MECSERVE

Energy & Sustainability Statement

for

Charities Aid Foundation

The Firs, Church Grove
London Borough of Richmond Upon Thames
Hampton Wick
KT1 4AL

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ISSUE

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1.0	15.12.2016	Draft report for comments	A Kazantzis/ P Dalapas	N Dabidian	
2.0	02.03.2017	Final issue	A Kazantzis/ P Dalapas	N Dabidian	Design team comments have been addressed

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EXECUTIVE SUMMARY

Mecserve Ltd has been appointed by Charities Aid Foundation to prepare an Energy and Sustainability Statement to support the planning application for the proposed scheme at The Firs, Church Grove in the London Borough of Richmond Upon Thames. Building works on the site include demolition of existing building and erection of a five-storey block comprising nine residential units.

This Energy Statement, prepared in line with the Greater London Authority guidance on preparing energy assessments (March 2016), outlines the key features and strategies adopted by the development team to enhance the energy and sustainability performance of the proposed redevelopment of The Firs, Church Grove. The scheme complies with all relevant policies in regards to Energy and Sustainability set by London Borough of Richmond upon Thames' Development Management Plan. Sections 2 and 3 review these policies and demonstrate how design meets planning targets and requirements in terms of energy and carbon emissions.

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

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

The following passive and active energy efficiency features have been considered in the proposed strategy for The Firs, Church Grove:

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

The following Low/Zero Carbon Technologies proposed for the Firs, Church Grove scheme will generate renewable energy on site:

- Photovoltaic panels installed on the roof will provide electricity to the new flats.

Following the proposed energy strategy, the new flats achieve significant carbon savings that exceed the 35% reduction target over 2013 TER in CO2 emissions set by Richmond Upon Thames Council. The Sustainable Construction Checklist, provided by Richmond Council, has been also completed, showing that the scheme can achieve a B rating i.e. helps to significantly improve the Borough's stock of sustainable developments.

Table 1 demonstrates the overall reduction in the regulated and unregulated carbon emission of the development after each stage of the London Plan Energy Hierarchy. The total non-regulated carbon dioxide emission of the development according to BRE is around 10.51 tonnes per year. 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 consumption.

Table 1 Total CO_2 emissions reduction for the development

		Carbon dioxide emissions (Tonnes CO_2 per annum)	
		Regulated	Unregulated
Baseline Emissions		10.13	10.51
Be Lean	After energy demand reduction	9.50	9.46
Be Clean	After CHP	9.50	9.46
Be Green	After renewable energy	6.48	9.46

Table 2 demonstrates the total regulated CO_2 savings from each stage of the Energy Hierarchy. As demonstrated below, an overall 36% reduction in carbon emissions can be achieved over Part L 2013 TER when applying the proposed strategy, which exceeds the 35% reduction required by Richmond Upon Thames Council.

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

	Regulated carbon dioxide savings	
	(Tonnes CO2 per annum)	(%)
Savings from energy demand reduction	0.63	6.2
Savings from CHP	0.0	0.00
Savings from renewable energy	3.02	31.8
Total Cumulative Savings	**3.65**	**36.0**
Total Target Savings	**3.55**	**20.0**
Annual Surplus	**0.10**	

Figure 1 below illustrates the total carbon savings achieved at each stage of the London Plan Energy Hierarchy for The Firs, Church Grove. Overall, the scheme exceeds the carbon reduction required by Richmond Upon Thames Council.

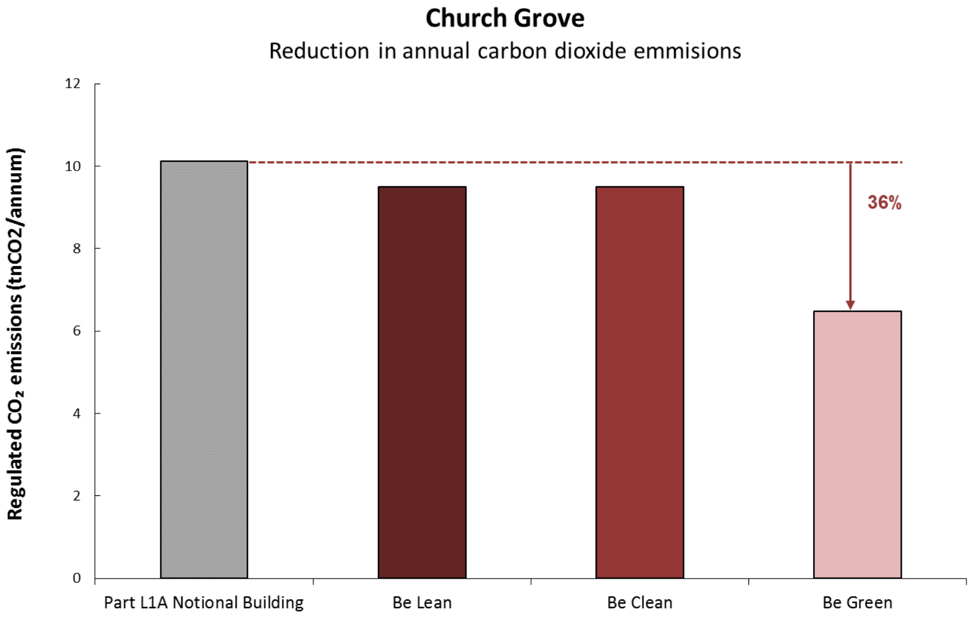

Figure 1 Total carbon savings achieved over Baseline Emissions

1. INTRODUCTION

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

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

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

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

1.1 PROPOSED DEVELOPMENT

The proposed development is located at The Firs, Church Grove in the London Borough of Richmond Upon Thames. The development proposed is the demolition of the existing property and redevelopment of the site to provide a four-storey (plus basement storey) detached property comprising nine self-contained residential units (3 x 2-bedroom and 6 x 1-bedroom); the proposals also include hard and soft landscaping, new boundary treatment, secured cycle storage for 9 units, covered bin and recycling store, car waiting area and car parking for 9 units on basement level.

For a detailed description of the proposed design, please refer to the Design and Access Statement prepared by Flower Michelin 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

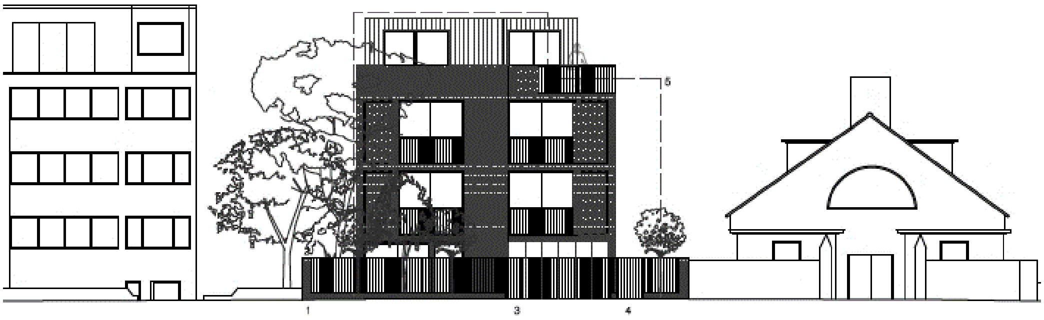

Figure 3 Proposed scheme – The Firs, Church Grove Road view

2. OVERVIEW OF ENVIRONMENTAL STANDARDS, TARGETS AND POLICIES

2.1 NATIONAL POLICIES

ENERGY WHITE PAPER

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

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

CLIMATE CHANGE ACT 2008

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

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

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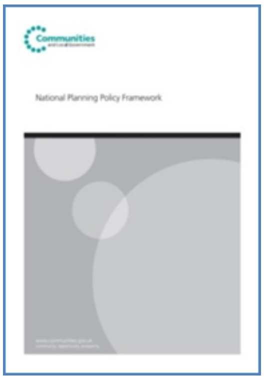
[2] Dti, (2003); Energy White Paper Our Energy Future - Creating a Low Carbon Economy. TSO.
[3] OPSI, (2008); Climate Change Act. HMSO.

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 (INCLUDING FURTHER ALTERATIONS MARCH 2015)

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

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


CHAPTER FIVE
LONDON'S RESPONSE TO CLIMATE CHANGE


SUSTAINABLE DESIGN AND CONSTRUCTION
SUPPLEMENTARY PLANNING GUIDANCE
MAYOR OF LONDON

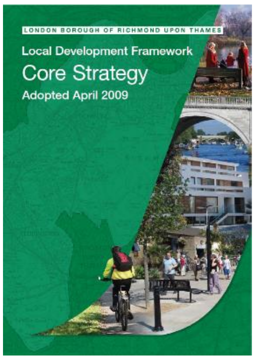
Supplementary Planning Guidance, Sustainable Design and Construction (April 2014) provides framework for implementing the London policies.

2.3 LOCAL POLICIES

LONDON BOROUGH OF RICHMOND UPON THAMES CORE STRATEGY (ADOPTED APRIL 2009)

The Core Strategy, adopted in April 2009, contains strategic policies to guide the future development of the Borough. It sets out the Strategic Planning Framework for the Borough for the next 15 years taking account of others plans and strategies and is the delivery mechanism for the spatial element of the Community Plan.

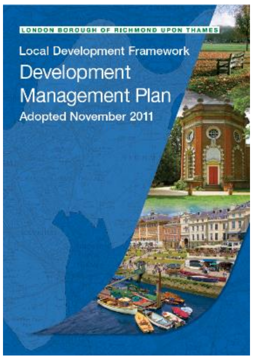
The following is the review of the London Plan and the Local Plan polices for Climate Change mitigation and Climate Change Adaptation followed by measures implemented in the proposed development to meet the applicable policy requirements.



LONDON BOROUGH OF RICHMOND UPON THAMES
Local Development Framework
Core Strategy
Adopted April 2009

3. CLIMATE CHANGE MITIGATION AND ADAPTATION STRATEGY

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



LONDON BOROUGH OF RICHMOND UPON THAMES
Local Development Framework
Development Management Plan
Adopted November 2011

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.

The Development Management Plan (DMP) (adopted November 2011) of London Borough of Richmond Upon Thames takes forward the strategic objectives in the Core Strategy and is consistent with it and with National Regional Policies.

This document contains policies which take account of environmental issues such as:

- 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 Richmond Upon Thames local policies relate to Climate Change Mitigation, in the context of this proposed development.

LONDON PLAN 2016 CLIMATE CHANGE MITIGATION POLICIES

- 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;

LONDON BOROUGH OF RICHMOND UPON THAMES CORE STRATEGY 2009 AND DEVELOPMENT MANAGEMENT PLAN 2011 CLIMATE CHANGE MITIGATION POLICIES

- Policy CP1 Sustainable Development
- Policy CP2 Reducing Carbon Emissions
- Policy DM SD 1 Sustainable Construction
- Policy DM SD 2 Renewable Energy and Decentralised Energy Networks

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

3.2 CLIMATE CHANGE MITIGATION – REVIEW AND MEASURES IMPLEMENTED

Policy 5.2 Minimising Carbon Dioxide Emissions

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

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

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

The proposed scheme, comprising 9 new built dwellings, is not classified as a major development according to London Plan. Therefore, Policy 5.2 is not applicable to the proposed development. The energy strategy proposed, however, follows the London Plan Energy Hierarchy and this report is written in line with GLA guidance on reporting energy assessments.

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

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

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 of 36% over 2013 TER. This exceeds the reduction target set by Richmond Council.

Policy 5.3 Sustainable Design and Construction

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

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

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

A Sustainable Construction Checklist has been completed for the scheme as required by the Richmond Council showing that a B rating can be achieved. The checklist goes through all the sustainability features integrated in the design to enhance the performance of the development and minimise its environmental impact.

Passive design measures such as enhanced thermal performance of well insulated thermal elements and use of Accredited Construction Details as well as condensing boilers of high efficiency and Mechanical Ventilation with Heat Recovery (MVHR) will help reduce heating demand first and then energy consumption. Low water use fittings will be installed to minimise water consumption on site targeting a daily consumption less than 110 litres/person/day. The new dwellings will rely mainly on natural cross ventilation through openable windows to remove excessive solar gains and eliminate the risk of overheating. When needed, extra supply air can be provided through the MVHR units, bypassing heat recovery when not needed. Materials of low environmental impact, which will be responsibly resourced, will be also specified for the scheme. More information can be found on the Design and Access Statement prepared by Flower Michelin Architects.

Policy 5.6 Decentralised Energy in Development Proposals

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

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

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

- Communal heating and cooling.

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

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

According to the London Heat Map (Figure 4), there is no district heating system currently available in close proximity to the site and there is no potential for a future network to become available in the future. The development, comprising 9 No. residential units, have constant heating demand throughout the year, mainly for hot water. However, due to the small number of units, even if a network was available, the cost of connecting to this one would be significantly high and therefore such a connection would not be considered financially viable.

