Persephone Gardens

Energy Statement

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1.0 Executive Summary

This preliminary report considers the predicted energy demand for the proposed Persephone Gardens development in West Hampstead, London, hereafter referred to as the 'Development'.

This document complies with the requirements at both national and local level, as set out in the National Planning Policy Framework (2012), The London Plan (March 2016) Camden Local Plan (2017) and Camden Planning Guidance (CPG3), 2015.

The energy requirements of the Development have been modelled in compliance with Part L2A and L1A of the Building Regulations 2013 and are based on the site layout plans provided by Robin Partington & Partners.

This report includes annualised baseline calculations which predict the likely energy consumption and associated CO_2 emissions for this Development. The total baseline energy and carbon emissions for the Development, taking into account regulated energy demands are:

- **922,061 kWh/annum**
- **303.17 Tonnes CO_2/annum**

Unregulated energy use is not covered by existing regulations and includes energy consumed by the occupants through activities and appliances; in this case it would typically be small power usage (appliances, computers, equipment etc.). The following unregulated energy use for the Development was calculated:

- **649,196 kWh/annum**
- **198.52 Tonnes CO_2/annum**

The following energy hierarchy has been adhered to in order to determine the most appropriate strategy for the Development:

1. **Be Lean**, Reduce energy and carbon emissions through the use of passive design and energy efficiency measures;
2. **Be Clean**, Reduce energy and carbon emissions by investigating the possibility of installing a site wide Combined Heat and Power (CHP) system or connecting to an existing decentralised CHP network;
3. **Be Green**, Reduce energy and carbon emissions by installing Low or Zero Carbon Technologies such as Air Source Heat Pumps (ASHP), Solar panels, Photovoltaics (PV), Wind Turbines etc.

Be Lean

In order to initially reduce carbon emissions from a base Part L 2013 compliant Development, the following passive design and energy efficiency measures have been incorporated:

- Improve the thermal performance of the building fabric for the new build elements beyond with Part L 2013;

- The use of accredited construction details within the residential element in accordance with Appendix K, SAP 2012;
- The provision of energy efficient lighting (PIR controls and occupancy sensing in relevant areas of the retail and community units);
- The provision of zonal thermal and lighting controls;
- The provision of variable speed pumps and fans;
- The enhancement of pipework and ductwork, thermal insulation;
- The use of energy efficient mechanical ventilation with heat recovery;
- Electric Power Factor correction;
- Specific Fan Powers improved beyond Part L requirements.

Further examples of the proposed measures to be provided are in Section 7.0 'Passive Design and Energy Efficiency Measures' of this report.

Following the above measures being incorporated the total baseline energy and carbon emissions for the Development, taking into account regulated energy demands, are reduced to:

- **894,981 kWh/annum**
- **294.14 Tonnes CO_2/annum**

Be Clean

In accordance with The London Plan March 2016 and the London Borough of Camden CPG3 (2015) the following energy strategies have been considered for the development:

1. Connection to an existing Combined Cooling Heating and Power (CCHP)/ Combined Heating and Power (CHP) distribution Networks
   - There are currently no available CCHP/CHP distribution networks to connect to.
2. A Gas fired Central CHP Plant
   - In order to economically justify installing a CHP unit on site, a minimum requirement of 4000 hours running time per year is necessary. Based on the heating and the hot water demand of the apartments and commercial space, a gas fired CHP is appropriate and therefore proposed.

Following the CHP being incorporated the total baseline energy and carbon emissions for the development, taking into account regulated energy demands, are reduced to:

- **766,641 kWh/annum**
- **228.16 Tonnes CO_2/annum**

Be Green

A range of low or zero carbon technologies have been considered for incorporation within the proposed Development; it has been proposed in this case that Photovoltaic (PV) Panels are feasible and should be utilised on the Development within the commercial element.

Further details of the feasibility analysis of low or zero carbon technologies are in Section 9.0 'Renewable Energy' of this report.

Following the inclusion of the on-site renewable technology, the total baseline energy and carbon emissions for the Development, taking into account regulated energy demands have further reduced to:

- **762,599 kWh/annum**
- **226.44 Tonnes CO_2/annum**

Proposed Energy Strategy for Persephone Gardens:

In summary the energy strategy comprises of:

1. Passive Design and Energy Efficient Measures (Section 7.0);
2. Combined Heat and Power (CHP) (Section 8.0); and
3. Photovoltaics (Section 9.0).

The scheme takes into consideration the site layout and requirements for the building type to produce a design that incorporates the most appropriate technologies available to the site. This provides a scheme that is commercially viable whilst targeting compliance with all policies applicable to this development.

The Energy Strategy consists of passive design and energy efficient measures such as the provision of energy efficient lighting and the provision of time and temperature zone heating controls. The use of further/emerging technologies may be included for use within this development if their feasibility increases in the future, in line with best practice.

This review has resulted in the formulation of an Energy Strategy to be adopted for the development involving the use of passive design and energy efficiency measures, CHP and the installation of PV; which achieves compliance with Part L2A and L1A 2013, the London Borough of Camden's Local Planning Guidance, CPG3 requirements, and targets compliance with The London Plan 2016 requirements.

The following Table 2.1 and 2.2 highlights the carbon and energy savings that are currently anticipated for the Development from a base Part L2A and L1A 2013 compliant build.

	Carbon Dioxide Emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline : Part L 2013 of the Building Regulations Compliant Development	303.17	198.52
After Energy Demand Reduction	294.14	It is anticipated that a circa 3% saving can be achieved through the use of energy efficient equipment, for example A or A+ appliances. This would reduce the unregulated carbon emissions to: 192.56
After CHP	228.16	
After PV	226.44	

Table 2.1 Carbon Dioxide Emissions Development

	Regulated Carbon Dioxide Savings	
	Tonnes CO_2 per annum	%
Savings from energy demand reduction	9.03	2.98
Savings from CHP	65.98	21.76
Savings from PV	1.72	0.57
Total Cumulative Savings	**76.73**	**25.31**
Total Target Savings	**106.11**	**35%**
Annual Shortfall	**29.38**	**9.69%**

Table 2.2 Regulated Carbon Savings Development

The proposed Development includes residential and commercial elements, the following Table 2.3 and Table 2.4 demonstrates the carbon savings achieved independently by the non-residential and residential elements respectively.

