	2			(26)
Windows Type 1			1.89	x	1/[1/(1.6)+ 0.04]	=	2.84			(27)
Windows Type 2			0.92	x	1/[1/(1.6)+ 0.04]	=	1.38			(27)
Windows Type 3			3.84	x	1/[1/(1.6)+ 0.04]	=	5.77			(27)
Windows Type 4			1.23	x	1/[1/(1.6)+ 0.04]	=	1.85			(27)
Walls Type1	80.78	9.88	70.9	x	0.18	=	12.76			(29)
Walls Type2	5.89	0	5.89	x	0.17	=	1.01			(29)
Roof	12.86	0	12.86	x	0.15	=	1.93			(30)
Total area of elements, m²			99.53							(31)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 29.55 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 4723.14 (34)

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 7.18 (36)

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

Total fabric heat loss (33) + (36) = 36.73 (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=	23.69	23.61	23.53	23.14	23.07	22.74	22.74	22.68	22.87	23.07	23.22	23.37	(38)

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

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

(40)m=	1.18	1.18	1.18	1.17	1.17	1.16	1.16	1.16	1.16	1.17	1.17	1.17

Average = Sum(40)$_{1…12}$ /12= 1.17 (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 1.73 (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 75.19 (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=	82.71	79.71	76.7	73.69	70.68	67.67	67.67	70.68	73.69	76.7	79.71	82.71

Total = Sum(44)$_{1…12}$ = 902.33 (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=	122.66	107.28	110.7	96.51	92.61	79.91	74.05	84.98	85.99	100.21	109.39	118.79

Total = Sum(45)$_{1…12}$ = 1183.09 (45)

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

(46)m=	18.4	16.09	16.61	14.48	13.89	11.99	11.11	12.75	12.9	15.03	16.41	17.82	(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)

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=	32.92	29.72	32.89	31.81	32.86	31.78	32.83	32.85	31.8	32.88	31.84	32.91	(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=	155.58	137	143.59	128.33	125.47	111.7	106.89	117.83	117.79	133.09	141.23	151.7	(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=	155.58	137	143.59	128.33	125.47	111.7	106.89	117.83	117.79	133.09	141.23	151.7	

Output from water heater (annual)$_{1…12}$ 1570.19 (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=	49.01	43.1	45.03	40.04	39.01	34.52	32.83	36.47	36.54	41.54	44.33	47.73	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	(66)

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

(67)m=	14.77	13.12	10.67	8.08	6.04	5.1	5.51	7.16	9.61	12.2	14.24	15.18	(67)

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

(68)m=	150.4	151.96	148.03	139.66	129.09	119.15	112.52	110.96	114.89	123.26	133.83	143.77	(68)

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

(69)m=	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	(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=	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	(71)

Water heating gains (Table 5)

(72)m=	65.88	64.14	60.53	55.62	52.43	47.94	44.13	49.01	50.75	55.83	61.57	64.15	(72)

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

(73)m=	282.94	281.11	271.12	255.24	239.45	224.08	214.04	219.02	227.14	243.19	261.54	274.99	(73)

6. Solar gains:

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

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
East	0.9x	1	x	1.89	x	19.64	x	0.63	x	0.7	=	7.96	(76)
East	0.9x	1	x	0.92	x	19.64	x	0.63	x	0.7	=	3.87	(76)
East	0.9x	1	x	3.84	x	19.64	x	0.63	x	0.7	=	16.16	(76)
East	0.9x	1	x	1.23	x	19.64	x	0.63	x	0.7	=	5.18	(76)
East	0.9x	1	x	1.89	x	38.42	x	0.63	x	0.7	=	15.56	(76)