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

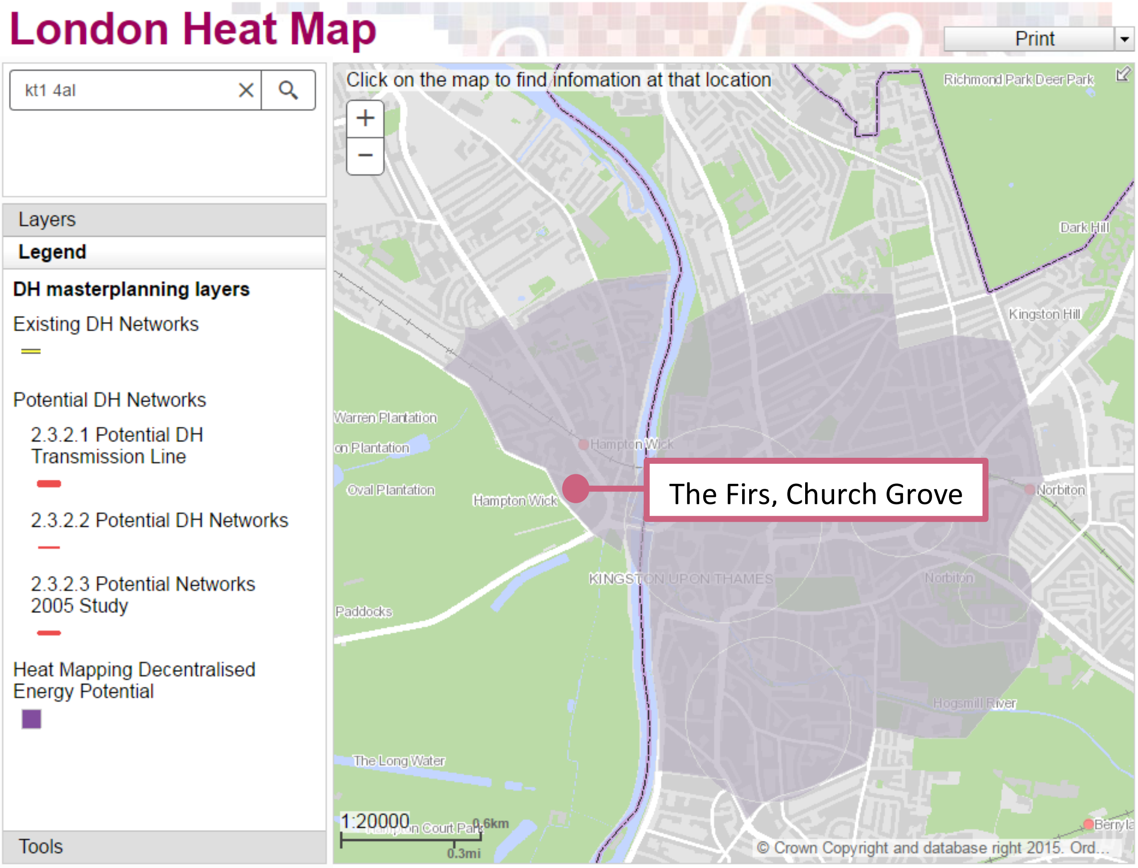


Figure 4 Image of London Heat Map (www.londonheatmap.org.uk)

Given the scale of the proposed scheme, consisting of 9 new flats, installation of Combined Heat and Power (CHP) is not considered to be feasible, as there is not high heating and hot water demand to enable the CHP unit to run continuously for long period thus ensuring maximum carbon and cost savings. As per GLA guidance on energy assessments, a higher number of residential units is required to justify installation of a CHP unit.

Policy 5.7 Renewable Energy

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

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

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

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

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

The roofscape has been designed to balance the impact of the development on the neighbourhood, provide space for exploit opportunities for the enhancement of biodiversity and provide space for photovoltaic panels.

The design team, after carefully reviewing the roofscape, has provided a zone for 23 No. of 333Wp photovoltaic panels. These will have a peak electricity generation capacity of approximately 7.66 kWp. The renewable energy generated by these panels will be connected into the development's electrical distribution system.

The scheme achieves a 31.8% reduction in its annual carbon emissions due to the use of renewable energy technologies installed on site. The proposed technologies will have no impact on local biodiversity or air quality and won't be visible from street level.

Policy CP1 Sustainable Development

1.A The policy seeks to maximise the effective use of resources including land, water and energy, and assist in reducing any long term adverse environmental impacts of development. Development will be required to conform to the Sustainable Construction checklist, including the requirement to meet the Code for Sustainable Homes level 3 (for new homes), Ecohomes "excellent" (for conversions) or BREEAM "excellent" (for other types of development). This requirement will be adjusted in future years through subsequent DPDs, to take into account the then prevailing standards in the Code for Sustainable Homes and any other National Guidance, and ensure that these standards are met or exceeded.

The following principles will be promoted:

1.B Appropriate location of land uses

Facilities and services should be provided at the appropriate level locally, taking account of the network of town centres identified in policy CP8.

Higher density residential and mixed use developments to be in town centres, near to public transport to reduce the need to travel by car.

1.C Making best use of land

The use of existing and proposed new facilities should be maximised through management initiatives, such as co-location or dual use.

Redevelopment of sites should normally only take place where there can be an increase in the number of housing units and/or quantity of commercial floorspace.

1.D Reducing environmental impact

The environmental benefits of retaining and, where appropriate, refurbishing existing buildings, should be compared against redevelopment.

Development should seek to minimise the use of open land for development and seek to maintain the natural vegetation, especially trees, where possible.

Local environmental impacts of development with respect to factors such as noise, air quality and contamination should be minimised.

1.E Environmental gain to compensate for any environmental cost of development will be sought.

Policy DM SD 1 Sustainable Construction

All development in terms of materials, design, landscaping, standard of construction and operation should include measures capable of mitigating and adapting to climate change to meet future needs.

New buildings should be flexible to respond to future social, technological and economic needs by conforming to the Borough's Sustainable Construction Checklist SPD.

New homes will be required to meet or exceed requirements of the Code for Sustainable Homes Level 3.

They also must achieve a minimum 25 per cent reduction in carbon dioxide emissions over Building Regulations (2010) in line with best practice from 2010 to 2013, 40 per cent improvement from 2013 to 2016, and 'zero carbon' standards (2) from 2016. It is expected that efficiency measures will be prioritised as a means towards meeting these targets. These requirements may be adjusted in future years to take into account the then prevailing standards and any other national guidance to ensure the standards are met or exceeded.

New non-residential buildings over 100sqm will be required to meet the relevant BREEAM 'excellent' standards. For conversions see Policy DM SD 3 'Retrofitting.

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

The scheme is designed to reduce annual carbon emissions by more than 35% over the Target Emission Rate set by Part L 2013 thus complying with Policy DM SD 1 Sustainable Construction in terms of carbon emissions. Code for Sustainable Homes scheme is now scrapped by the government; however, the following sections outline all the sustainable features integrated in the design of the Firs, Church Grove. A Sustainable Construction Checklist has been completed for the scheme as required by the Richmond Council showing that a B rating can be achieved. The checklist goes through all the sustainability features integrated in the design to enhance the performance of the development and minimise its environmental impact.

The development makes efficient use of land within the borough by providing additional residential units. The site is well served by public transportation links thus reducing car usage. In addition, secure cycle storage will be provided to encourage tenants to cycle. More information can be found in the Design and Access Statement prepared by Flower Michelin Architects.

Policy CP2 Reducing Carbon Emissions

2.A The Borough will reduce its carbon dioxide emissions by requiring measures that minimise energy consumption in new development and promoting these measures in existing development, particularly in its own buildings.

2.B The Council will require the evaluation, development and use of decentralised energy in appropriate development.

2.C The Council will increase the use of renewable energy by requiring all new development to achieve a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation unless it can be demonstrated that such provision is not feasible, and by promoting its use in existing development.

Policy DM SD 2 Renewable Energy and Decentralised Energy Networks

New development will be required to conform with the Sustainable Construction Checklist SPD and:

a. Maximise opportunities for the micro-generation of renewable energy. Some form of low carbon renewable and/or de-centralised energy will be expected in all new development, and
b. Developments of 1 dwelling unit or more, or 100sqm of non-residential floor space or more will be required to reduce their total carbon dioxide emissions by following a hierarchy that first requires an efficient design to minimise the amount of energy used, secondly, by using low carbon technologies and finally, where feasible and viable, including a contribution from renewable sources.
c. Local opportunities to contribute towards decentralised energy supply from renewable and low-carbon technologies will be encouraged where there is no over-riding adverse local impact.
d. All new development will be required to connect to existing or planned decentralised energy networks where one exists. In all major developments and large Proposals Sites identified in the (forthcoming) Site Allocations DPD, provision should be made for future connection to a local energy network should one become available.

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

The scheme is under new smaller residential schemes i.e. below 10 units. The energy strategy presented in this statement shows how the proposed development will achieve a high reduction in carbon emissions over Part L baseline emissions.

The design team has carried out a feasibility study, presented in the Appendix 1, to identify those renewable energy technologies that are appropriate for the proposed development. According to the London Heat Map, there is no existing district heating scheme within the immediate vicinity of the development as shown in the Figure 4.

The scheme achieves a 31.8% reduction in its annual carbon emissions due to the use of renewable energy technologies installed on site.

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 Richmond Upon Thames local policies relate to Climate Change Adaptation, in the context of this proposed development.

LONDON PLAN 2016 CLIMATE CHANGE ADAPTATION POLICIES

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

LONDON BOROUGH OF RICHMOND UPON THAMES CORE STRATEGY 2009 AND DEVELOPMENT MANAGEMENT PLAN 2011 CLIMATE CHANGE ADAPTATION POLICIES

- Policy CP3 Climate Change – Adapting to the effects
- Policy CP4 Biodiversity
- Policy CP6 Waste
- Policy DM SD 4 Adapting to Higher Temperature and Need for Cooling
- Policy DM SD 5 Living Roofs
- Policy DM SD 6 Flood Risk
- Policy DM SD 7 Sustainable Drainage
- Policy DM SD 9 Protecting Water Resources and Infrastructure
- Policy DM OS 5 Biodiversity and new development

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

3.4 CLIMATE CHANGE ADAPTATION – POLICY REVIEW AND MEASURES IMPLEMENTED

Policy 5.9 Overheating and Cooling

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

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

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

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

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

Policy DM SD 4 Adapting to Higher Temperature and Need for Cooling

All new developments, in their layout, design, construction, materials, landscaping and operation, are required to take into account and adapt to higher temperatures, avoid and mitigate overheating and excessive heat generation to counteract the urban heat island effect, and meet the need for cooling.

All new development proposals should reduce 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 shading, reducing solar reflectance, 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).

Opportunities to adapt existing buildings, places and spaces to manage higher temperatures should be maximised and will be supported.

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

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

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

Policy 5.10 Urban Greening

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

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

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

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

The proposed design, including new planting and a green roof, aims to enhance the ecological value and biodiversity of the site. Further information in regards to the landscape design can be found in the Design and Access Statement prepared by Michelin Flower Architects.

Policy 5.13 Sustainable Drainage

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

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

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

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

Policy DM SD 7 Sustainable Drainage

All development proposals are required to follow the drainage hierarchy (see below) when disposing of surface water and must utilise Sustainable Drainage Systems (SuDS) wherever practical. Any discharge should be reduced to greenfield run-off rates wherever feasible.

When discharging surface water to a public sewer, developers will be required to provide evidence that capacity exists in the public sewerage network to serve their development.

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

The surface water drainage will be designed to avoid, reduce and delay the discharge of rainfall run-off using SUDS techniques, such as use of permeable paving and small detention basin features aimed at conveying and storing surface water at surface before discharging all surface water to ground via soakaways. Please refer to the FRA report prepared by RSK for a detailed description of the SuDS startegy.