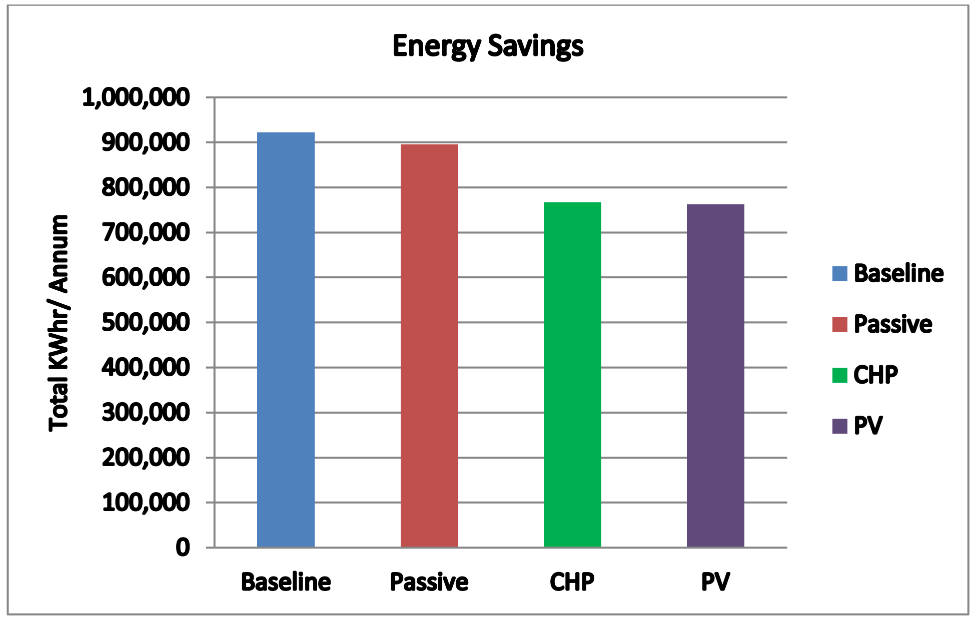
	Regulated Carbon Dioxide Savings	
	Tonnes CO_2 per annum	%
Savings from energy demand reduction	5.88	3.10%
Savings from CHP	34.18	18.03%
Savings from PV	1.72	0.91%
Total Cumulative Savings	**41.78**	**22.04%**
Total Target Savings	**66.35**	**35.00%**
Annual Shortfall	**24.57**	**12.96%**

Table 2.3 Regulated Carbon Savings Non-Residential (Part L2A)

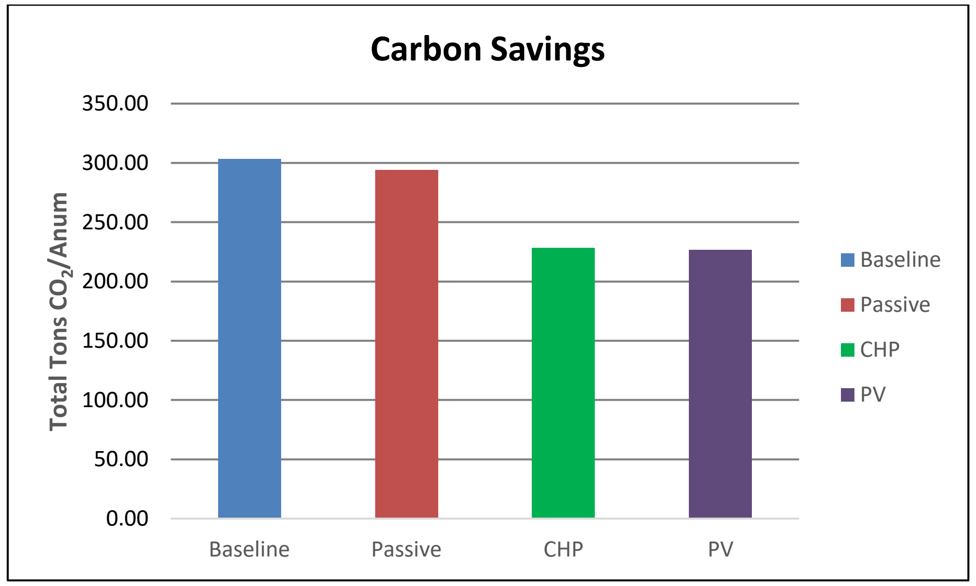
	Regulated Carbon Dioxide Savings	
	Tonnes CO_2 per annum	%
Savings from energy demand reduction	3.15	2.77%
Savings from CHP	31.80	27.99%
Total Cumulative Savings	**34.95**	**30.76%**
Total Target Savings	**113.60**	**100%**
Annual Shortfall - To Zero Carbon	**78.65**	**69.24%**

Table 2.4 Regulated Carbon Savings Residential (Part L1A)

The London Plan requires all major developments to achieve a 40% carbon reduction beyond Part L 2010 and the GLA Supplementary Planning Guidance, April 2014, requires all major developments to achieve 35% carbon reduction beyond Part L 2013. The Housing Supplementary Planning Guidance, March 2016, Standard 35, requires residential development proposals to achieve zero carbon from the 1st of October 2016. The Mayor's Housing Standards' Viability Assessment assumed a carbon off-set price of £60 per tonne of carbon dioxide for a period of 30 years. The Development has an anticipated CO_2 improvement of 25.31% beyond Part L 2013. This provides a shortfall of 9.69% with The London Plan, March 2016; therefore a financial contribution shall be required by the Council. The Development achieves a 22.33% carbon saving from the use of combined heat and power and photovoltaics. The energy and carbon savings achieved for the Development can be visually represented as per Graphs 1.1 and 1.2 below.



Graph 1.1: Cumulative Annual Energy Savings



Graph 1.2: Cumulative Annual Carbon Savings

2.0 Introduction

This report has been prepared by the Cudd Bentley Consulting Sustainability Team to develop an energy strategy for the proposed Development at Persephone Gardens. The proposed Development is located in West Hampstead and the planning application shall include 82 No. apartments and a care home with 15 No. care rooms, associated communal areas for residents including a pool, gym and restaurant as well as landscaping. This document will be considered as part of the planning application.

The Cudd Bentley Consulting (CBC) Sustainability Team consists of a variety of qualified Engineers and Environmental Consultants with a broad range of backgrounds including Mechanical Engineering, Building Services Engineering and Environmental Science. The CBC Sustainability Team are CIBSE Low Carbon Consultants, CIBSE Low Carbon Energy Assessors, Domestic Energy Assessors, BREEAM Assessors and Accredited Professionals. This broad range of knowledge and qualification allows the CBC Sustainability Team to produce sustainability documentation for planning submissions that are tailored to the individual requirements of the Development and to ensure National and Local Policy compliance is demonstrated with clarity.

Government policies now require significant energy reductions from proposed buildings. Building a greener future sets a planned trajectory outlined via Part L 2013 of the Building Regulations. These commitments have been the key focus point in addressing policies and strategies to reduce energy use and carbon emissions through energy efficiency and low or zero carbon technologies (LZC).