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East	0.9x	1	x	0.92	x	38.42	x	0.63	x	0.7	=	7.58	(76)
East	0.9x	1	x	3.84	x	38.42	x	0.63	x	0.7	=	31.62	(76)
East	0.9x	1	x	1.23	x	38.42	x	0.63	x	0.7	=	10.13	(76)
East	0.9x	1	x	1.89	x	63.27	x	0.63	x	0.7	=	25.63	(76)
East	0.9x	1	x	0.92	x	63.27	x	0.63	x	0.7	=	12.48	(76)
East	0.9x	1	x	3.84	x	63.27	x	0.63	x	0.7	=	52.07	(76)
East	0.9x	1	x	1.23	x	63.27	x	0.63	x	0.7	=	16.68	(76)
East	0.9x	1	x	1.89	x	92.28	x	0.63	x	0.7	=	37.38	(76)
East	0.9x	1	x	0.92	x	92.28	x	0.63	x	0.7	=	18.2	(76)
East	0.9x	1	x	3.84	x	92.28	x	0.63	x	0.7	=	75.95	(76)
East	0.9x	1	x	1.23	x	92.28	x	0.63	x	0.7	=	24.33	(76)
East	0.9x	1	x	1.89	x	113.09	x	0.63	x	0.7	=	45.81	(76)
East	0.9x	1	x	0.92	x	113.09	x	0.63	x	0.7	=	22.3	(76)
East	0.9x	1	x	3.84	x	113.09	x	0.63	x	0.7	=	93.08	(76)
East	0.9x	1	x	1.23	x	113.09	x	0.63	x	0.7	=	29.81	(76)
East	0.9x	1	x	1.89	x	115.77	x	0.63	x	0.7	=	46.9	(76)
East	0.9x	1	x	0.92	x	115.77	x	0.63	x	0.7	=	22.83	(76)
East	0.9x	1	x	3.84	x	115.77	x	0.63	x	0.7	=	95.28	(76)
East	0.9x	1	x	1.23	x	115.77	x	0.63	x	0.7	=	30.52	(76)
East	0.9x	1	x	1.89	x	110.22	x	0.63	x	0.7	=	44.65	(76)
East	0.9x	1	x	0.92	x	110.22	x	0.63	x	0.7	=	21.73	(76)
East	0.9x	1	x	3.84	x	110.22	x	0.63	x	0.7	=	90.71	(76)
East	0.9x	1	x	1.23	x	110.22	x	0.63	x	0.7	=	29.06	(76)
East	0.9x	1	x	1.89	x	94.68	x	0.63	x	0.7	=	38.35	(76)
East	0.9x	1	x	0.92	x	94.68	x	0.63	x	0.7	=	18.67	(76)
East	0.9x	1	x	3.84	x	94.68	x	0.63	x	0.7	=	77.92	(76)
East	0.9x	1	x	1.23	x	94.68	x	0.63	x	0.7	=	24.96	(76)
East	0.9x	1	x	1.89	x	73.59	x	0.63	x	0.7	=	29.81	(76)
East	0.9x	1	x	0.92	x	73.59	x	0.63	x	0.7	=	14.51	(76)
East	0.9x	1	x	3.84	x	73.59	x	0.63	x	0.7	=	60.56	(76)
East	0.9x	1	x	1.23	x	73.59	x	0.63	x	0.7	=	19.4	(76)
East	0.9x	1	x	1.89	x	45.59	x	0.63	x	0.7	=	18.47	(76)
East	0.9x	1	x	0.92	x	45.59	x	0.63	x	0.7	=	8.99	(76)
East	0.9x	1	x	3.84	x	45.59	x	0.63	x	0.7	=	37.52	(76)
East	0.9x	1	x	1.23	x	45.59	x	0.63	x	0.7	=	12.02	(76)
East	0.9x	1	x	1.89	x	24.49	x	0.63	x	0.7	=	9.92	(76)
East	0.9x	1	x	0.92	x	24.49	x	0.63	x	0.7	=	4.83	(76)
East	0.9x	1	x	3.84	x	24.49	x	0.63	x	0.7	=	20.15	(76)
East	0.9x	1	x	1.23	x	24.49	x	0.63	x	0.7	=	6.46	(76)
East	0.9x	1	x	1.89	x	16.15	x	0.63	x	0.7	=	6.54	(76)
East	0.9x	1	x	0.92	x	16.15	x	0.63	x	0.7	=	3.18	(76)

East	0.9x	1	x	3.84	x	16.15	x	0.63	x	0.7	=	13.29	(76)
East	0.9x	1	x	1.23	x	16.15	x	0.63	x	0.7	=	4.26	(76)

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

(83)m=	33.17	64.89	106.86	155.85	191	195.52	186.15	159.9	124.28	77	41.36	27.28	(83)