Policy 5.12 Flood Risk Management

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

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

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

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

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

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

Policy DM SD 6 Flood Risk

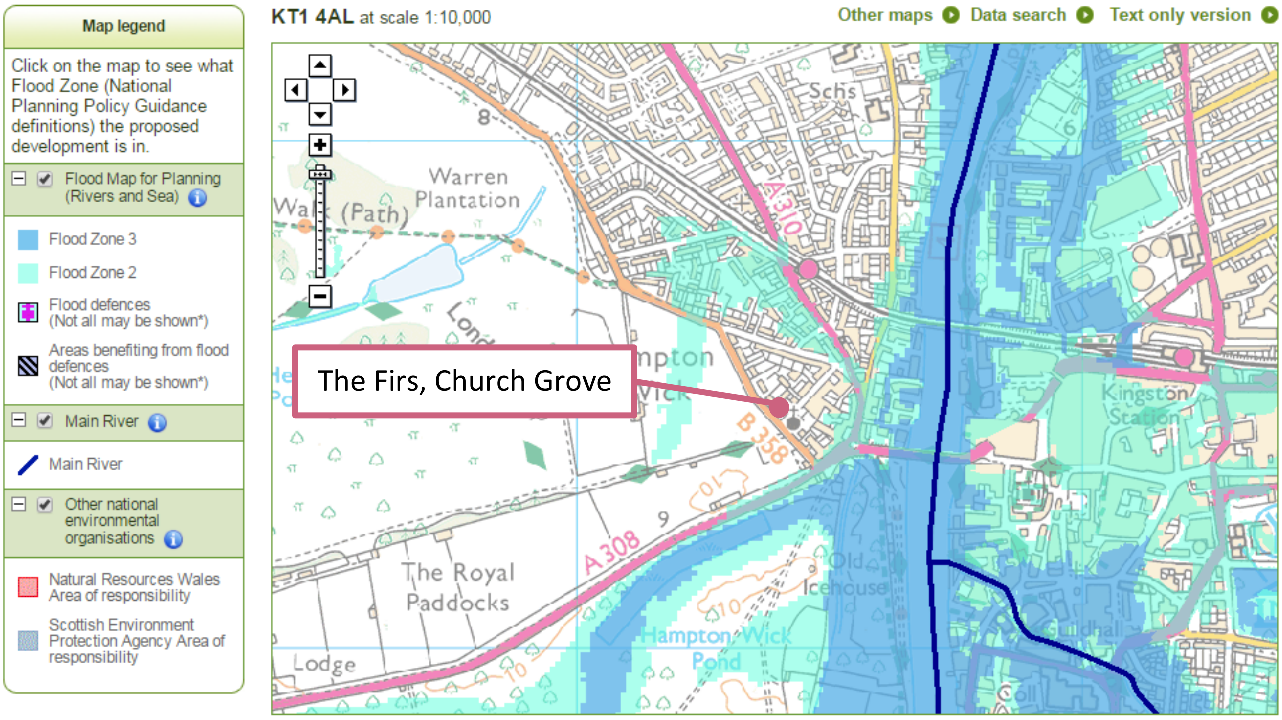
Development will be guided to areas of lower risk by applying the Sequential Test as set out in paragraph 3.1.35. Unacceptable developments and land uses will be restricted in line with PPS25 and as outlined below. Developments and Flood Risk Assessments must consider all sources of flooding and the likely impacts of climate change.

Where a Flood Risk Assessment is required and in addition to the Environment Agency's normal floodplain compensation requirement, attenuation areas to alleviate fluvial and/or surface water flooding must be considered where there is an opportunity. The onus is on the applicant/developer for proposals on sites of 10 dwellings or 1000sqm of non-residential development or more to provide evidence and justification if attenuation areas cannot be used.

In areas at risk of flooding, all proposals on sites of 10 dwellings or 1000sqm of non-residential development or more are required to submit a Flood Warning and Evacuation Plan.

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

The site is in a low flood risk zone according to the Environmental Agency Flood Map (Figure 5). A FRA report has been prepared by RSK.



The Firs, Church Grove

Figure 5 Environment Agency Flood Map

Policy 5.15 Water Use Supplies

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

- minimising use of mains water;
- reaching cost-effective minimum leakage levels;
- in conjunction with demand side measures, promoting the provision of additional sustainable water resources in a timely and efficient manner, reducing the water supply deficit and achieving security of supply in London;

- minimising the amount of energy consumed in water supply;
- promoting the use of rainwater harvesting and using dual potable and grey water recycling systems, where they are energy and cost-effective;
- maintaining and upgrading water supply infrastructure;
- ensuring the water supplied will not give rise to likely significant adverse effects to the environment particularly designated sites of European importance for nature conservation.

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

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

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

Policy DM SD 9 Protecting Water Resources and Infrastructure

The borough's water resources and supplies will be protected by resisting development proposals that would pose an unacceptable threat to surface water and groundwater quantity and quality. This includes pollution caused by water run-off from developments into nearby waterways.

New developments must achieve a high standard of water efficiency by:

1. meeting the minimum mandatory target for water consumption as set out in the Code for Sustainable Homes, or
2. meeting a minimum of 2 credits on water consumption for other types of developments (BREEAM "excellent"), or
3. meeting a minimum of 3 credits on water consumption for conversions (EcoHomes "excellent"), and
4. utilising rainwater harvesting for all external water uses to reduce the consumption of potable water wherever possible.

The above requirements may be adjusted in future years to take into account the then prevailing standards and any other national guidance to ensure that these standards are met or exceeded.

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

All new apartments will have low water use fittings to reduce the water consumption and the energy consumption on site. Installation of low flow rate showers, taps and dual flush toilets, together with smaller baths (where applicable) will mean that all apartments will achieve a maximum internal water use of 110 litres per person/day (including an allowance of 5 litres or less per head per day for external water consumption).

Policy CP3 Climate Change – Adapting to the effects

3.A Development will need to be designed to take account of the impacts of climate change over its lifetime, including:

- Water conservation and drainage
- The need for Summer cooling
- Risk of subsidence
- Flood risk from the River Thames and its tributaries

3.B Development in areas of high flood risk will be restricted, in accordance with PPS25, and using the Environment Agency's Catchment Flood Management Plan, Borough's Strategic Flood Risk Assessment and site level assessments to determine risk.

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 new flats. All units will feature low water use fittings to reduce the water consumption. According to the Environmental Agency Flood Map, the site is in a low flood risk zone (Figure 5).

Policy CP4 Biodiversity

4.A The Borough's biodiversity including the SSSIs and Other Sites of Nature Importance will be safeguarded and enhanced. Biodiversity enhancements will be encouraged particularly in areas of deficiency (parts of Whitton, Hampton, Teddington, Twickenham and South Kew), in areas of new development and along wildlife corridors and green chains such as the River Thames and River Crane corridors.

4.B Weighted priority in terms of their importance will be afforded to protected species and priority species and habitats in the UK, Regional and Richmond upon Thames Biodiversity Action Plans.

Policy DM OS 5 Biodiversity and new development

All new development will be expected to preserve and where possible enhance existing habitats including river corridors and biodiversity features, including trees.

All developments will be required to enhance existing and incorporate new biodiversity features and habitats into the design of buildings themselves as well as in appropriate design and landscaping schemes of new developments with the aim to attract wildlife and promote biodiversity, where possible.

When designing new habitats and biodiversity features, consideration should be given to the use of native species as well as the adaptability to the likely effects of climate change.

New habitats and biodiversity features should make a positive contribution to and should be integrated and linked to the wider green and blue infrastructure network, including de-culverting rivers, where possible.

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

The proposed design, including new planting and a green roof, aims to enhance the ecological value and biodiversity of the site. Further information in regards to the landscape design can be found in the Design and Access Statement prepared by Michelin Flower Architects.

Policy CP6 Waste

This Borough supports the objectives of sustainable waste management and will:

6.A Maximise self-sufficiency in waste management capacity (in line with London Plan target of 85% self-sufficiency within London by 2020).

6.B Seek to minimise waste creation, increase household recycling and composting rates to at least 40% by 2010, 50% by 2020, address waste as a resource and look to disposal as the last option, in line with the waste hierarchy.

6.C Work with its partners in the West London Waste Authority to prepare a Joint Waste Plan, which will identify locations suitable for waste management facilities to meet The London Plan consolidated with Alterations since 2004 apportionment and other requirements.

6.D Safeguard and improve existing waste sites at Craneford Way, Twickenham and Townmead Road, Kew unless compensatory provision is made.

6.E Monitor changes in the stock of waste management facilities, waste arisings, and the amount of waste recycled, recovered and going for disposal.

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

New development will feature covered bins and recycling stores on the communal areas. The scheme will also take advantage of the recycling and waste collection services provided by the Richmond Council. For details of the site servicing strategy please see the Design and Access statement.

Policy DM SD 5 Living Roofs

Living roofs should be incorporated into new developments where technically feasible and subject to considerations of visual impact. The onus is on the applicant/developer for proposals with roof plate areas of 100sqm or more to provide evidence and justification if a living roof cannot be incorporated. The aim should be to use at least 70% of any potential roof plate area as a living roof.

The use of living roofs in smaller developments, renovations, conversions and extensions is encouraged and supported.

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

A green roof is proposed for the roof of unit 5. This is considered part of the SUDs techniques integrated in the design to manage water runoff. The living roof is also expected to enhance the ecological value of the site.

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 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

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

Table 3: Part L1A 2013 Criteria

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

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

4.2 ENERGY MODELLING

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

4.3 BASELINE CARBON EMISSION RATE

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

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

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

Table 4 Baseline Carbon Dioxide emissions

Regulated Carbon dioxide emissions (Area-weighted average)	The Firs, Church Grove
Baseline Carbon Emission Rate (Part L1A 2013 TER) - regulated energy consumption	10.13 $tnCO_2$/annum
Baseline Carbon Emission Rate (SAP 2012) - unregulated energy consumption`	10.51 $tnCO_2$/annum
Part L1A 2013 Target Fabric Energy Efficiency Rate (TFEE)	50.94 kWh/sqm/annum

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 green: use renewable energy.

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

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

The council asks for residential dwellings to achieve 35% reduction over current Building Regulation's Target Emission Rate. New residential dwellings are required to demonstrate how this target has been met by following the London Plan Energy Hierarchy described above.

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 demonstrates how the prosed development will achieve energy and CO_2 emissions reduction over the baseline emissions.

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

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

Table 5 Proposed building fabric specifications

Building Fabric	U-value [W/m²K]	Wall	0.18
		Floor	0.13
		Roof	0.13
		Window	1.40 – Double-glazed (G-value: 0.63)
		Roof light	1.40 – Double-glazed (G-value: 0.63)
	Air permeability		3 m^3/m^2hr @50Pa
	Thermal Bridging		All junctions need to conform with Accredited Construction Details

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

ACTIVE DESIGN

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

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

Table 6 Proposed building services systems

HVAC Systems	Primary Heating System	Individual gas-fired condensing boiler with automatic ignition of 89% efficiency
	Heating Controls	Time and temperature zone control
	Ventilation	Whole house balanced mechanical ventilation with heat recovery of 91% and SFP of 0.44 W/l/s
	Comfort Cooling	Not provided
DHW	Hot Water System	Each unit will be provided with 125lt hot water cylinder of 1.05kWh/day standing heat loss fed by the gas-fired boiler.
	DHW Controls	Cylinder in heated space with thermostat and separate timer for DHW. Primary pipework is fully insulated.
Lighting	Installed Light fittings	All light fittings are dedicated low energy types i.e. either LED or fluorescent.

SAVINGS FROM 'BE LEAN' MEASURES

After implementing all the passive and active energy efficiency measures listed in sections above, the carbon dioxide emissions of the proposed scheme are reduced from 10.13 tnCO2 to 9.50 tnCO2 per year. Therefore, the reduction in Carbon Emission of the building at this stage is 6.2%, as the following table demonstrates.

Table 7 Carbon Dioxide emissions reduction for the development

Regulated Carbon dioxide emissions (Tonnes CO_2 per annum)		The Firs, Church Grove
Baseline Emissions		10.13
Be Lean	After energy demand reduction	9.50
Carbon Savings over Baseline		0.63
Carbon Reduction over Baseline		6.2%

Subsequently, the reduction in Fabric Energy Efficiency of the building is 2.0%, as the following table demonstrates.

Table 8 Fabric Energy Efficiency Rate reduction for the development

Fabric Energy Efficiency (kWh per m^2 per annum)	The Firs, Church Grove
Part L1A Target Fabric Energy Efficiency (TFEE) Rate	50.94
Dwelling Fabric Energy Efficiency (DFEE) Rate	49.91
Reduction over 2013 TFEE	2.0%

4.6 NON-REGULATED ENERGY USE

The London Plan (March 2016) requires that the energy demand and carbon dioxide emissions of the nonregulated end uses should also be calculated and reported in the energy assessments. In accordance with BRE SAP calculation procedures for estimating the non-regulated carbon emissions, the carbon emission from appliances in the development will be circa 9.02 tonnes per year and total emissions from cooking in all dwellings are approximately 1.49 tonnes per year. The total carbon emissions of the residential units from non-regulated energy use is therefore 10.51 tonnes per year.

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

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

It is estimated that proposed strategies may reduce the unregulated carbon emission by at least 10%. 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, 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. Due to the number of flats been added to the existing block, the annual demand for space heating and domestic hot water for the scheme is expected to be low throughout the year.

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

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.

Photovoltaics were identified as the technology most appropriate to this site. Appendix A of this report provides brief commentary on the technologies not considered appropriate for the scheme.