In line with the National and Local Policy and best practice the following approach has been adopted in forming the energy strategy for the development:

1. To propose to improve the building fabric from minimum Part L 2013 Building Regulations requirements; (BE LEAN)
2. To propose to reduce energy consumption and carbon dioxide emissions through passive and energy efficiency measures; (BE LEAN)
3. Investigate the feasibility of connecting into an existing district heat network and where this is not available investigate the feasibility of providing a Central CHP Plant to serve the base heating and hot water requirements for the development; (BE CLEAN)
4. To propose to reduce energy consumption and carbon dioxide emissions further through the use of on-site renewable / LZC energy technologies. (BE GREEN)

The recommended strategy takes into consideration the site layout and requirements for the building to produce a design that incorporates the most appropriate technologies available to the site that are commercially viable, whilst targeting compliance with all policies applicable to this development.

3.0 Policy Review

National Planning Policy

An effective planning system is required to contribute to achieving sustainable development. The ***National Planning Policy Framework*** (NPPF), 2012, outlines what the government deems as sustainable development in England.

Sustainable development is described as having three dimensions; economic, social and environmental.

1. Economic Role – Contributing to creating a strong competitive economy with affordable energy costs;
2. Social Role – Supporting communities to be strong and healthy by providing a high quality built environment, accessible local services and providing security of supply;
3. Environmental Role – contributing to protecting our environment, built, natural and historic by reducing carbon emissions and promoting a move to a low carbon economy.

The above three dimensional scenario can be described as an energy trilemma, this is demonstrated in Fig 3.1 below. Each dimension is dependent on each other and sustainable development proposals should adhere to each role. This energy statement shall ensure the proposed Development is one that contributes economically, socially and environmentally in accordance with the NPPF, 2012.

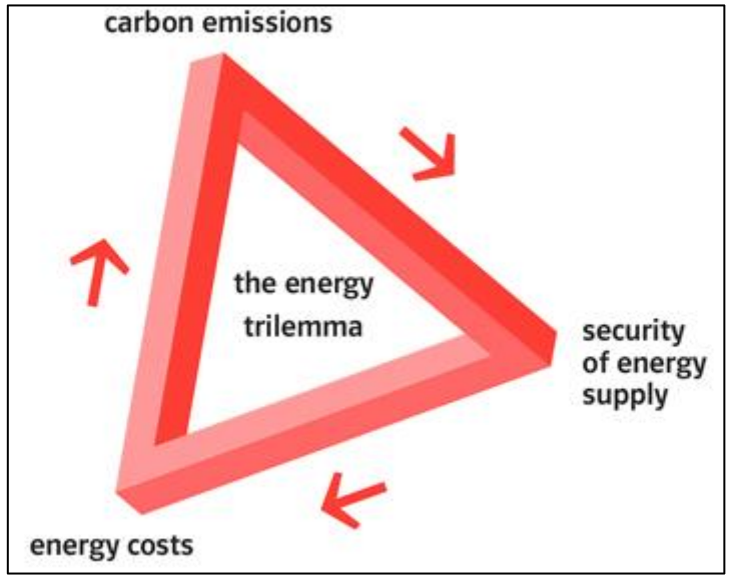


Fig 3.1 The Energy Trilemma

Guidance has been followed from the ***National Planning Policy Framework*** (NPPF), 2012, to provide an energy strategy which reduces energy use and carbon emissions, in line with best practice. This will provide a balanced scheme which focuses on optimal use of non-renewable resources (energy efficiency measures) whilst providing a renewable energy strategy best suited to the sites and their building uses. Below are some key extracts relevant to the development from Chapter ten 'Meeting the Challenge of Climate Change, Flooding & Coastal Change':

Paragraph 94

Local planning authorities should adopt proactive strategies to mitigate and adapt to climate change.

Paragraph 95

Local Planning authorities should:

- Plan for new development in locations & ways which reduce greenhouse gas emissions;
- Actively support energy efficiency improvements to existing buildings.

Paragraph 96

Local authorities should expect new developments:

- To comply with adopted Local Plan policies on local requirements for decentralised energy supply unless this can be demonstrated that this is not feasible or viable;
- To take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

Paragraph 97

Local planning authorities should recognise the responsibility on all communities to contribute to energy generation from renewable or low carbon sources. They should:

- Have a positive strategy to promote energy from renewable and low carbon sources;
- Design their policies to maximise renewable and low carbon energy development;
- Consider identifying suitable areas for renewable and low carbon energy sources and supporting infrastructure.

Identifying opportunities where development can draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.

The London Plan 2016

The London plan states that:

"*Tackling climate change will also require a move towards more sustainable energy sources, and the London Plan seeks to support the development of decentralised energy systems, including the use of low carbon and renewable energy and the greater utilisation of energy generated from waste*" (Chapter 5, Paragraph 5.9).

The following policies outline requirements made by the Greater London Authority in relation to climate change and energy use.

Policy 5.1 Climate Change Mitigation

The Mayor seeks to achieve an overall reduction in London's carbon dioxide emissions of 60 per cent (below 1990 levels) by 2025. All Boroughs are to develop policies to promote the reduction of carbon dioxide emissions and to help achieve the mayor's strategic carbon dioxide emissions target.

Policy 5.2 Minimising Carbon Dioxide Emissions

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

- Be Lean: use less energy –This involves the use of passive and energy efficiency design measures to reduce the energy requirement and subsequent carbon footprint of the site. These provide a footprint which delivers compliance with Building Regulations Part L (2013) and the Baseline Energy and Carbon emission figures for the development;
- Be Clean: supply energy efficiently – The use of a central energy centre has been considered to serve the development, to provide the primary heating and cooling requirements for the development;
- Be Green: use renewable energy – The use of renewable energy has been investigated in the context of the site and the overall usage patterns of energy throughout the development.

Development proposals are required to demonstrate via an energy assessment that the development achieves a 40% reduction in carbon emissions beyond Part L 2010.

Policy 5.3 Sustainable Design and Construction

Development proposals should demonstrate that sustainable design standards are integral to the proposal. This should include:

- Minimising carbon dioxide emissions across the site, including the building and services (such as heating and cooling systems);
- Avoiding internal overheating and contributing to the urban heat island effect;
- Efficient use of natural resources (including water), including making the most of natural systems both within and around buildings;
- Minimising pollution (including noise, air and urban runoff);
- Minimising the generation of waste and maximising reuse or recycling;
- Avoiding impacts from natural hazards (including flooding);
- Ensuring developments are comfortable and secure for users, including avoiding the creation of adverse local climatic conditions;
- Securing sustainable procurement of materials, using local supplies where feasible, and;
- Promoting and protecting biodiversity and green infrastructure

Design features such as green roofs can enhance biodiversity, absorb rainfall, improve the performance of the building, reduce the urban heat island effect and improve the appearance of a development.

Policy 5.5 Decentralised Energy Networks

- The Mayor expects 25 per cent of the heat and power used in London to be generated through the use of localised decentralised energy systems by 2025.
- The Mayor prioritises the development of decentralised heating and cooling networks at the development and area wide levels, including larger scale heat transmission networks.
- Boroughs are to develop policies and proposals to identify and establish decentralised energy network opportunities.

Policy 5.6 Decentralised Energy in Development Proposals

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.