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

(84)m=	316.11	346	377.98	411.09	430.45	419.61	400.19	378.92	351.43	320.18	302.89	302.26	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	1	0.99	0.97	0.92	0.79	0.62	0.68	0.89	0.98	1	1	(86)

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

(87)m=	19.74	19.86	20.09	20.41	20.71	20.91	20.98	20.97	20.82	20.44	20.03	19.71	(87)

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

(88)m=	19.94	19.94	19.94	19.94	19.95	19.95	19.95	19.95	19.95	19.95	19.94	19.94	(88)

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

(89)m=	1	0.99	0.99	0.96	0.88	0.7	0.49	0.54	0.83	0.97	0.99	1	(89)

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

(90)m=	18.25	18.43	18.77	19.23	19.64	19.89	19.94	19.94	19.8	19.28	18.69	18.22	(90)

fLA = Living area ÷ (4) = 0.46 (91)

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

(92)m=	18.93	19.08	19.37	19.77	20.13	20.35	20.42	20.41	20.26	19.81	19.3	18.9	(92)

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

(93)m=	18.93	19.08	19.37	19.77	20.13	20.35	20.42	20.41	20.26	19.81	19.3	18.9	(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

Utilisation factor for gains, hm:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(94)m=	1	0.99	0.99	0.96	0.89	0.74	0.55	0.6	0.85	0.97	0.99	1	(94)

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

(95)m=	314.83	343.62	372.32	394.51	383.4	309.82	220.92	228.86	298.94	310.74	300.64	301.27	(95)

Monthly average external temperature from Table 8

(96)m=	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)

Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m]

(97)m=	883.99	855.77	775.71	650.79	504.08	342.2	226.92	238.14	367.35	550.8	731.41	883.33	(97)

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

(98)m=	423.46	344.17	300.12	184.52	89.79	0	0	0	0	178.6	310.16	433.05	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2263.86 (98)

Space heating requirement in kWh/m²/year 44.2 (99)

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

Space heating:

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

DER WorkSheet: New dwelling as built

Fraction of space heat from main system(s)	(202) = 1 – (201) =	1	(202)
Fraction of total heating from main system 1	(204) = (202) × [1 – (203)] =	1	(204)
Efficiency of main space heating system 1		93.5	(206)
Efficiency of secondary/supplementary heating system, %		0	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Space heating requirement (calculated above)	423.46	344.17	300.12	184.52	89.79	0	0	0	0	178.6	310.16	433.05		
(211)m = {[(98)m x (204)] } x 100 ÷ (206)	452.9	368.09	320.99	197.35	96.03	0	0	0	0	191.02	331.72	463.15		(211)
Total (kWh/year) =Sum(211)$_{1...5,10....12}$=													2421.24	(211)
Space heating fuel (secondary), kWh/month = {[(98)m x (201)] } x 100 ÷ (208) (215)m=	0	0	0	0	0	0	0	0	0	0	0	0		
Total (kWh/year) =Sum(215)$_{1...5,10....12}$=													0	(215)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	kWh/year	
Output from water heater (calculated above)	155.58	137	143.59	128.33	125.47	111.7	106.89	117.83	117.79	133.09	141.23	151.7		
Efficiency of water heater													86.6	(216)
(217)m=	89.42	89.35	89.2	88.86	88.19	86.6	86.6	86.6	86.6	88.79	89.24	89.45		(217)
Fuel for water heating, kWh/month (219)m = (64)m x 100 ÷ (217)m (219)m=	173.99	153.32	160.98	144.42	142.28	128.98	123.42	136.06	136.02	149.89	158.25	169.59		
Total = Sum(219a)$_{1...12}$ =													1777.19	(219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			2421.24	
Water heating fuel used			1777.19	
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			260.84	(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	=	522.99	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	383.87	(264)
Space and water heating	(261) + (262) + (263) + (264) =				906.86	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	38.93	(267)
Electricity for lighting	(232)	x	0.519	=	135.38	(268)

DER WorkSheet: New dwelling as built

Total CO2, kg/year	sum of (265)…(271) =	1081.16	(272)
Dwelling CO2 Emission Rate	(272) ÷ (4) =	21.11	(273)
EI rating (section 14)		85	(274)