PHOTOVOLTAIC (PV) PANELS

Installation of Photovoltaic panels on new building's roof is considered an appropriate renewable technology. As there are no taller buildings or other topographical features in close proximity that could overshadow the roof, the installed PV panels would receive maximum solar energy throughout the day. Proposed roof provides a location for PVs that will keep them well hidden from the main façade and will thus have minimal visual impact from the street level views.

Details of the proposed PV panels will be confirmed at the detailed design stage by MCS accredited body responsible for design and installation of PV panels. The current layout as shown in the Figure 6 below is indicative and is based on Southeast facing panels and 10-degree inclination (minimum angle required for self-cleaning by rainwater). The proposed configuration of the PV array should also allow enough space between the panels to avoid overshadowing during winter when the sun is at its lowest altitude. A distance of circa 1 m should be kept from the roof edge and nearby features for access and health and safety issues.

The energy output of the PV panels will either be used to meet the demand of the development, or will be exported to the grid. Feed in Tariffs will be applicable to the installation according to current legislation and the PV panels will generate revenue each year.

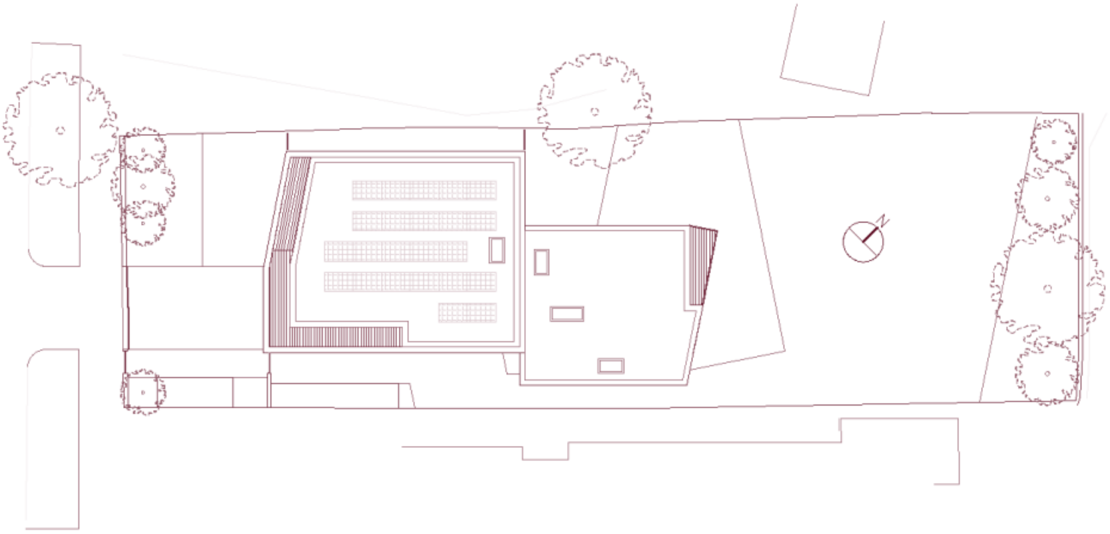


Figure 6 Roof layout showing indicative location of PV panels

Table 9 Proposed Renewable Energy Technology (PV panels)

Photovoltaic (PV) Panels	**No. of panels**	23
	Power output	7.66kW (333Wp each)
	Area of PV panels	25.7 sqm (1.559m x 1.046m each)
	Orientation	Southeast
	Inclination	10°

The installation will result in a saving approximately 3.02 tonnes of carbon per year. Table 10 is a summary of the contribution of photovoltaic panel installation to the reduction in energy consumption and carbon emissions of the building.

Table 10 Carbon Dioxide emissions reduction for the development

Regulated Carbon dioxide emissions (Tonnes CO2 per annum)		The Firs, Church Grove
Baseline Emissions		10.13
Be Lean	After energy demand reduction	9.50
Be Clean	After CHP	9.50
Be Green	After renewable energy	6.48
Carbon Savings over Clean stage		3.02
Carbon Reduction over Clean Stage		31.8%

5. RICHMOND SUSTAINABLE CONSTRUCTION CHECKLIST

The Sustainable Construction Checklist SPD forms part of the assessment for planning applications for conversion and retrofit properties within the London Borough of Richmond upon Thames. It is used to assess compliance with Richmond's Borough's minimum policy requirements on energy and carbon dioxide emissions.

The Checklist covers a range of sustainability issues, from energy consumption to site accessibility. The Sustainable Construction Checklist SPD sections are listed below. The score is totalled and converted to a rating which reflects the positive contribution which the development has made towards incorporating sustainability measures. The minimum score required for each rating is shown in table (Table 5) below.

Table 11 LBRUT Sustainable Construction Checklist – Scoring Matrix

Sustainable Construction Checklist SPD Sections	Score	Rating	Significance
Minimum Compliance	81 or more	A++	Project strives to achieve a highest standard in energy efficient sustainable development
Energy use and pollution	64-80	A+	Project strives to achieve a highest standard in energy efficient sustainable development
Transport	55-63	A	Makes a major contribution towards achieving sustainable development in Richmond
Biodiversity	35-54	B	Helps to significantly improve the Borough's stock of sustainable developments
Flooding and Drainage	20-34	C	Minimal effort to increase beyond general compliance
Improving Resource Efficiency	19 or less	FAIL	Does not comply with SDP policy
Accessibility			

A Sustainable Construction Checklist has been completed for the scheme that shows that "B" rating can be achieved for the residential units.

A completed Sustainable Construction Checklist can be found in Appendix 3. The following table provides comments for the targeted credits.

Table 12 Sustainable Construction Checklist – Comments

1	Based on SAP 2012 Calculations, a 35% reduction against Part L1A 2013 Target Emission Rate is required by Policy DM SD 1.
1.b	The development will meet the target of 110 litres or less per head per day (including an allowance of 5 litres or less per head per day for external water consumption) set by Richmond upon Thames' Council. A water use calculator will be submitted at detailed design stage prior to selecting the fittings.
2.1.a	Heat load calculations will be carried out by the M&E team at design stage to calculate the heating demand of the flats and size the heating system. Building fabric will exceed minimum Part L1A requirements in terms of thermal performance. Dwellings will rely on natural ventilation to maintain indoor air quality levels and minimise the risk of overheating. When required, additional flow rates can be provided through whole house mechanical ventilation, bypassing heat recovery.
2.2.b	The development, consisting of nine flats, has no cooling demand. According to the London Heat Map, there is no district heating in close proximity for the scheme to connect to. Due to the size of the scheme i.e. nine residential units, provision of a Combined Heat and Power (CHP) unit cannot be considered as high base heating load is required to ensure that the unit will run continuously for a high number of hours per years. Therefore, individual combi boilers of high efficiency with user friendly controls are recommended for the scheme.
2.3.a	The contractor will need to implement reduction strategies for dust emissions from construction sites by using the Considerate Constructors Scheme (CCS) in order to help improving sustainability in London Borough of Richmond upon Thames.
2.3.c	Due to the residential type of the building there will be minimum noise generation and therefore no impact on the surrounding properties.
2.3.d	Due to the residential type of the building and the use of low energy light fittings externally there will be minimum disturbance to the surroundings due to artificial lighting.
3.1.e	The development will provide secured cycle storage for 9 units.
4	The design aims to enhance the ecological value and biodiversity of the scheme by replanting trees and adding trees and additional planting in the peripheral areas.
5	The development is in a low flood risk zone. Please refer to the Flood Risk Assessment prepared by RSK for a detailed description of the SuDS strategy.

6.1.a	Works include the demolition of existing construction and the erection of a five-storey building, comprising of nine flats.
6.1.b	Due to the residential type of the building, the land occupied by the development is not considered contaminated.

6. CONCLUSIONS

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

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

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

Passive and active energy efficiency features include:

- Building fabric of high thermal performance, in terms of U-values, increased air tightness and use of Accredited Construction Details;
- Building services systems of high efficiency, including gas-fired condensing boilers and MVHR units, as well as light fitting of low energy types;
- Roof mounted photovoltaic panels to generate renewable energy on-site.

Non-regulated energy demand will be reduced by using energy efficient appliances that consume less energy than standard domestic equipment.

This energy performance statement has demonstrated that the new development has achieved a carbon emission reduction in excess of 35% over 2013 TER in CO2 emissions as required by Richmond Upon Thames Council for smaller residential schemes (below 10 units). The following table (Table 13) provides a summary of the carbon savings achieved at each stage of the London Plan Energy Hierarchy as a result of the proposed energy strategy described in the report.

Table 13 Carbon Dioxide emissions reduction for the development

Regulated Carbon dioxide emissions (Tonnes CO_2 per annum)		The Firs, Church Grove
Baseline Emissions		10.13
Be Lean	After energy demand reduction	9.50
Be Clean	After CHP	9.50
Be Green	After renewable energy	6.48
Carbon Savings over Baseline Emissions		3.65
Carbon Reduction over Baseline Emissions		36%

Table 14 demonstrates the total regulated CO2 savings from each stage of the Energy Hierarchy. As demonstrated below overall 36% reduction in carbon emission can be achieved applying the proposed strategies. The Sustainable Construction Checklist has been also completed for the scheme, showing that this can achieve a B rating i.e. helps to significantly improve the Borough's stock of sustainable developments.

Table 14 Regulated carbon dioxide savings from each stage of the Energy Hierarchy

	Regulated carbon dioxide savings	
	(Tonnes CO2 per annum)	(%)
Savings from energy demand reduction	0.63	6.2
Savings from CHP	0.00	0.0
Savings from renewable energy	3.02	31.8
Total Cumulative Savings	**3.65**	**36.0**
Total Target Savings	**3.55**	**20.0**
Annual Surplus	**0.10**	

Figure 7 below illustrate the total carbon savings and the total reduction achieved at each stage of the proposed Energy Hierarchy respectively.

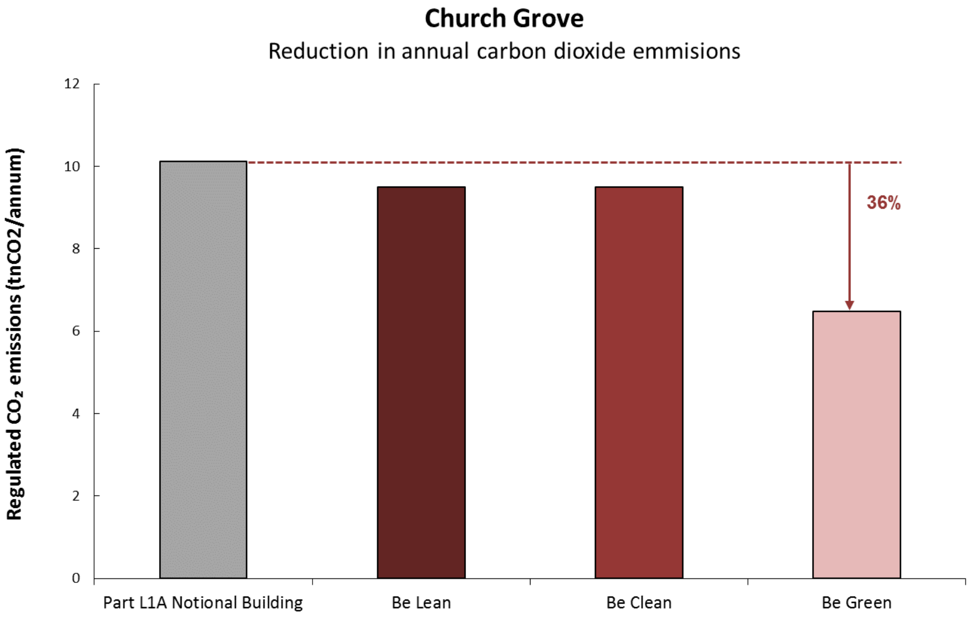


Figure 7 Total carbon savings achieved at each stage over Baseline Emissions

APPENDIX 1. RENEWABLE ENERGY SYSTEMS NOT FEASIBLE FOR THE SITE

A.1 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.

A.2 WIND TURBINES

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

A.3 HEAT PUMPS (GROUND/WATER/AIR)

GROUND SOURCE HEAT PUMP

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

However, given that the heating demand for this development is low, the cost of installing a ground source heat pump would not make this system financially viable. Therefore, given that a ground source system would be complex, technically risky, costly and deliver limited carbon emissions savings, we would therefore not recommend this approach for the development.

AIR SOURCE HEAT PUMP

Air-source or aerothermal heat-pumps work on the same principals as a ground-source heating system but extract heat or coolth from the air.

ASHPs perform better when connected to an underfloor heating system that requires lower water temperature ASHPs have low maintenance costs and they are simple to install compared to a GSHP. ASHPs, however, tend to drop their efficiencies when ambient air temperature is low during wintertime as there is no heat to absorb. For this reason, we would not recommend ASHPs for this development.