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

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

Policy 5.7 Renewable Energy

The Mayor seeks to increase the proportion of energy generated from renewable sources. Development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.

Policy 5.8 Innovative Energy Technologies

The Mayor supports and encourages the more widespread use of innovative energy technologies to reduce use of fossil fuels and carbon dioxide emissions. The Mayor will seek to work with Boroughs that are interested in the following technologies:

1. Electric and hydrogen fuel cell vehicles;
2. Hydrogen supply and distribution infrastructure;
3. Anaerobic digestion, gasification and pyrolysis for the treatment of waste.

Policy 5.9 Overheating and Cooling

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

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

1. Minimise internal heat generation through energy efficient design
2. Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls
3. Manage the heat within the building through exposed internal thermal mass and high ceilings
4. Passive ventilation
5. Mechanical ventilation
6. Active cooling systems (ensuring they are the lowest carbon options).

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

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

Greater London Authority Sustainable Design and Construction Supplementary Planning Guidance (2014)

2.4 Energy and Carbon Dioxide Emissions

In line with The London Plan Policy 5.2 the following carbon savings are required:

Residential:

• 2013 – 2016 40% improvement beyond 2010 Building Regulations;

• 2016 – 2031 Zero carbon.

Non-domestic:

• 2013 – 2016 40% improvement beyond 2010 Building Regulations;

• 2016 – 2019 As per the Building Regulations requirements;

• 2019 – 2031 Zero carbon.

To avoid complexity and extra costs, the Mayor has adopted a flat carbon dioxide improvement beyond Part L 2013 of 35% for both residential and non-residential developments.

Local Planning Policy

Camden Planning Guidance Sustainability – CPG3 (2015)

Section 3 – Energy Efficiency: New Buildings

- All developments are to be designed to minimise carbon dioxide emissions;
- The most cost effective ways to minimise energy demand are through good design and high levels of insulation and air tightness.

Section 4 – Energy Efficiency: Existing Buildings

- As a guide, at least 10% of the project cost should be spent on environmental improvements;
- Potential measures will be bespoke to each property;
- Sensitive improvements can be made to historic buildings to reduce carbon dioxide emissions.

Section 5 – Decentralised Energy Networks and Combined Heat and Power

- Decentralised energy could provide 20% of Camden's heating demand by 2020;
- Combined heat and power plants can reduce carbon dioxide emissions by 30-40% compared to a conventional gas boiler;
- Where feasible and viable your development will be required to connect to a decentralised energy network or include CHP.

Section 6 – Renewable Energy

- There are a variety of renewable energy technologies that can be installed to supplement a development's energy needs;
- Developments are to target a 20% reduction in carbon dioxide emissions from on-site renewable energy technologies.

Section 7 – Water Efficiency

- At least 50% of water consumed in homes and workplaces does not need to be of drinkable quality re-using water;
- All developments are to be water efficient;
- Developments over 10 units or 1000sq m should include grey water recycling.

Section 8 – Sustainable Use of Materials

- Reduce waste by firstly re-using your building, where this is not possible you should implement the waste hierarchy;
- The waste hierarchy prioritises the reduction, re-use and recycling of materials;
- Source your materials responsibly and ensure they are safe to health.

Section 10 – Brown Roofs, Green Roofs and Green Walls36

- All developments should incorporate green and brown roofs;
- The appropriate roof or wall will depend on the development, the location and other specific factors;
- Specific information needs to be submitted with applications for green/ brown roofs and walls.

Section 11 – Flooding

- Developments are required to prevent or mitigate against flooding;
- All developments are expected to manage drainage and surface water;
- There is a hierarchy you should follow when designing a sustainable drainage system.

Section 12 – Adapting to Climate Change

- All development should consider how it can be occupied in the future when the weather will be different;
- The early design stage is the most effective time to incorporate relevant design and technological measures.

Section 13 – Biodiversity

Proposals should demonstrate:

- How biodiversity considerations have been incorporated into the development;
- If any mitigation measures will be included;
- What positive measures for enhancing biodiversity are planned.

Camden Local Plan (Adoption Version) – June 2017

Policy CC1 Climate change mitigation

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

We will:

a. promote zero carbon development and require all development to reduce carbon dioxide emissions through following the steps in the energy hierarchy;

b. require all major development to demonstrate how London Plan targets for carbon dioxide emissions have been met;

c. ensure that the location of development and mix of land uses minimise the need to travel by car and help to support decentralised energy networks;

d. support and encourage sensitive energy efficiency improvements to existing buildings;

e. require all proposals that involve substantial demolition to demonstrate that it is not possible to retain and improve the existing building; and

f. expect all developments to optimise resource efficiency.

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

g. working with local organisations and developers to implement decentralised energy networks in the parts of Camden most likely to support them;

h. protecting existing decentralised energy networks (e.g. at Gower Street, Bloomsbury, King's Cross, Gospel Oak and Somers Town) and safeguarding potential network routes; and

i. requiring all major developments to assess the feasibility of connecting to an existing decentralised energy network, or where this is not possible establishing a new network.

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

Policy CC2 Adapting to climate change

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

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

a. the protection of existing green spaces and promoting new appropriate green infrastructure;

b. not increasing, and wherever possible reducing, surface water runoff through increasing permeable surfaces and use of Sustainable Drainage Systems;

c. incorporating bio-diverse roofs, combination green and blue roofs and green walls where appropriate; and

d. measures to reduce the impact of urban and dwelling overheating, including application of the cooling hierarchy.

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

Sustainable design and construction measures

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

e. ensuring development schemes demonstrate how adaptation measures and sustainable development principles have been incorporated into the design and proposed implementation;

f. encourage new build residential development to use the Home Quality Mark and Passivhaus design standards;

g. encouraging conversions and extensions of 500 sqm of residential floor space or above or five or more dwellings to achieve "excellent" in BREEAM domestic refurbishment; and

h. expecting non-domestic developments of 500 sqm of floor space or above to achieve "excellent" in BREEAM assessments and encouraging zero carbon in new development from 2019.

4.0 Development Approach

This report adopts the following approach to provide compliance with the Local and National Planning Policies:

1. To propose to improve building fabric from minimum Part L 2013 Building Regulations requirements;

2. To propose to reduce energy consumption and carbon dioxide emissions through passive and energy efficiency measures;
3. Investigate the feasibility of connecting into an existing district heat network and where this is not available investigate the feasibility of providing a Central CHP Plant to serve the base heating and hot water requirements for the development;
4. To propose to reduce energy consumption and carbon dioxide emissions further through the use of on-site renewable / LZC energy technologies.

5.0 Details of Proposed Development

The proposed Development is located in West Hampstead and the planning application shall include for a care home with 82 No. apartments and 15 No. care rooms, associated communal areas for residents including a pool, gym and restaurant as well as landscaping. The proposed lower plans are shown in Figures 5.1, 5.2 and 5.3.