APPENDIX F DFEE WORKSHEET OF TYPICAL NEW-EXTENSION

Dwelling Fabric Energy Efficiency WorkSheet: New dwelling as built

User Details:

Assessor Name:	Panagiotis Dalapas	**Stroma Number:**	STRO030082
Software Name:	Stroma FSAP 2012	**Software Version:**	Version: 1.0.4.14

Property Address: No 65-Plot 4-Proposed

Address : Plot 4, 65 Guilford Street, WC1N 1DD

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Ground floor	51.22	(1a)	x	2.55	(2a)	=	130.61	(3a)

Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) 51.22 (4)

Dwelling volume (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) = 130.61 (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							2	x 10 =	20	(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) = 20 ÷ (5) = 0.15 (8)

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

Number of storeys in the dwelling (ns) 0 (9)

Additional infiltration [(9)-1]x0.1 = 0 (10)

Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction 0 (11)

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

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 0 (12)

If no draught lobby, enter 0.05, else enter 0 0 (13)

Percentage of windows and doors draught stripped 0 (14)

Window infiltration 0.25 - [0.2 x (14) ÷ 100] = 0 (15)

Infiltration rate (8) + (10) + (11) + (12) + (13) + (15) = 0 (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area 4 (17)

If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) 0.35 (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) = 0.25 (21)

Infiltration rate modified for monthly wind speed

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

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

0.32	0.31	0.3	0.27	0.27	0.23	0.23	0.23	0.25	0.27	0.28	0.29

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0 (23a)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m^2)	Openings m^2	Net Area A ,m^2		U-value W/m2K		A X U (W/K)	k-value kJ/m^2·K	A X k kJ/K	
Doors			2	x	1	=	2			(26)
Windows Type 1			1.89	x1/[1/(1.6)+ 0.04]		=	2.84			(27)
Windows Type 2			0.92	x1/[1/(1.6)+ 0.04]		=	1.38			(27)
Windows Type 3			3.84	x1/[1/(1.6)+ 0.04]		=	5.77			(27)
Windows Type 4			1.23	x1/[1/(1.6)+ 0.04]		=	1.85			(27)
Walls Type1	80.78	9.88	70.9	x	0.18	=	12.76			(29)
Walls Type2	5.89	0	5.89	x	0.17	=	1.01			(29)
Roof	12.86	0	12.86	x	0.15	=	1.93			(30)
Total area of elements, m^2			99.53							(31)

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

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

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 29.55 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 4723.14 (34)

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 7.18 (36)

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

Total fabric heat loss (33) + (36) = 36.73 (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=	23.69	23.61	23.53	23.14	23.07	22.74	22.74	22.68	22.87	23.07	23.22	23.37	(38)

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

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

(40)m=	1.18	1.18	1.18	1.17	1.17	1.16	1.16	1.16	1.16	1.17	1.17	1.17	
											Average = Sum(40)$_{1…12}$ /12=	1.17	(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 1.73 (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 75.19 (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=	82.71	79.71	76.7	73.69	70.68	67.67	67.67	70.68	73.69	76.7	79.71	82.71		
											Total = Sum(44)$_{1…12}$ =		902.33	(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=	122.66	107.28	110.7	96.51	92.61	79.91	74.05	84.98	85.99	100.21	109.39	118.79		
											Total = Sum(45)$_{1…12}$ =		1183.09	(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)

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=	104.26	91.19	94.1	82.04	78.72	67.93	62.94	72.23	73.09	85.18	92.98	100.97	(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=	104.26	91.19	94.1	82.04	78.72	67.93	62.94	72.23	73.09	85.18	92.98	100.97	

Output from water heater (annual)$_{1…12}$ 1005.63 (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=	26.07	22.8	23.52	20.51	19.68	16.98	15.74	18.06	18.27	21.3	23.25	25.24	(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=	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	86.3	(66)

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

(67)m=	14.77	13.12	10.67	8.08	6.04	5.1	5.51	7.16	9.61	12.2	14.24	15.18	(67)

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

(68)m=	150.4	151.96	148.03	139.66	129.09	119.15	112.52	110.96	114.89	123.26	133.83	143.77	(68)

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

(69)m=	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	31.63	(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=	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	-69.04	(71)

Water heating gains (Table 5)