A.4 SOLAR HOT WATER HEATING (SHWH)

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

APPENDIX 2. TER WORKSHEET OF TYPICAL APARTMENT

TER WorkSheet: New dwelling design stage

User Details:

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

Property Address: Unit 6 - Be Lean

Address : Unit 6 - The Firs, Church Grove, Hampton Wick, LONDON, KT1 4AL

1. Overall dwelling dimensions:

	Area(m²)			**Av. Height(m)**			**Volume(m³)**	
Basement	54	(1a)	x	2.7	(2a)	=	145.8	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	54	(4)						
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)		=	145.8	(5)

2. Ventilation rate:

	main heating		**secondary heating**		**other**		**total**		**m³ per hour**	
Number of chimneys	0	+	0	+	0	=	0	x 40 =	0	(6a)
Number of open flues	0	+	0	+	0	=	0	x 20 =	0	(6b)
Number of intermittent fans							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) =	0.14	(8)

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

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

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

If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.39	(18)

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

Number of sides sheltered		3	(19)
Shelter factor	(20) = 1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor	(21) = (18) x (20) =	0.3	(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

TER WorkSheet: New dwelling design stage

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

0.38	0.38	0.37	0.33	0.32	0.29	0.29	0.28	0.3	0.32	0.34	0.35

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=	0.57	0.57	0.57	0.55	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56	(24d)

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

(25)m=	0.57	0.57	0.57	0.55	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Windows Type 1			6.75	x	1/[1/(1.4)+ 0.04]	=	8.95			(27)
Windows Type 2			2.99	x	1/[1/(1.4)+ 0.04]	=	3.96			(27)
Windows Type 3			3.76	x	1/[1/(1.4)+ 0.04]	=	4.98			(27)
Walls	55.9	13.5	42.4	x	0.18	=	7.63			(29)
Roof	5.4	0	5.4	x	0.13	=	0.7			(30)
Total area of elements, m²			61.3							(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) = 26.23 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 2592.6 (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 5.45 (36)

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

Total fabric heat loss (33) + (36) = 31.68 (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=	27.58	27.44	27.31	26.68	26.56	26.01	26.01	25.91	26.22	26.56	26.8	27.05	(38)

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

(39)m=	59.26	59.12	58.99	58.36	58.24	57.69	57.69	57.59	57.9	58.24	58.48	58.73

Average = Sum(39)$_{1…12}$ /12= 58.36 (39)

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

(40)m=	1.1	1.09	1.09	1.08	1.08	1.07	1.07	1.07	1.07	1.08	1.08	1.09

Average = Sum(40)$_{1…12}$ /12= 1.08 (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 1.81 (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 77.14 (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=	84.85	81.77	78.68	75.6	72.51	69.43	69.43	72.51	75.6	78.68	81.77	84.85

Total = Sum(44)$_{1…12}$ = 925.68 (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=	125.84	110.06	113.57	99.01	95	81.98	75.97	87.17	88.22	102.81	112.22	121.87

Total = Sum(45)$_{1…12}$ = 1213.71 (45)

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

(46)m=	18.88	16.51	17.04	14.85	14.25	12.3	11.4	13.08	13.23	15.42	16.83	18.28	(46)

Water storage loss:

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

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

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

Water storage loss:

a) If manufacturer’s declared loss factor is known (kWh/day): 1.25 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.68 (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) 0.68 (55)

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

(56)m=	20.99	18.96	20.99	20.31	20.99	20.31	20.99	20.99	20.31	20.99	20.31	20.99	(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=	20.99	18.96	20.99	20.31	20.99	20.31	20.99	20.99	20.31	20.99	20.31	20.99	(57)

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

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

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

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

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

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

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

(62)m=	170.09	150.03	157.82	141.84	139.25	124.8	120.22	131.42	131.04	147.06	155.04	166.12	(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=	170.09	150.03	157.82	141.84	139.25	124.8	120.22	131.42	131.04	147.06	155.04	166.12	

Output from water heater (annual)$_{1...12}$ 1734.72 (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=	77.24	68.57	73.16	67.18	66.99	61.52	60.66	64.39	63.59	69.58	71.57	75.92	(65)

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

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

Metabolic gains (Table 5), Watts

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(66)m=	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	(66)

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

(67)m=	14.05	12.48	10.15	7.68	5.74	4.85	5.24	6.81	9.14	11.61	13.55	14.44	(67)

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

(68)m=	157.6	159.24	155.12	146.35	135.27	124.86	117.91	116.27	120.39	129.17	140.24	150.65	(68)

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

(69)m=	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	(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=	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	(71)

Water heating gains (Table 5)

(72)m=	103.82	102.04	98.34	93.31	90.04	85.44	81.53	86.54	88.32	93.53	99.41	102.04	(72)

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

(73)m=	328.59	326.88	316.72	300.45	284.17	268.27	257.8	262.74	270.97	287.42	306.31	320.26	(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)	
Northeast 0.9x	0.77	x	3.76	x	11.28	x	0.63	x	0.7	=	12.97	(75)
Northeast 0.9x	0.77	x	3.76	x	22.97	x	0.63	x	0.7	=	26.39	(75)
Northeast 0.9x	0.77	x	3.76	x	41.38	x	0.63	x	0.7	=	47.55	(75)
Northeast 0.9x	0.77	x	3.76	x	67.96	x	0.63	x	0.7	=	78.09	(75)
Northeast 0.9x	0.77	x	3.76	x	91.35	x	0.63	x	0.7	=	104.97	(75)

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Northeast	0.9x	0.77	x	3.76	x	97.38	x	0.63	x	0.7	=	111.9	(75)
Northeast	0.9x	0.77	x	3.76	x	91.1	x	0.63	x	0.7	=	104.68	(75)
Northeast	0.9x	0.77	x	3.76	x	72.63	x	0.63	x	0.7	=	83.46	(75)
Northeast	0.9x	0.77	x	3.76	x	50.42	x	0.63	x	0.7	=	57.94	(75)
Northeast	0.9x	0.77	x	3.76	x	28.07	x	0.63	x	0.7	=	32.25	(75)
Northeast	0.9x	0.77	x	3.76	x	14.2	x	0.63	x	0.7	=	16.31	(75)
Northeast	0.9x	0.77	x	3.76	x	9.21	x	0.63	x	0.7	=	10.59	(75)
Southwest	0.9x	0.77	x	6.75	x	36.79		0.63	x	0.7	=	75.9	(79)
Southwest	0.9x	0.77	x	6.75	x	62.67		0.63	x	0.7	=	129.29	(79)
Southwest	0.9x	0.77	x	6.75	x	85.75		0.63	x	0.7	=	176.9	(79)
Southwest	0.9x	0.77	x	6.75	x	106.25		0.63	x	0.7	=	219.19	(79)
Southwest	0.9x	0.77	x	6.75	x	119.01		0.63	x	0.7	=	245.51	(79)
Southwest	0.9x	0.77	x	6.75	x	118.15		0.63	x	0.7	=	243.73	(79)
Southwest	0.9x	0.77	x	6.75	x	113.91		0.63	x	0.7	=	234.98	(79)
Southwest	0.9x	0.77	x	6.75	x	104.39		0.63	x	0.7	=	215.35	(79)
Southwest	0.9x	0.77	x	6.75	x	92.85		0.63	x	0.7	=	191.54	(79)
Southwest	0.9x	0.77	x	6.75	x	69.27		0.63	x	0.7	=	142.89	(79)
Southwest	0.9x	0.77	x	6.75	x	44.07		0.63	x	0.7	=	90.91	(79)
Southwest	0.9x	0.77	x	6.75	x	31.49		0.63	x	0.7	=	64.96	(79)
Northwest	0.9x	0.77	x	2.99	x	11.28	x	0.63	x	0.7	=	10.31	(81)
Northwest	0.9x	0.77	x	2.99	x	22.97	x	0.63	x	0.7	=	20.99	(81)
Northwest	0.9x	0.77	x	2.99	x	41.38	x	0.63	x	0.7	=	37.81	(81)
Northwest	0.9x	0.77	x	2.99	x	67.96	x	0.63	x	0.7	=	62.1	(81)
Northwest	0.9x	0.77	x	2.99	x	91.35	x	0.63	x	0.7	=	83.47	(81)
Northwest	0.9x	0.77	x	2.99	x	97.38	x	0.63	x	0.7	=	88.99	(81)
Northwest	0.9x	0.77	x	2.99	x	91.1	x	0.63	x	0.7	=	83.25	(81)
Northwest	0.9x	0.77	x	2.99	x	72.63	x	0.63	x	0.7	=	66.37	(81)
Northwest	0.9x	0.77	x	2.99	x	50.42	x	0.63	x	0.7	=	46.07	(81)
Northwest	0.9x	0.77	x	2.99	x	28.07	x	0.63	x	0.7	=	25.65	(81)
Northwest	0.9x	0.77	x	2.99	x	14.2	x	0.63	x	0.7	=	12.97	(81)
Northwest	0.9x	0.77	x	2.99	x	9.21	x	0.63	x	0.7	=	8.42	(81)

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

(83)m=	99.18	176.67	262.26	359.37	433.94	444.62	422.91	365.17	295.56	200.79	120.2	83.96	(83)

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

(84)m=	427.77	503.54	578.98	659.82	718.11	712.89	680.71	627.91	566.53	488.21	426.51	404.22	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.98	0.95	0.87	0.7	0.51	0.37	0.42	0.67	0.92	0.98	0.99	(86)

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

(87)m=	20.01	20.2	20.47	20.76	20.94	20.99	21	21	20.96	20.72	20.31	19.97	(87)

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

(88)m=	20	20.01	20.01	20.02	20.02	20.03	20.03	20.03	20.02	20.02	20.01	20.01	(88)

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

(89)m=	0.99	0.98	0.94	0.83	0.64	0.44	0.29	0.33	0.59	0.89	0.98	0.99	(89)

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

(90)m=	18.7	18.97	19.36	19.76	19.96	20.02	20.03	20.03	20	19.72	19.14	18.65	(90)

fLA = Living area ÷ (4) = 0.48 (91)

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

(92)m=	19.32	19.56	19.89	20.24	20.43	20.48	20.49	20.49	20.46	20.2	19.7	19.28	(92)

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

(93)m=	19.32	19.56	19.89	20.24	20.43	20.48	20.49	20.49	20.46	20.2	19.7	19.28	(93)

8. Space heating requirement

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, hm:													
(94)m=	0.99	0.97	0.94	0.84	0.67	0.47	0.33	0.37	0.63	0.89	0.98	0.99	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	422.87	490.77	543.47	555.66	481.4	336.03	224.05	234.79	354.26	435.54	416.13	400.64	(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=	890.31	866.59	789.7	661.83	508.31	339.46	224.46	235.58	368.22	558.95	736.77	885.74	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	347.77	252.55	183.2	76.44	20.02	0	0	0	0	91.82	230.86	360.92	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 1563.58 (98)

Space heating requirement in kWh/m²/year 28.96 (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)													
	347.77	252.55	183.2	76.44	20.02	0	0	0	0	91.82	230.86	360.92	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	371.95	270.11	195.94	81.75	21.41	0	0	0	0	98.2	246.91	386.01	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 1672.27 (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)

TER WorkSheet: New dwelling design stage

Water heating

Output from water heater (calculated above)

170.09	150.03	157.82	141.84	139.25	124.8	120.22	131.42	131.04	147.06	155.04	166.12

Efficiency of water heater 79.8 (216)

(217)m=	86.68	86.19	85.21	83.25	81	79.8	79.8	79.8	79.8	83.6	85.87	86.83	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	196.22	174.06	185.21	170.38	171.91	156.4	150.65	164.69	164.21	175.91	180.55	191.31

Total = Sum(219a)$_{1…12}$ = 2081.49 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		1672.27	
Water heating fuel used		2081.49	
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		248.14	(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	=	361.21	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	449.6	(264)
Space and water heating	(261) + (262) + (263) + (264) =			810.81	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	38.93	(267)
Electricity for lighting	(232) x	0.519	=	128.78	(268)
Total CO2, kg/year		sum of (265)…(271) =		978.52	(272)

TER = 18.12 (273)

APPENDIX 3. DER WORKSHEET OF TYPICAL APARTMENT – BE LEAN

DER WorkSheet: New dwelling design stage

User Details:

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

Property Address: Unit 6 - Be Lean

Address : Unit 6 - The Firs, Church Grove, Hampton Wick, LONDON, KT1 4AL

1. Overall dwelling dimensions:

	Area(m²)		Av. Height(m)		Volume(m³)	
Basement	54	(1a) x	2.7	(2a) =	145.8	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	54	(4)				
Dwelling volume				(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) =	145.8	(5)