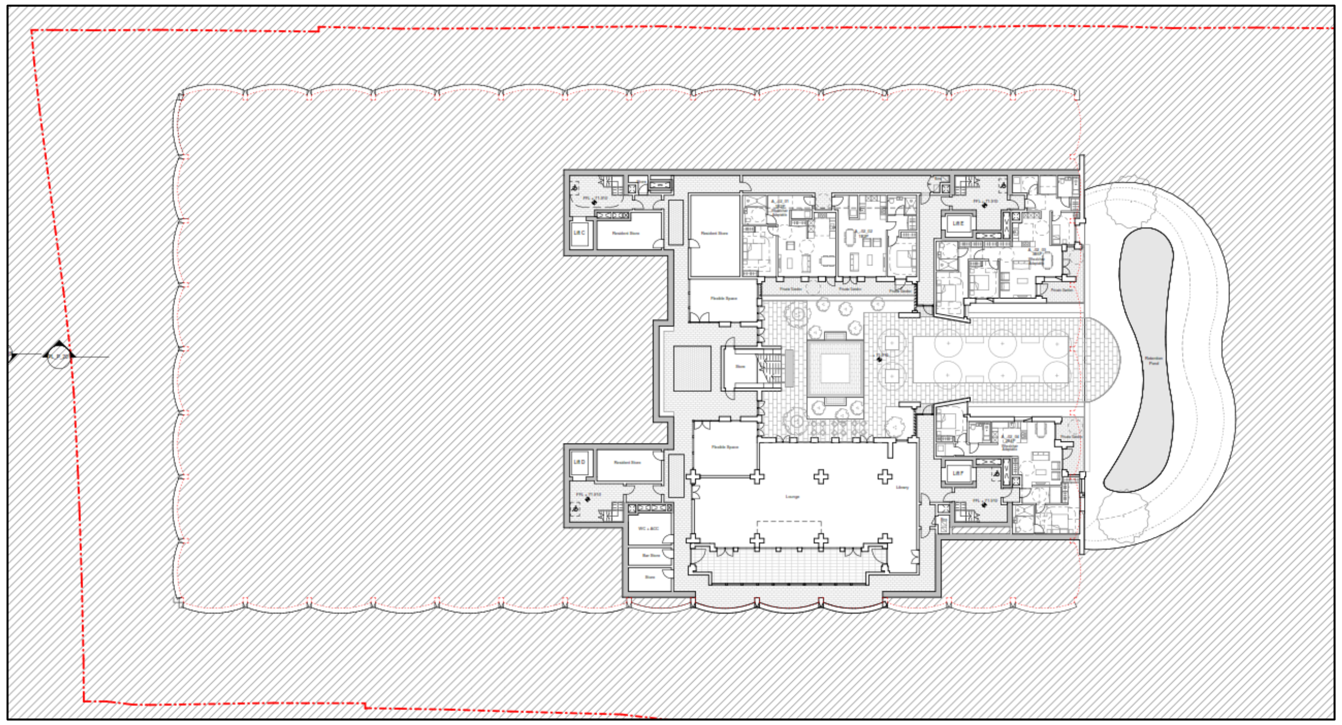


Figure 5.1 Proposed Level -02 Floor Layout

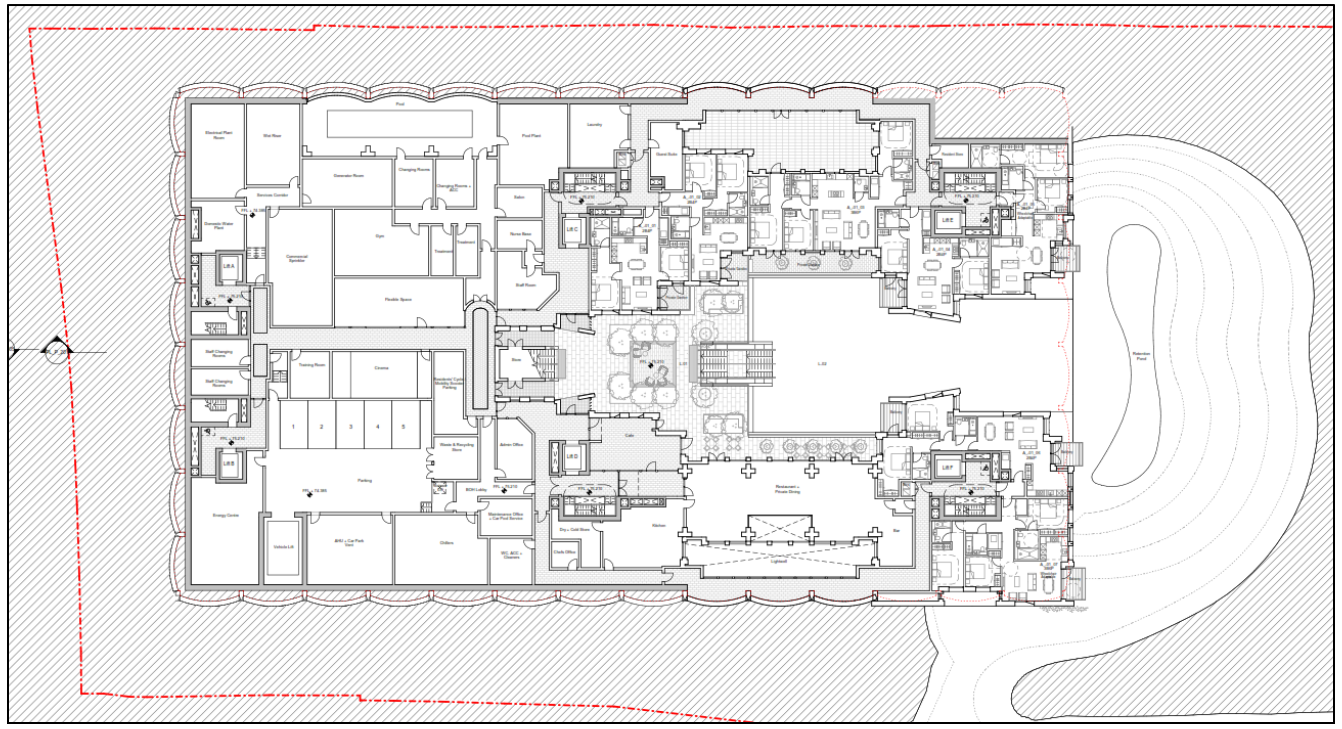


Figure 5.2 Proposed Level -01 Floor Layout

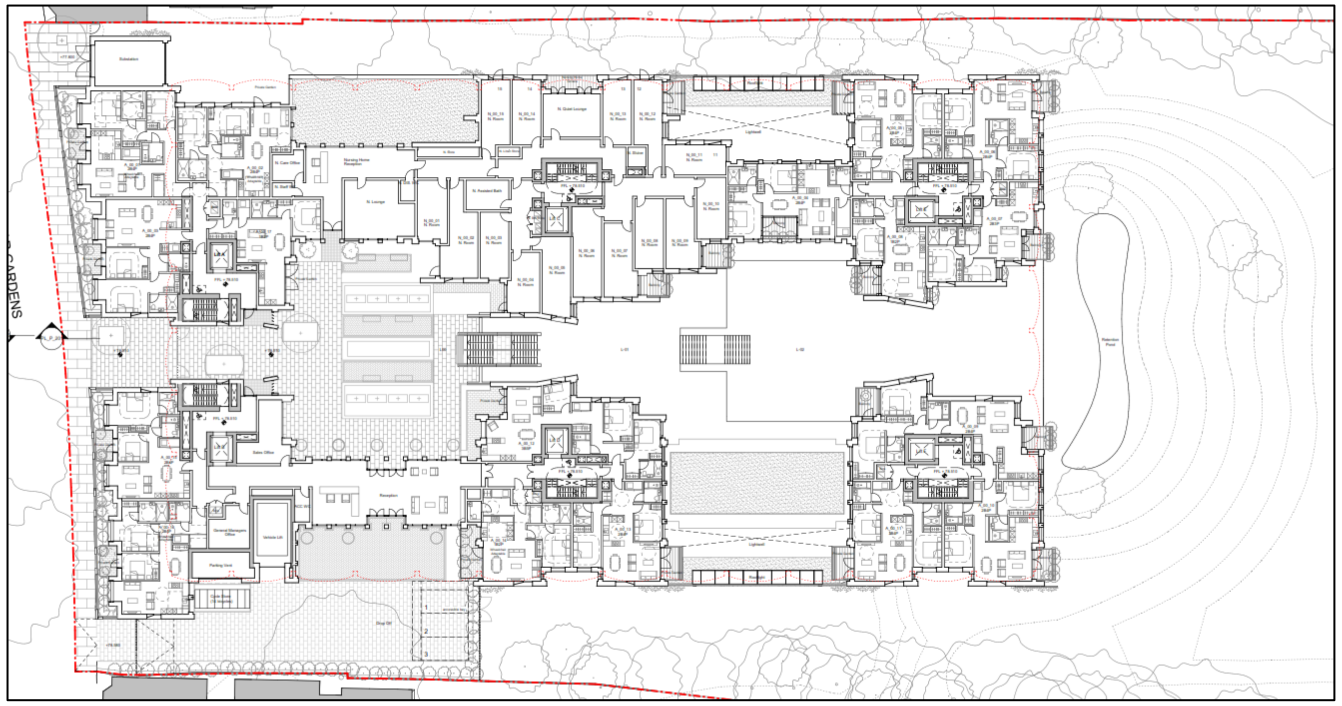


Figure 5.3 Proposed Level 00 Floor Layout

5.1 Building Regulations Part L

The proposed development consists of new build residential and commercial elements. The residential element of the Development is to be assessed under Part L1A 2013 of the Building Regulations. The proposed commercial elements of the Development shall be assessed under Part L2A 2013 of the Building Regulations.

6.0 Assessment of Baseline Energy Demand

The primary energy demands of the Development will be:

- Heating;
- Cooling;
- Lighting;
- Hot Water;
- General Power;
- Ventilation.

To assess the preliminary energy consumption of the Development, computer calculations have been completed using approved SBEM software (Bentley, Hevacomp, Version V8i, SS1 SP5) for the commercial elements and the residential elements have been assessed using approved SAP software (JPA Designer, Version 9.92). The calculations generate annualised energy consumption for the development, from which the “carbon footprint” can be assessed.

The assessment of the energy demand for the site has been based on the notional development according to the Development’s uses, through the construction of a building model in compliance with the requirements of Part L2A and L1A 2013 of the Building Regulations.

The total baseline energy and carbon emissions for the Development (built to Part L 2013), taking into account regulated energy demands are:

- **922,061 kWhr/annum**
- **303.17 Tonnes CO_2/annum**

(A full set of calculations supporting these figures included in Appendix A & B of this document)

7.0 Passive Design and Energy Efficient Measures

To provide carbon savings beyond a base Part L 2013 build and achieve compliance with local policies, the following passive design and energy efficiency measures are recommended.

7.1 Passive Design

Landscape – The surrounding landscape can have a positive and negative impact on the energy performance of a building. Shading from surrounding buildings and or trees can reduce solar gain but it can also increase the need for artificial lighting if daylight is blocked. The Development is located west of Hampstead and south of Hampstead Cemetery and is surrounded by residential properties. Due to the size of the site, potential landscape benefits can be investigated, including green roofs. The design of the Development, being built in different blocks at upper levels, will provide shading on itself and therefore reduce solar gain.