(72)m=	35.03	33.92	31.62	28.49	26.45	23.59	21.15	24.27	25.38	28.62	32.29	33.93	(72)

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

(73)m=	249.1	247.9	239.21	225.11	210.47	196.73	188.07	191.28	198.77	212.98	229.25	241.77	(73)

6. Solar gains:

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

Orientation:		Access Factor Table 6d		Area m²		Flux Table 6a		g_ Table 6b		FF Table 6c		Gains (W)	
East	0.9x	1	x	1.89	x	19.64	x	0.63	x	0.7	=	7.96	(76)
East	0.9x	1	x	0.92	x	19.64	x	0.63	x	0.7	=	3.87	(76)
East	0.9x	1	x	3.84	x	19.64	x	0.63	x	0.7	=	16.16	(76)
East	0.9x	1	x	1.23	x	19.64	x	0.63	x	0.7	=	5.18	(76)
East	0.9x	1	x	1.89	x	38.42	x	0.63	x	0.7	=	15.56	(76)

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East	0.9x	1	x	0.92	x	38.42	x	0.63	x	0.7	=	7.58	(76)
East	0.9x	1	x	3.84	x	38.42	x	0.63	x	0.7	=	31.62	(76)
East	0.9x	1	x	1.23	x	38.42	x	0.63	x	0.7	=	10.13	(76)
East	0.9x	1	x	1.89	x	63.27	x	0.63	x	0.7	=	25.63	(76)
East	0.9x	1	x	0.92	x	63.27	x	0.63	x	0.7	=	12.48	(76)
East	0.9x	1	x	3.84	x	63.27	x	0.63	x	0.7	=	52.07	(76)
East	0.9x	1	x	1.23	x	63.27	x	0.63	x	0.7	=	16.68	(76)
East	0.9x	1	x	1.89	x	92.28	x	0.63	x	0.7	=	37.38	(76)
East	0.9x	1	x	0.92	x	92.28	x	0.63	x	0.7	=	18.2	(76)
East	0.9x	1	x	3.84	x	92.28	x	0.63	x	0.7	=	75.95	(76)
East	0.9x	1	x	1.23	x	92.28	x	0.63	x	0.7	=	24.33	(76)
East	0.9x	1	x	1.89	x	113.09	x	0.63	x	0.7	=	45.81	(76)
East	0.9x	1	x	0.92	x	113.09	x	0.63	x	0.7	=	22.3	(76)
East	0.9x	1	x	3.84	x	113.09	x	0.63	x	0.7	=	93.08	(76)
East	0.9x	1	x	1.23	x	113.09	x	0.63	x	0.7	=	29.81	(76)
East	0.9x	1	x	1.89	x	115.77	x	0.63	x	0.7	=	46.9	(76)
East	0.9x	1	x	0.92	x	115.77	x	0.63	x	0.7	=	22.83	(76)
East	0.9x	1	x	3.84	x	115.77	x	0.63	x	0.7	=	95.28	(76)
East	0.9x	1	x	1.23	x	115.77	x	0.63	x	0.7	=	30.52	(76)
East	0.9x	1	x	1.89	x	110.22	x	0.63	x	0.7	=	44.65	(76)
East	0.9x	1	x	0.92	x	110.22	x	0.63	x	0.7	=	21.73	(76)
East	0.9x	1	x	3.84	x	110.22	x	0.63	x	0.7	=	90.71	(76)
East	0.9x	1	x	1.23	x	110.22	x	0.63	x	0.7	=	29.06	(76)
East	0.9x	1	x	1.89	x	94.68	x	0.63	x	0.7	=	38.35	(76)
East	0.9x	1	x	0.92	x	94.68	x	0.63	x	0.7	=	18.67	(76)
East	0.9x	1	x	3.84	x	94.68	x	0.63	x	0.7	=	77.92	(76)
East	0.9x	1	x	1.23	x	94.68	x	0.63	x	0.7	=	24.96	(76)
East	0.9x	1	x	1.89	x	73.59	x	0.63	x	0.7	=	29.81	(76)
East	0.9x	1	x	0.92	x	73.59	x	0.63	x	0.7	=	14.51	(76)
East	0.9x	1	x	3.84	x	73.59	x	0.63	x	0.7	=	60.56	(76)
East	0.9x	1	x	1.23	x	73.59	x	0.63	x	0.7	=	19.4	(76)
East	0.9x	1	x	1.89	x	45.59	x	0.63	x	0.7	=	18.47	(76)
East	0.9x	1	x	0.92	x	45.59	x	0.63	x	0.7	=	8.99	(76)
East	0.9x	1	x	3.84	x	45.59	x	0.63	x	0.7	=	37.52	(76)
East	0.9x	1	x	1.23	x	45.59	x	0.63	x	0.7	=	12.02	(76)
East	0.9x	1	x	1.89	x	24.49	x	0.63	x	0.7	=	9.92	(76)
East	0.9x	1	x	0.92	x	24.49	x	0.63	x	0.7	=	4.83	(76)
East	0.9x	1	x	3.84	x	24.49	x	0.63	x	0.7	=	20.15	(76)
East	0.9x	1	x	1.23	x	24.49	x	0.63	x	0.7	=	6.46	(76)
East	0.9x	1	x	1.89	x	16.15	x	0.63	x	0.7	=	6.54	(76)
East	0.9x	1	x	0.92	x	16.15	x	0.63	x	0.7	=	3.18	(76)