2. Ventilation rate:

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

			Air changes per hour	
Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) =	0	÷ (5) =	0	(8)
If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)				
Number of storeys in the dwelling (ns)			0	(9)
Additional infiltration		[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction			0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35				
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0			0	(12)
If no draught lobby, enter 0.05, else enter 0			0	(13)
Percentage of windows and doors draught stripped			0	(14)
Window infiltration		0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate		(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area			3	(17)
If based on air permeability value, then (18) = [(17) ÷ 20]+(8), otherwise (18) = (16)			0.15	(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) =	0.12	(21)

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

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

Wind Factor (22a)m = (22)m ÷ 4

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

DER WorkSheet: New dwelling design stage

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

0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

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

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 78.2 (23c)

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

(24a)m=	0.26	0.25	0.25	0.24	0.23	0.22	0.22	0.22	0.23	0.23	0.24	0.25	(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 + [$(22b)m^2$ x 0.5]

(24d)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.26	0.25	0.25	0.24	0.23	0.22	0.22	0.22	0.23	0.23	0.24	0.25	(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	
Windows Type 1			12.2	x1/[1/(1.4)+ 0.04]		=	16.17			(27)
Windows Type 2			5.4	x1/[1/(1.4)+ 0.04]		=	7.16			(27)
Windows Type 3			6.8	x1/[1/(1.4)+ 0.04]		=	9.02			(27)
Walls	55.9	24.4	31.5	x	0.18	=	5.67			(29)
Roof	5.4	0	5.4	x	0.13	=	0.7			(30)
Total area of elements, m^2			61.3							(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) = 38.72 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 1938.6 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m^2K Indicative Value: Medium 250 (35)

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

Thermal bridges : S (L x Y) calculated using Appendix K 9.82 (36)

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

Total fabric heat loss (33) + (36) = 48.54 (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=	12.38	12.24	12.1	11.4	11.26	10.56	10.56	10.42	10.84	11.26	11.54	11.82	(38)

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

(39)m=	60.91	60.77	60.63	59.94	59.8	59.1	59.1	58.96	59.38	59.8	60.08	60.35	

Average = $\text{Sum}(39)_{1\ldots12}$ /12= 59.9 (39)

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

(40)m=	1.13	1.13	1.12	1.11	1.11	1.09	1.09	1.09	1.1	1.11	1.11	1.12

Average = Sum(40)$_{1…12}$ /12= 1.11 (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 1.81 (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 77.14 (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=	84.85	81.77	78.68	75.6	72.51	69.43	69.43	72.51	75.6	78.68	81.77	84.85

Total = Sum(44)$_{1…12}$ = 925.68 (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=	125.84	110.06	113.57	99.01	95	81.98	75.97	87.17	88.22	102.81	112.22	121.87

Total = Sum(45)$_{1…12}$ = 1213.71 (45)

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

(46)m=	18.88	16.51	17.04	14.85	14.25	12.3	11.4	13.08	13.23	15.42	16.83	18.28	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 125 (47)

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

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

Water storage loss:

a) If manufacturer’s declared loss factor is known (kWh/day): 1.05 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.57 (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) 0.57 (55)

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

(56)m=	17.58	15.88	17.58	17.01	17.58	17.01	17.58	17.58	17.01	17.58	17.01	17.58	(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=	17.58	15.88	17.58	17.01	17.58	17.01	17.58	17.58	17.01	17.58	17.01	17.58	(57)

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

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

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

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

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

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

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

(62)m=	166.68	146.94	154.41	138.53	135.84	121.5	116.81	128.01	127.74	143.65	151.74	162.7	(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=	166.68	146.94	154.41	138.53	135.84	121.5	116.81	128.01	127.74	143.65	151.74	162.7	

Output from water heater (annual)$_{1…12}$ 1694.56 (64)

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

(65)m=	74.51	66.1	70.43	64.54	64.26	58.88	57.93	61.66	60.95	66.85	68.93	73.19	(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=	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	(66)

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

(67)m=	14.05	12.48	10.15	7.68	5.74	4.85	5.24	6.81	9.14	11.61	13.55	14.44	(67)

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

(68)m=	157.6	159.24	155.12	146.35	135.27	124.86	117.91	116.27	120.39	129.17	140.24	150.65	(68)

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

(69)m=	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	(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=	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	(71)

Water heating gains (Table 5)

(72)m=	100.15	98.37	94.67	89.64	86.37	81.77	77.86	82.87	84.65	89.86	95.74	98.38	(72)

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

(73)m=	324.93	323.21	313.06	296.79	280.51	264.6	254.13	259.07	267.31	283.75	302.65	316.59	(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)	
Northeast	0.9x	0.77	x	6.8	x	11.28	x	0.63	x	0.7	=	23.45	(75)
Northeast	0.9x	0.77	x	6.8	x	22.97	x	0.63	x	0.7	=	47.73	(75)
Northeast	0.9x	0.77	x	6.8	x	41.38	x	0.63	x	0.7	=	85.99	(75)
Northeast	0.9x	0.77	x	6.8	x	67.96	x	0.63	x	0.7	=	141.22	(75)
Northeast	0.9x	0.77	x	6.8	x	91.35	x	0.63	x	0.7	=	189.83	(75)

Northeast	0.9x	0.77	x	6.8	x	97.38	x	0.63	x	0.7	=	202.38	(75)
Northeast	0.9x	0.77	x	6.8	x	91.1	x	0.63	x	0.7	=	189.32	(75)
Northeast	0.9x	0.77	x	6.8	x	72.63	x	0.63	x	0.7	=	150.93	(75)
Northeast	0.9x	0.77	x	6.8	x	50.42	x	0.63	x	0.7	=	104.78	(75)
Northeast	0.9x	0.77	x	6.8	x	28.07	x	0.63	x	0.7	=	58.33	(75)
Northeast	0.9x	0.77	x	6.8	x	14.2	x	0.63	x	0.7	=	29.5	(75)
Northeast	0.9x	0.77	x	6.8	x	9.21	x	0.63	x	0.7	=	19.15	(75)
Southwest	0.9x	0.77	x	12.2	x	36.79		0.63	x	0.7	=	137.18	(79)
Southwest	0.9x	0.77	x	12.2	x	62.67		0.63	x	0.7	=	233.68	(79)
Southwest	0.9x	0.77	x	12.2	x	85.75		0.63	x	0.7	=	319.73	(79)
Southwest	0.9x	0.77	x	12.2	x	106.25		0.63	x	0.7	=	396.16	(79)
Southwest	0.9x	0.77	x	12.2	x	119.01		0.63	x	0.7	=	443.73	(79)
Southwest	0.9x	0.77	x	12.2	x	118.15		0.63	x	0.7	=	440.52	(79)
Southwest	0.9x	0.77	x	12.2	x	113.91		0.63	x	0.7	=	424.71	(79)
Southwest	0.9x	0.77	x	12.2	x	104.39		0.63	x	0.7	=	389.22	(79)
Southwest	0.9x	0.77	x	12.2	x	92.85		0.63	x	0.7	=	346.2	(79)
Southwest	0.9x	0.77	x	12.2	x	69.27		0.63	x	0.7	=	258.26	(79)
Southwest	0.9x	0.77	x	12.2	x	44.07		0.63	x	0.7	=	164.32	(79)
Southwest	0.9x	0.77	x	12.2	x	31.49		0.63	x	0.7	=	117.4	(79)
Northwest	0.9x	0.77	x	5.4	x	11.28	x	0.63	x	0.7	=	18.62	(81)
Northwest	0.9x	0.77	x	5.4	x	22.97	x	0.63	x	0.7	=	37.9	(81)
Northwest	0.9x	0.77	x	5.4	x	41.38	x	0.63	x	0.7	=	68.29	(81)
Northwest	0.9x	0.77	x	5.4	x	67.96	x	0.63	x	0.7	=	112.15	(81)
Northwest	0.9x	0.77	x	5.4	x	91.35	x	0.63	x	0.7	=	150.75	(81)
Northwest	0.9x	0.77	x	5.4	x	97.38	x	0.63	x	0.7	=	160.71	(81)
Northwest	0.9x	0.77	x	5.4	x	91.1	x	0.63	x	0.7	=	150.35	(81)
Northwest	0.9x	0.77	x	5.4	x	72.63	x	0.63	x	0.7	=	119.86	(81)
Northwest	0.9x	0.77	x	5.4	x	50.42	x	0.63	x	0.7	=	83.21	(81)
Northwest	0.9x	0.77	x	5.4	x	28.07	x	0.63	x	0.7	=	46.32	(81)
Northwest	0.9x	0.77	x	5.4	x	14.2	x	0.63	x	0.7	=	23.43	(81)
Northwest	0.9x	0.77	x	5.4	x	9.21	x	0.63	x	0.7	=	15.21	(81)

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

(83)m=	179.25	319.31	474.01	649.53	784.31	803.62	764.38	660.01	534.19	362.91	217.25	151.76	(83)

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

(84)m=	504.18	642.52	787.06	946.32	1064.82	1068.22	1018.51	919.08	801.49	646.66	519.89	468.34	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.96	0.88	0.71	0.51	0.35	0.26	0.29	0.5	0.82	0.97	0.99	(86)

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

(87)m=	20.09	20.36	20.67	20.91	20.98	21	21	21	20.99	20.84	20.42	20.04	(87)

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

(88)m=	19.98	19.98	19.98	19.99	19.99	20.01	20.01	20.01	20	19.99	19.99	19.99	(88)

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

(89)m=	0.98	0.95	0.85	0.66	0.46	0.3	0.2	0.23	0.43	0.77	0.95	0.99	(89)

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

(90)m=	18.8	19.19	19.61	19.9	19.98	20	20.01	20.01	19.99	19.84	19.28	18.73	(90)

fLA = Living area ÷ (4) = 0.48 (91)

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

(92)m=	19.42	19.75	20.12	20.38	20.46	20.48	20.48	20.48	20.47	20.32	19.82	19.35	(92)

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

(93)m=	19.42	19.75	20.12	20.38	20.46	20.48	20.48	20.48	20.47	20.32	19.82	19.35	(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	0.94	0.86	0.68	0.49	0.32	0.23	0.26	0.47	0.79	0.95	0.98	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	493.36	605.29	673.73	646.11	517.01	346.78	229.25	240.46	374.18	511.04	494.8	460.91	(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=	920.88	902.54	825.6	688.14	523.83	347.44	229.32	240.62	378.21	581.04	764.23	914.62	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	318.07	199.75	112.99	30.26	5.08	0	0	0	0	52.08	193.99	337.56	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 1249.79 (98)

Space heating requirement in kWh/m²/year 23.14 (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 89.9 (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)													
	318.07	199.75	112.99	30.26	5.08	0	0	0	0	52.08	193.99	337.56	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	353.81	222.19	125.68	33.66	5.65	0	0	0	0	57.93	215.79	375.49	

Total (kWh/year) =Sum(211)$_{1...5,10...12}$= 1390.2 (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)

166.68	146.94	154.41	138.53	135.84	121.5	116.81	128.01	127.74	143.65	151.74	162.7

Efficiency of water heater 79.8 (216)

(217)m=	86.15	85.32	83.78	81.44	80.12	79.8	79.8	79.8	79.8	82.26	85.17	86.35	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	193.47	172.22	184.31	170.1	169.54	152.26	146.38	160.42	160.07	174.63	178.17	188.43

Total = Sum(219a)$_{1...12}$ = 2050 (219)

Annual totals	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		1390.2	
Water heating fuel used		2050	
Electricity for pumps, fans and electric keep-hot			
mechanical ventilation - balanced, extract or positive input from outside	115.62		(230a)
central heating pump:	30		(230c)
Total electricity for the above, kWh/year sum of (230a)…(230g) =		145.62	(231)
Electricity for lighting		248.14	(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	=	300.28	(261)
Space heating (secondary)	(215)	x	0.519	=	0	(263)
Water heating	(219)	x	0.216	=	442.8	(264)
Space and water heating	(261) + (262) + (263) + (264) =				743.08	(265)
Electricity for pumps, fans and electric keep-hot	(231)	x	0.519	=	75.58	(267)
Electricity for lighting	(232)	x	0.519	=	128.78	(268)
Total CO2, kg/year			sum of (265)…(271) =		947.44	(272)
Dwelling CO2 Emission Rate			(272) ÷ (4) =		17.55	(273)
EI rating (section 14)					87	(274)

APPENDIX 4. DER WORKSHEET OF TYPICAL APARTMENT – BE GREEN

DER WorkSheet: New dwelling design stage

User Details:

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

Property Address: Unit 6 - Be Green

Address : Unit 6 - The Firs, Church Grove, Hampton Wick, LONDON, KT1 4AL

1. Overall dwelling dimensions:

	Area(m²)			Av. Height(m)			Volume(m³)	
Basement	54	(1a)	x	2.7	(2a)	=	145.8	(3a)
Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n)	54	(4)						
Dwelling volume					(3a)+(3b)+(3c)+(3d)+(3e)+.....(3n)	=	145.8	(5)