Layout & Design – The proposed layout of a building can have an impact on the energy consumption. The position and size of windows for example will determine the amount of daylight, solar gains and natural ventilation the building will receive. The residential units within the Development contain a range of orientations, with a number of residential units facing south west and south east. The surrounding buildings and the proposed Development itself will provide shading and therefore reduce the associated solar gain.

Orientation – Orientation plays a critical role in passive design, with the south side of a building receiving the most sunshine hours per day. The east and west orientations however receive the most intensive sunshine hours in the morning and evening respectively. The proposed Development has facades facing each direction and therefore a number of apartments would benefit from the morning and afternoon sun. However, the Development consists of 3 separate blocks at the upper two levels which will aid with preventing solar overheating. Furthermore, the Development shall be located adjacent to other buildings, the outline of adjacent buildings can be seen in Figure 7.1 below.

Figure 7.1 Proposed Development South Elevation

7.2 Thermal Efficiency

In order to achieve compliance with Building Regulations the following 'U' values shall be incorporated within the residential element of the development, in accordance with Part L1A (2013), these 'U' values go beyond the minimum requirements of Part L1A 2013.

- External Walls - U = 0.18 W/m².K;
- Exposed Floors - U = 0.13 W/m².K;
- Exposed Roofs - U = 0.13 W/m².K;
- Glazing - U = 1.4 W/m².K; G' value of 0.63;
- Air Permeability - 4 $m^3/hr/m^2$@ 50 Pa.
- Accredited Construction Details in accordance with Table K1 of Appendix K, Sap 2012, see Appendix D.

The following 'U' values shall be incorporated within the commercial element of the development, in accordance with Part L2A (2013), these 'U' values go beyond the minimum requirements of Part L2A 2013.

- External Walls - U = 0.22 W/m².K;
- Exposed Floors - U = 0.20 W/m².K;
- Exposed Roofs - U = 0.16 W/m².K;
- Glazing - U = 1.4 W/m².K; G' value of 0.43;
- Air Permeability - 4 $m^3/hr/m^2$@ 50 Pa.