East	0.9x	1	x	3.84	x	16.15	x	0.63	x	0.7	=	13.29	(76)
East	0.9x	1	x	1.23	x	16.15	x	0.63	x	0.7	=	4.26	(76)

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

(83)m=	33.17	64.89	106.86	155.85	191	195.52	186.15	159.9	124.28	77	41.36	27.28	(83)

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

(84)m=	282.27	312.78	346.07	380.96	401.47	392.25	374.21	351.18	323.05	289.97	270.61	269.04	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	1	1	0.99	0.98	0.94	0.82	0.66	0.71	0.92	0.99	1	1	(86)

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

(87)m=	19.67	19.8	20.03	20.36	20.67	20.89	20.97	20.96	20.79	20.39	19.97	19.65	(87)

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

(88)m=	19.94	19.94	19.94	19.94	19.95	19.95	19.95	19.95	19.95	19.95	19.94	19.94	(88)

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

(89)m=	1	1	0.99	0.97	0.91	0.74	0.52	0.58	0.86	0.98	1	1	(89)

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

(90)m=	18.73	18.85	19.09	19.41	19.71	19.9	19.94	19.94	19.82	19.44	19.03	18.7	(90)

fLA = Living area ÷ (4) = 0.46 (91)

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

(92)m=	19.16	19.28	19.52	19.84	20.15	20.35	20.41	20.41	20.26	19.87	19.46	19.14	(92)

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

(93)m=	19.16	19.28	19.52	19.84	20.15	20.35	20.41	20.41	20.26	19.87	19.46	19.14	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	1	1	0.99	0.97	0.91	0.77	0.59	0.64	0.88	0.98	1	1	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	281.62	311.47	342.64	369.7	366.17	302.53	219.05	225.76	284.72	284.33	269.44	268.56	(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=	897.82	867.84	784.49	655.29	505.2	342.03	226.79	237.93	367.31	554.65	740.91	897.57	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	458.46	373.88	328.74	205.63	103.43	0	0	0	0	201.12	339.46	467.99	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 2478.7 (98)

Space heating requirement in kWh/m²/year 48.39 (99)

8c. Space cooling requirement

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

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	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	559	440.07	451.49	0	0	0	0	(100)

Utilisation factor for loss hm

(101)m=	0	0	0	0	0	0.83	0.9	0.87	0	0	0	0	(101)

Useful loss, hmLm (Watts) = (100)m x (101)m

(102)m=	0	0	0	0	0	461.49	395.01	392.87	0	0	0	0	(102)

Gains (solar gains calculated for applicable weather region, see Table 10)

(103)m=	0	0	0	0	0	549.23	525.76	496.65	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	63.18	97.28	77.21	0	0	0	0

Total = Sum(104)$_{6..8}$ = 237.67 (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)

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

(107)m=	0	0	0	0	0	15.79	24.32	19.3	0	0	0	0

Total = Sum(107)$_{6..8}$ = 59.42 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 1.16 (108)

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

Fabric Energy Efficiency (99) + (108) = 49.55 (109)