2. Ventilation rate:

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

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

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

Number of storeys in the dwelling (ns)		0	(9)
Additional infiltration	[(9)-1]x0.1 =	0	(10)
Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction		0	(11)
if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35			
If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0		0	(12)
If no draught lobby, enter 0.05, else enter 0		0	(13)
Percentage of windows and doors draught stripped		0	(14)
Window infiltration	0.25 - [0.2 x (14) ÷ 100] =	0	(15)
Infiltration rate	(8) + (10) + (11) + (12) + (13) + (15) =	0	(16)
Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3	(17)
If based on air permeability value, then	(18) = [(17) ÷ 20]+(8), otherwise (18) = (16)	0.15	(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) =	0.12	(21)

Infiltration rate modified for monthly wind speed

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

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

0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14

Calculate effective air change rate for the applicable case

If mechanical ventilation: 0.5 (23a)

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

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 78.2 (23c)

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

(24a)m=	0.26	0.25	0.25	0.24	0.23	0.22	0.22	0.22	0.23	0.23	0.24	0.25	(24a)

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

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

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

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

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

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

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

(24d)m=	0	0	0	0	0	0	0	0	0	0	0	0	(24d)

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

(25)m=	0.26	0.25	0.25	0.24	0.23	0.22	0.22	0.22	0.23	0.23	0.24	0.25	(25)

3. Heat losses and heat loss parameter:

ELEMENT	Gross area (m²)	Openings m²	Net Area A ,m²		U-value W/m2K		A X U (W/K)	k-value kJ/m²·K	A X k kJ/K	
Windows Type 1			12.2		x1/[1/(1.4)+ 0.04]	=	16.17			(27)
Windows Type 2			5.4		x1/[1/(1.4)+ 0.04]	=	7.16			(27)
Windows Type 3			6.8		x1/[1/(1.4)+ 0.04]	=	9.02			(27)
Walls	55.9	24.4	31.5	x	0.18	=	5.67			(29)
Roof	5.4	0	5.4	x	0.13	=	0.7			(30)
Total area of elements, m²			61.3							(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) = 38.72 (33)

Heat capacity Cm = S(A x k) ((28)…(30) + (32) + (32a)…(32e) = 1938.6 (34)

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

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

Thermal bridges : S (L x Y) calculated using Appendix K 9.82 (36)

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

Total fabric heat loss (33) + (36) = 48.54 (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=	12.38	12.24	12.1	11.4	11.26	10.56	10.56	10.42	10.84	11.26	11.54	11.82	(38)

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

(39)m=	60.91	60.77	60.63	59.94	59.8	59.1	59.1	58.96	59.38	59.8	60.08	60.35	

Average = Sum(39)$_{1\ldots12}$ /12= 59.9 (39)

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

(40)m=	1.13	1.13	1.12	1.11	1.11	1.09	1.09	1.09	1.1	1.11	1.11	1.12

Average = Sum(40)$_{1…12}$ /12= 1.11 (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 1.81 (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 77.14 (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=	84.85	81.77	78.68	75.6	72.51	69.43	69.43	72.51	75.6	78.68	81.77	84.85	

Total = Sum(44)$_{1…12}$ = 925.68 (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=	125.84	110.06	113.57	99.01	95	81.98	75.97	87.17	88.22	102.81	112.22	121.87

Total = Sum(45)$_{1…12}$ = 1213.71 (45)

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

(46)m=	18.88	16.51	17.04	14.85	14.25	12.3	11.4	13.08	13.23	15.42	16.83	18.28	(46)

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 125 (47)

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

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

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 1.05 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage, kWh/year (48) x (49) = 0.57 (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) 0.57 (55)

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

(56)m=	17.58	15.88	17.58	17.01	17.58	17.01	17.58	17.58	17.01	17.58	17.01	17.58	(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=	17.58	15.88	17.58	17.01	17.58	17.01	17.58	17.58	17.01	17.58	17.01	17.58	(57)

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

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

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

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

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

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

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

(62)m=	166.68	146.94	154.41	138.53	135.84	121.5	116.81	128.01	127.74	143.65	151.74	162.7	(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=	166.68	146.94	154.41	138.53	135.84	121.5	116.81	128.01	127.74	143.65	151.74	162.7	

Output from water heater (annual)$_{1\ldots12}$ 1694.56 (64)

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

(65)m=	74.51	66.1	70.43	64.54	64.26	58.88	57.93	61.66	60.95	66.85	68.93	73.19	(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=	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	90.4	(66)

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

(67)m=	14.05	12.48	10.15	7.68	5.74	4.85	5.24	6.81	9.14	11.61	13.55	14.44	(67)

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

(68)m=	157.6	159.24	155.12	146.35	135.27	124.86	117.91	116.27	120.39	129.17	140.24	150.65	(68)

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

(69)m=	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	32.04	(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=	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	-72.32	(71)

Water heating gains (Table 5)

(72)m=	100.15	98.37	94.67	89.64	86.37	81.77	77.86	82.87	84.65	89.86	95.74	98.38	(72)

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

(73)m=	324.93	323.21	313.06	296.79	280.51	264.6	254.13	259.07	267.31	283.75	302.65	316.59	(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)	
Northeast 0.9x	0.77	x	6.8	x	11.28	x	0.63	x	0.7	=	23.45	(75)
Northeast 0.9x	0.77	x	6.8	x	22.97	x	0.63	x	0.7	=	47.73	(75)
Northeast 0.9x	0.77	x	6.8	x	41.38	x	0.63	x	0.7	=	85.99	(75)
Northeast 0.9x	0.77	x	6.8	x	67.96	x	0.63	x	0.7	=	141.22	(75)
Northeast 0.9x	0.77	x	6.8	x	91.35	x	0.63	x	0.7	=	189.83	(75)

Northeast	0.9x	0.77	x	6.8	x	97.38	x	0.63	x	0.7	=	202.38	(75)
Northeast	0.9x	0.77	x	6.8	x	91.1	x	0.63	x	0.7	=	189.32	(75)
Northeast	0.9x	0.77	x	6.8	x	72.63	x	0.63	x	0.7	=	150.93	(75)
Northeast	0.9x	0.77	x	6.8	x	50.42	x	0.63	x	0.7	=	104.78	(75)
Northeast	0.9x	0.77	x	6.8	x	28.07	x	0.63	x	0.7	=	58.33	(75)
Northeast	0.9x	0.77	x	6.8	x	14.2	x	0.63	x	0.7	=	29.5	(75)
Northeast	0.9x	0.77	x	6.8	x	9.21	x	0.63	x	0.7	=	19.15	(75)
Southwest	0.9x	0.77	x	12.2	x	36.79		0.63	x	0.7	=	137.18	(79)
Southwest	0.9x	0.77	x	12.2	x	62.67		0.63	x	0.7	=	233.68	(79)
Southwest	0.9x	0.77	x	12.2	x	85.75		0.63	x	0.7	=	319.73	(79)
Southwest	0.9x	0.77	x	12.2	x	106.25		0.63	x	0.7	=	396.16	(79)
Southwest	0.9x	0.77	x	12.2	x	119.01		0.63	x	0.7	=	443.73	(79)
Southwest	0.9x	0.77	x	12.2	x	118.15		0.63	x	0.7	=	440.52	(79)
Southwest	0.9x	0.77	x	12.2	x	113.91		0.63	x	0.7	=	424.71	(79)
Southwest	0.9x	0.77	x	12.2	x	104.39		0.63	x	0.7	=	389.22	(79)
Southwest	0.9x	0.77	x	12.2	x	92.85		0.63	x	0.7	=	346.2	(79)
Southwest	0.9x	0.77	x	12.2	x	69.27		0.63	x	0.7	=	258.26	(79)
Southwest	0.9x	0.77	x	12.2	x	44.07		0.63	x	0.7	=	164.32	(79)
Southwest	0.9x	0.77	x	12.2	x	31.49		0.63	x	0.7	=	117.4	(79)
Northwest	0.9x	0.77	x	5.4	x	11.28	x	0.63	x	0.7	=	18.62	(81)
Northwest	0.9x	0.77	x	5.4	x	22.97	x	0.63	x	0.7	=	37.9	(81)
Northwest	0.9x	0.77	x	5.4	x	41.38	x	0.63	x	0.7	=	68.29	(81)
Northwest	0.9x	0.77	x	5.4	x	67.96	x	0.63	x	0.7	=	112.15	(81)
Northwest	0.9x	0.77	x	5.4	x	91.35	x	0.63	x	0.7	=	150.75	(81)
Northwest	0.9x	0.77	x	5.4	x	97.38	x	0.63	x	0.7	=	160.71	(81)
Northwest	0.9x	0.77	x	5.4	x	91.1	x	0.63	x	0.7	=	150.35	(81)
Northwest	0.9x	0.77	x	5.4	x	72.63	x	0.63	x	0.7	=	119.86	(81)
Northwest	0.9x	0.77	x	5.4	x	50.42	x	0.63	x	0.7	=	83.21	(81)
Northwest	0.9x	0.77	x	5.4	x	28.07	x	0.63	x	0.7	=	46.32	(81)
Northwest	0.9x	0.77	x	5.4	x	14.2	x	0.63	x	0.7	=	23.43	(81)
Northwest	0.9x	0.77	x	5.4	x	9.21	x	0.63	x	0.7	=	15.21	(81)

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

(83)m=	179.25	319.31	474.01	649.53	784.31	803.62	764.38	660.01	534.19	362.91	217.25	151.76	(83)

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

(84)m=	504.18	642.52	787.06	946.32	1064.82	1068.22	1018.51	919.08	801.49	646.66	519.89	468.34	(84)

7. Mean internal temperature (heating season)

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

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

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(86)m=	0.99	0.96	0.88	0.71	0.51	0.35	0.26	0.29	0.5	0.82	0.97	0.99	(86)

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

(87)m=	20.09	20.36	20.67	20.91	20.98	21	21	21	20.99	20.84	20.42	20.04	(87)

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

(88)m=	19.98	19.98	19.98	19.99	19.99	20.01	20.01	20.01	20	19.99	19.99	19.99	(88)

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

(89)m=	0.98	0.95	0.85	0.66	0.46	0.3	0.2	0.23	0.43	0.77	0.95	0.99	(89)

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

(90)m=	18.8	19.19	19.61	19.9	19.98	20	20.01	20.01	19.99	19.84	19.28	18.73	(90)

fLA = Living area ÷ (4) = 0.48 (91)

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

(92)m=	19.42	19.75	20.12	20.38	20.46	20.48	20.48	20.48	20.47	20.32	19.82	19.35	(92)

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

(93)m=	19.42	19.75	20.12	20.38	20.46	20.48	20.48	20.48	20.47	20.32	19.82	19.35	(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	0.94	0.86	0.68	0.49	0.32	0.23	0.26	0.47	0.79	0.95	0.98	(94)
Useful gains, hmGm , W = (94)m x (84)m													
(95)m=	493.36	605.29	673.73	646.11	517.01	346.78	229.25	240.46	374.18	511.04	494.8	460.91	(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=	920.88	902.54	825.6	688.14	523.83	347.44	229.32	240.62	378.21	581.04	764.23	914.62	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m													
(98)m=	318.07	199.75	112.99	30.26	5.08	0	0	0	0	52.08	193.99	337.56	

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 1249.79 (98)

Space heating requirement in kWh/m²/year 23.14 (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 89.9 (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)													
	318.07	199.75	112.99	30.26	5.08	0	0	0	0	52.08	193.99	337.56	
(211)m = {[(98)m x (204)] } x 100 ÷ (206)													(211)
	353.81	222.19	125.68	33.66	5.65	0	0	0	0	57.93	215.79	375.49	

Total (kWh/year) =Sum(211)$_{1...5,10....12}$= 1390.2 (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)

DER WorkSheet: New dwelling design stage

Water heating

Output from water heater (calculated above)

	166.68	146.94	154.41	138.53	135.84	121.5	116.81	128.01	127.74	143.65	151.74	162.7	
Efficiency of water heater													79.8 (216)
(217)m=	86.15	85.32	83.78	81.44	80.12	79.8	79.8	79.8	79.8	82.26	85.17	86.35	(217)

Fuel for water heating, kWh/month

(219)m = (64)m x 100 ÷ (217)m

(219)m=	193.47	172.22	184.31	170.1	169.54	152.26	146.38	160.42	160.07	174.63	178.17	188.43	

Total = Sum(219a)$_{1...12}$ = 2050 (219)

Annual totals		**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1			1390.2	
Water heating fuel used			2050	
Electricity for pumps, fans and electric keep-hot				
mechanical ventilation - balanced, extract or positive input from outside		115.62		(230a)
central heating pump:		30		(230c)
Total electricity for the above, kWh/year	sum of (230a)…(230g) =		145.62	(231)
Electricity for lighting			248.14	(232)
Electricity generated by PVs			-647.18	(233)

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

	Energy kWh/year	**Emission factor** kg CO2/kWh		**Emissions** kg CO2/year	
Space heating (main system 1)	(211) x	0.216	=	300.28	(261)
Space heating (secondary)	(215) x	0.519	=	0	(263)
Water heating	(219) x	0.216	=	442.8	(264)
Space and water heating	(261) + (262) + (263) + (264) =			743.08	(265)
Electricity for pumps, fans and electric keep-hot	(231) x	0.519	=	75.58	(267)
Electricity for lighting	(232) x	0.519	=	128.78	(268)
Energy saving/generation technologies Item 1		0.519	=	-335.89	(269)
Total CO2, kg/year		sum of (265)…(271) =		611.56	(272)
Dwelling CO2 Emission Rate		(272) ÷ (4) =		11.33	(273)
EI rating (section 14)				92	(274)

APPENDIX 5. SUSTAINABLE CONSTRUCTION CHECKLIST SPD

LBRUT Sustainable Construction Checklist - January 2016

This document forms part of the Sustainable Construction Checklist SPD. This document **must** be filled out as part of the planning application for the following developments: all residential development providing **one or more new residential units (including conversions leading to one or more new units)**, and all other forms of development providing **100sqm or more of non-residential floor space**. Developments including new non-residential development of less than 100sqm floor space, extensions less than 100sqm, and other conversions are strongly encouraged to comply with this checklist. Where further information is requested, please either fill in the relevant section, or refer to the document where this information may be found in detail, e.g. Flood Risk Assessment or similar. **Further guidance** on completing the Checklist may be found in the Justification and Guidance section of this SPD.