7.3 Energy Efficiency Measures

Together with the above passive design measures, the proposed energy strategy includes the following energy efficiency measures throughout the development:

- The provision of energy efficient lighting, to achieve 2.4 W/m^2 @ 100 lux delivered, 100% energy efficient light fittings to the residential units;
- The provision of energy efficient lighting control (PIR controls, daylight sensing and occupancy sensing in relevant areas);
- The provision of zonal thermal controls;
- The provision of energy and light metering, to warn out of range values;
- The provision of variable speed pumps and fans;
- The enhancement of pipework and ductwork, thermal insulation;
- The use of energy efficient heat recovery, to achieve 80% η;
- Electric Power Factor correction;
- LENI calculations to be carried out;

- Specific Fan Powers improved beyond Part L requirements;
- Fully insulated primary pipework;
- Water consumption limited to 110 litres/person/day;
- The use of Accredited Construction details in accordance with Appendix K of Sap 2012 (Table can be seen in Appendix D).

From the utilisation of the above passive design and energy efficiency measures the total energy and carbon emissions for the development (built to Part L 2013) are reduced to:

- **894,981 kWhr/annum**
- **294.14 Tonnes CO_2/annum**

(A full set of calculations supporting these figures included in Appendix A & B of this document)

7.4 Cooling

In order to prevent and mitigate any potential overheating risks and minimise excessive heat generation contributing to the urban heat island effect, in accordance with Policy 5.9 of the London Plan 2015, the following design strategies have been considered for inclusion within the development following the GLA cooling hierarchy.

Cooling Hierarchy	Design Strategy
Minimise internal heat generation through energy efficient design.	Energy efficient measures as per the list above in Section 7.0.
Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls.	Improved double glazing will be provided with low G values and shading co-efficient to limit the effects of solar gain; Green roofs are to be included.
Manage the heat within the building through exposed internal thermal mass and high ceilings.	The residential units have a finished floor to ceiling level of 2.6m. High thermal mass of existing brick reservoir structure is retained within the restaurant, lounge and pool areas.
Passive ventilation.	Openable windows will be provided to provide a degree of passive ventilation.
Mechanical ventilation.	Energy efficient mechanical ventilation with heat recovery to be provided to the commercial areas.
Active cooling systems (ensuring they are the lowest carbon options).	Cooling is to be provided for the commercial and residential areas via a high efficiency chiller. Due to the potential vulnerability of the residential tenants, cooling is provided to the lounges and bedrooms within the residential areas, however the measures outlined in section 7.0 shall minimise the amount of cooling required.

SBEM & SAP calculations have been used to check compliance with Building Regulations; summertime temperature. Current SBEM models and SAP calculations confirm that the risk of overheating is considered to be within acceptable limits.

8.0 Decentralised Energy

Combined heat and power (CHP), also known as co-generation, is the simultaneous generation of both usable heat and electrical power from the same source. CHP provides heat and electricity at a reduced carbon cost and can therefore offer energy efficiency for developments that have a large and constant heat demand.

8.1 Existing Community Heating Network

The London Heat Map has been used to determine the proximity of existing Energy Centres surrounding the Development. The London Heat Map confirms that there are no existing District Heating Networks within proximity to the Development. It is anticipated that the Development will be designed to allow connection to the network, should it prove to be viable in the future.

8.2 Site Wide CHP

A centralised CHP option has been considered for the site, whereby a central CHP plant would provide 55% of the heating and hot water requirement for the apartments, 60% of the heating and 100% of the hot water to the commercial areas through a community heating network.

For the provision of a CHP installation to be commercially viable a base load, in this case heating and domestic hot water must extend for a minimum operational period of 4,000 – 5,000 hours per annum.

<table>
<tr><th>Months</th><th>Load per Day (hrs)</th><th>Load per week (hrs)</th><th>Load per month (hrs)</th><th colspan="2">Load for 6 months (hrs)</th></tr>
<tr><td>April to Sept</td><td>10</td><td>70</td><td>280</td><td colspan="2">1,680</td></tr>
<tr><td>October to March</td><td>18</td><td>126</td><td>504</td><td colspan="2">3,024</td></tr>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Total approximate Load for a year</td><td>4,704</td><td>hours</td></tr>
<tr><td colspan="2">Minimum required hours</td><td>4,000</td><td>hours</td></tr>
</table>

Table 8.1 CHP Loads

As can be seen from Table 8.1, there will be sufficient heating and hot water demand to justify the installation of a CHP system.

The exact CHP size will be subject to detailed calculations carried out at the technical design stage of the project.

Thermal storage capacity within individual plant and residential unit areas shall be provided to suit final calculations & load profiles, which shall ensure the CHP, is sized to meet the calculated heating and hotwater requirement to be delivered by the CHP unit. The plant should be run at maximum output for as long as possible with the ability to modulate down to maximise CHP running hours.

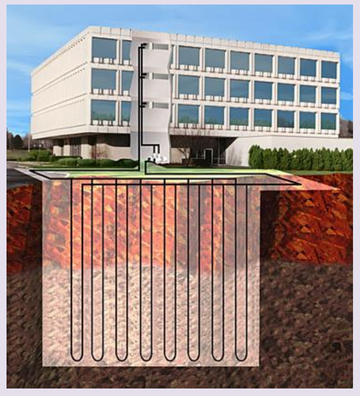
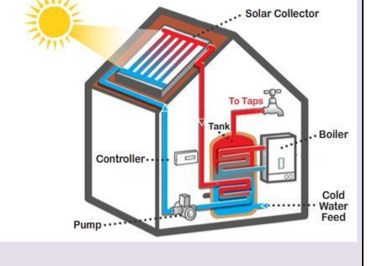
The proposed CHP plant location can be seen in Appendix F.

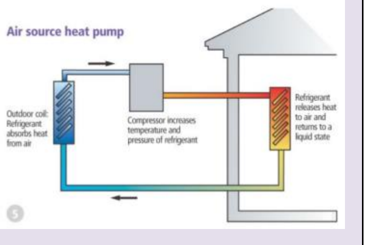
9.0 Renewable Energy

The use of renewable and low or zero carbon (LZC) technologies for the development has been addressed and the following, Table 9.1, reviews the primary options for generation of on-site renewable / LZC energy and considers their suitability for use on the development.

Renewable Technology Feasibility Assessment		**Feasible?**
Bio Fuel Boilers 	Bio-fuel boilers are specifically designed to burn solid biomass or liquid bio-fuel in order to heat water, or raise steam. This can then be used for space heating or DHW supply. Bio-fuel boilers are not proposed for use within the development for the following reasons: 1. Biomass boilers generate increased Oxides of Nitrogen (NOx) and particulates (PM10) which would affect air quality; 2. The requirement of bio-fuel would involve a vehicular movement of articulated lorries fortnightly delivering to the site. As this is a built up location, this would not be desirable; 3. The storage requirements for the biofuel would require a large plant space, with an auxiliary storage facility to allow for a two week period where delivery of fuel might not be available; 4. In accordance with the London Plan, in order to target a 35% carbon saving beyond Part L 2013, a CHP, a high efficiency chiller and PV's have been proposed as the most efficient way to meet the heating and cooling demands of the residential and commercial use; a bio-fuel boiler would run in conflict with the proposed technologies.	No
<u>Land Use</u> Large volumes of storage are required for fuel at ground level with sufficient vehicular access for fuel delivered. <u>Noise</u> Noise levels are generated by the operation of the bio-fuel boiler and associated deliveries of the bio-fuel. The plant room enclosure would have to be attenuated to acceptable levels imposed by planning and Acoustician recommendations. Delivery schedules would have to be scheduled to minimise potential noise issues.		