Property Name (if relevant): The Firs, Church Grove

Application No. (if known):

Address (include. postcode): The Firs, Church Grove, Hampton Wick, KT1 4AL

Completed by: Panos Dalapas, Senior Sustainability Consultant
Mecserve Ltd

For Non-Residential
Size of development (m2):

For Residential
Number of dwellings: 9

1 MINIMUM COMPLIANCE (RESIDENTIAL AND NON-RESIDENTIAL)

Energy Assessment

Has an energy assessment been submitted that demonstrates the expected energy and carbon dioxide emissions saving from energy efficiency and renewable energy measures, including the feasibility of CHP/CCHP and community heating systems? If yes, please tick. ✓

Carbon Dioxide emissions reduction

What is the carbon dioxide emissions reduction against a Building Regulations Part L (2013) baseline: 36%

Policy DM SD 1 and London Plan Policy 5.2 (2015) require a 35% reduction in CO_2 emissions beyond Building Regulations 2013.

Percentage of **total** site CO2 emissions saved through renewable energy installation? 31.80%

1A MINIMUM POLICY COMPLIANCE (NON-RESIDENTIAL AND DOMESTIC REFURBISHMENT)

Please check the Guidance Section of this SPD for the policy requirements

Environmental Rating of development:

Non-Residential new-build (100sqm or more)

BREEAM Level: Please Select — Have you attached a pre-assessment to support this? ☐

Extensions and conversions for residential dwellings

BREEAM Domestic Refurbishment: Please Select — Have you attached a pre-assessment to support this? ☐

Extensions and conversions for non-residential buildings

BREEAM Level: Please Select — Have you attached a pre-assessment to support this? ☐

Score awarded for Environmental Rating: **Subtotal** 0

BREEAM: Good = *0* , Very Good = 4, Excellent = *8,* Outstanding = *16*

1B MINIMUM POLICY COMPLIANCE (RESIDENTIAL)

Water Usage

Internal water usage limited to 105 litres person per day. (Excluding an allowance 5 litres per person per day for external water consumption). Calculations using the water efficiency calculator for new dwellings have been submitted. ☑ *1*

Subtotal 1

2. ENERGY USE AND POLLUTION

2.1 Need for Cooling

Score

a. How does the development incorporate cooling measures? Tick all that apply:

Energy efficient design incorporating specific heat demand to less than or equal to 15 kWh/sqm ☐ *6*
Reduce heat entering a building through providng/improving insulation and living roofs and walls ☑ *2*
Reduce heat entering a building through shading ☑ *3*
Exposed thermal mass and high ceilings ☐ *4*
Passive ventilation ☑ *3*
Mechanical ventilation with heat recovery ☑ *1*
Active cooling systems, i.e. Air Conditioning Unit ☐ *0*

2.2 Heat Generation

b. How have the heating and cooling systems, with preference to the heating system hierarchy, been selected (defined in London Plan policy **5.6**)? Tick all heating and cooling systems that will be used in the development:

Connection to existing heating or cooling networks powered by renewable energy ☐ *6*
Connection to existing heating or cooling networks powered by gas or electricity ☐ *5*
Site wide CHP network powered by renewable energy ☐ *4*
Site wide CHP network powered by gas ☐ *3*
Communal heating and cooling powered by renewable energy ☐ *2*
Communal heating and cooling powered by gas or electricity ☐ *1*
Individual heating and cooling ☑ *0*

2.3 Pollution: Air, Noise and Light

a. Does the development plan to implement reduction strategies for dust emissions from construction sites? ☑ *2*

b. Does the development plan include a biomass boiler? ☐ *-*

If yes, please refer to the biomass guidelines for the Borough of Richmond, please see guidance for supplementary information. If the proposed boiler is of a qualifying size, you may need to completed the information request form found on the Richmond website. ☐ *-*

c. Please tick only one option below

Has the development taken measures to reduce existing noise and enhance the existing soundscape of the site? ☑ *3*
Has the development taken care to not create any new noise generation/transmission issues in its intended operation? ☑ *1*

d. Has the development taken measures to reduce light pollution impacts on character, residential amenity and biodiversity? ☑ *3*

e. Have you attached a Lighting Pollution Report? ☐ *-*

Subtotal 18

Please give any additional relevant comments to the Energy Use and Pollution Section below

3. TRANSPORT

3.1 Provision for the safe efficient and sustainable movement of people and goods

a. Does your development provide opportunities for occupants to use innovative travel technologies?

Please explain:

b. Does your development include charging point(s) for electric cars? ☐ *2*

c. **For major developments ONLY**: Has a Transport Assessment been produced for your development based on TfL's Best Practice Guidance?

If you have provided a Transport Assessment as part of your planning application, please tick here and move to Section 3 of this Checklist. ☐ *5*

d. **For smaller developments ONLY**: Have you provided a Transport Statement? ☑ *5*

e. Does your development provide cycle storage? (Standard space requirements are set out in the the Council's Parking Standards - DM DPD Appendix 4) ☑ *2*

If so, for how many bicycles? 9
Is this shown on the site plans? ☑ *-*

f. Will the development create or improve links with local and wider transport networks? If yes, please provide details. ☐ *2*

Subtotal 7

Please give any additional relevant comments to the Transport Section below

Occupants will be provided with adequate and secure cycle storage to promote sustainable means of transportation.

4 BIODIVERSITY

4.1 Minimising the threat to biodiversity from new buildings, lighting, hard surfacing and people

a. Does your development involve the loss of an ecological feature or habitat, including a loss of garden or other green space? (Indicate if yes) ☑ *-2*

If so, please state how much in sqm? 165 sqm

b. Does your development involve the removal of any tree(s)? (Indicate if yes) *-* ☐

If so, has a tree report been provided in support of your application? (Indicate if yes) *-* ☐

c. Does your development plan to add (and not remove) any tree(s) on site? (Indicate if yes) *-* ☑

d. Please indicate which features and/or habitats that your development will incorporate to improve on site biodiversity:

Pond, reedbed or extensive native planting	*6*	☐	Area provided:		sqm
An extensive green roof	*5*	☐	Area provided:		sqm
An intensive green roof	*4*	☑	Area provided:		sqm
Garden space	*4*	☑	Area provided:		sqm
Additional native and/or wildlife friendly planting to peripheral areas	*3*	☑	Area provided:		sqm
Additional planting to peripheral areas	*2*	☐	Area provided:		sqm
A living wall	*2*	☐	Area provided:		sqm
Bat boxes	*0.5*	☐			
Bird boxes	*0.5*	☐			
Other	*0.5*	☐			

Subtotal 9

Please give any additional relevant comments to the Biodiversity Section below

Please refer to the Design and Access Statement in regards to landscape design.

5 FLOODING AND DRAINAGE

5.1 Mitigating the risks of flooding and other impacts of climate change in the borough

a. Is your site located in a high flood risk zone (Zone 3)? (Indicate if yes) ☐ *-2*

Have you submitted a Flood Risk Assessment? (Indicate if yes) ☑ *-*

b. Which of the following measures of the drainage hierarchy are incorporated onto your site? (tick all that apply)

Store rainwater for later use	☐	*5*
Use of infiltration techniques such as porous surfacing materials to allow drainage on-site	☑	*3*
Attenuate rainwater in ponds or open water features	☐	*4*
Store rainwater in tanks for gradual release to a watercourse	☐	*3*
Discharge rainwater directly to watercourse	☐	*2*
Discharge rainwater to surface water drain	☐	*1*
Discharge rainwater to combined sewer	☑	*0*

c. Please give the change in area of permeable surfacing which will result from your development proposal: sqm

Please provide details of the permeable surfacing below *please represent a loss in permeable area as a negative number*

Subtotal 3

Please give any additional relevant comments to the Flooding and Drainage Section below

Please refer to the Flood Risk Assessment prepared for the scheme.

6 IMPROVING RESOURCE EFFICIENCY

6.1 Reduce waste generated and amount disposed of by landfill though increasing level of re-use and recycling

a. Will demolition be required on your site prior to construction? *[Points will only be awarded if 10% or greater of demolition waste is reused/recycled]* ☑ *1*

If so, what percentage of demolition waste will be reused in the new development? 0 %

What percentage of demolition waste will be recycled? 0 %

b. Does your site have any contaminated land? ☐ *1*

Have you submitted an assessment of the site contamination?	☐	*2*
Are plans in place to remediate the contamination?	☐	*2*
Have you submitted a remediation plan?	☐	*1*
Are plans in place to include composting on site?	☐	*1*

6.2 Reducing levels of water waste

a. Will the following measures of water conservation be incorporated into the development? (Please tick all that apply):

Fitting of water efficient taps, shower heads etc	☑	*1*
Use of water efficient A or B rated appliances	☑	*1*
Rainwater harvesting for internal use	☐	*4*
Greywater systems	☐	*4*
Fit a water meter	☑	*1*

Subtotal 3

Please give any additional relevant comments to the Improving Resource Efficiency Section below

7 ACCESSIBILITY

7.1 Ensure flexible adaptable and long-term use of structures

a. **If the development is residential,** will it meet the requirements of the nationally described space standard for internal space and layout? ☑ *1*

If the standards are not met, in the space below, please provide details of the functionality of the internal space and layout

AND

b. **If the development is residential**, will it meet Building Regulation Requirement M4 (2) ‘accessible and adaptable dwellings’? ☑ *2*

If this is not met, in the space below, please provide details of any accessibility measures included in the development.

For major residential developments, are 10% or more of the units in the development to Building Regulation Requirement M4 (3) ‘wheelchair user dwellings’? ☐ *1*

OR

c. **If the development is non-residential,** does it comply with requirements included in Richmond's Design for Maximum Access SPG ☐ *2*

Please provide details of the accessibility measures specified in the Maximum Access SPG that will be included in the development

Subtotal 3

Please give any additional relevant comments to the Design Standards and Accessibility Section below

LBRUT Sustainable Construction Checklist- Scoring Matrix for *New Construction* **(Non-Residential and domestic refurb)**

TOTAL ***44***

Score	**Rating**	**Significance**
80 or more	*A+*	Project strives to achieve highest standard in energy efficient sustainable development
71-79	*A*	Makes a major contribution towards achieving sustainable development in Richmond
51-70	*B*	Helps to significantly improve the Borough's stock of sustainable developments
36-50	*C*	Minimal effort to increase sustainability beyond general compliance
35 or less	*FAIL*	Does not comply with SPD Policy

LBRUT Sustainable Construction Checklist- Scoring Matrix for New Construction **Residential new-build**

Score	**Rating**	**Significance**
81 or more	**A++**	Project strives to achieve highest standard in energy efficient sustainable development
64-80	*A+*	Project strives to achieve highest standard in energy efficient sustainable development
55-63	*A*	Makes a major contribution towards achieving sustainable development in Richmond
35-54	*B*	Helps to significantly improve the Borough's stock of sustainable developments
20-34	*C*	Minimal effort to increase sustainability beyond general compliance
19 or less	*FAIL*	Does not comply with SPD Policy

Authorisation:

I herewith declare that I have filled in this form to the best of my knowledge

Signature Panos Dalapas

Date 15-12-16