Renewable Technology Feasibility Assessment		**Feasible?**
Wind Turbines 	Wind turbines convert the kinetic energy in the wind into mechanical energy which is then converted into electricity. Wind turbines can provide electrical power either directly to a load or via a battery system Wind Turbines are not proposed for use within the development for the following reasons: 1. Wind turbines are considered inappropriate on spatial, planning, aesthetic and noise grounds due to the urban location. Noise pollution from wind turbines can be quite significant within a few hundred metres; 2. Wind turbine construction can be very expensive; 3. The site is not ideal; an ideal site is a hill with a flat, clear exposure. It should be free from strong turbulence and obstructions like large trees, houses or other buildings. As the building is located in a built up urban area, other buildings and trees will produce turbulence; 4. The financial viability of a small scale installation on the site would be compromised by the operational efficiency of the units (circa 30%); 5. Wind turbines, can cause electrical interference within a 2km radius; 6. Wind speeds for the site can be seen in Appendix D. At 10m the wind speed is 4.8m/s and 5.6m/s at 25m.	No
<u>Land Use</u> The site plans demonstrate that there is in-sufficient space for the allocation of a suitably sized wind turbine. <u>Noise</u> Noise levels are generated by the rotating blades; these noise levels will vary dependent on wind velocity and will need to be in acceptable levels imposed by planning and Acoustician recommendations.		

Renewable Technology Feasibility Assessment		Feasible?
Ground Source Heat Pumps 	Space heating & cooling can be provided by circulating water heated or cooled directly by the ground or via subterranean water. Ground water cooling through the use of aquifers makes use of the relatively stable ground/ water temperature which is available at a temperature range of 10 – 14°C. Ground Source Heat Pumps (GSHP) are not proposed for use within the development for the following reasons 1. The installation of ground source heat pumps for this development would involve extensive excavation works; 2. Due to the location, extensive excavation works would be disruptive; 3. In accordance with the London Plan, in order to target a 35% carbon saving beyond Part L 2013, a CHP, a high efficiency chiller and PV's have been proposed as the most efficient way to meet the heating and cooling demands of the residential and commercial use; GSHP would run in conflict with these systems.	No
<u>Land Use</u> This installation would require Environmental Agency approval (if an open loop system connecting to an aquifer is selected). Ground and Hydrology analysis would be required to investigate if favourable conditions exist. <u>Noise</u> There are no noise issues generated by this technology.		
Solar Water Heating 	Solar Water Heating systems use radiant energy from the sun to heat water. Systems comprise of a roof mounted heat collector piped to a coil located within a hot water storage cylinder. Solar Panels are not proposed for use within the proposed development for the following reasons: 1. In accordance with the London Plan, in order to target a 35% carbon saving beyond Part L 2013, a CHP, a high efficiency chiller and PV's have been proposed as the most efficient way to meet the heating and cooling demands of the residential and	No

Renewable Technology Feasibility Assessment		Feasible?
	commercial use; solar water heating would run in conflict with the proposed technologies.	
<u>Land Use</u> Roof space is required for the installation of solar panels; optimum installation is south facing at an angle of 30 degrees. <u>Noise</u> Noise levels are generated by pumps at roof level, these are insignificant so should pose no issues.		
Air Source Heat Pumps 	An Air Source Heat Pump extracts heat from the outside air in the same way that a fridge extracts heat from its inside. It can extract heat from the air even when the outside temperature is as low as minus 15°C. Air Source Heat Pumps are not proposed for use within the Development for the following reasons: In accordance with the London Plan, in order to target a 35% carbon saving beyond Part L 2013, a CHP, a high efficiency chiller and PV's have been proposed as the most efficient way to meet the heating and cooling demands of the residential and commercial use; ASHP would run in conflict with these systems.	No
<u>Land Use</u> Air Source Heat Pumps can be installed on ground mounted, roof mounted or wall mounted frames. When installing Air Source Heat Pumps there are various factors to consider; Heat Pumps should be positioned to provide shelter from high winds which can reduce efficiency by causing defrost problems and be kept free from leaves and debris. <u>Noise</u> Noise levels are generated by fans, and compressors causing vibrations. The noise levels are dependent on manufacturer and vary accordingly, these will need to be in acceptable levels imposed by planning and Acoustician recommendations.		

Renewable Technology Feasibility Assessment		Feasible?
Photovoltaics 	Photovoltaic (PV) modules convert sunlight directly to DC electricity. The solar cells consist of a thin piece of semiconductor material, in most cases silicon. Mono-crystalline PVs are proposed for use within the commercial element of the development for the following reasons: • The roof space is free from any over-shading from surrounding buildings; • Photovoltaics assist with targeting the carbon saving requirements from the London Plan and the London Borough of Camden's CPG3, section 6.0; • Photovoltaics are a low maintenance technology; • They provide a visible contribution to the public, promoting the use of renewable energy; • It is proposed that a 5 kWpeak system is installed south facing on the roof which equates to 20 panels, 1.6m²/panel, 32m² in total. The proposed location of the PV panels can be seen in Appendix E. The amount of PV that has been proposed is based on other available roof space being utilised for plant space.	Yes
Land Use There are no land issues or adverse visual impacts as the photovoltaic panels are roof mounted. Noise There are no noise issues generated by this technology.		

Table 9.1 Renewable Technology Feasibility Assessment

10.0 Summary of Proposed Scheme

Consideration has been given in Sections 8.0 and 9.0 of this document to the options that are available for the development in relation to Low Zero Carbon technologies and renewable energy. The technologies considered are as follows:

- Decentralised Gas fired CHP;
- Bio-fuel boilers;
- Wind Turbine;
- Ground Source Heat Pump;
- Solar Water Heating;
- Air Source Heat Pump;
- Photovoltaics.

This review has resulted in the formulation of an Energy Strategy to be adopted for the development involving the installation of CHP and photovoltaic panels. The following Tables 10.1 and 10.2 highlight the carbon emissions and savings that are currently anticipated for the development. Based on the analysis within this report, it is confirmed that the development achieves compliance with Part L 2013 and targets compliance with Camden's CPG3 (2015) and with The London Plan, 2016. The following Table 10.1 and 10.2 highlight the carbon and energy savings that are currently anticipated for the development from a base Part L 2013 compliant build.

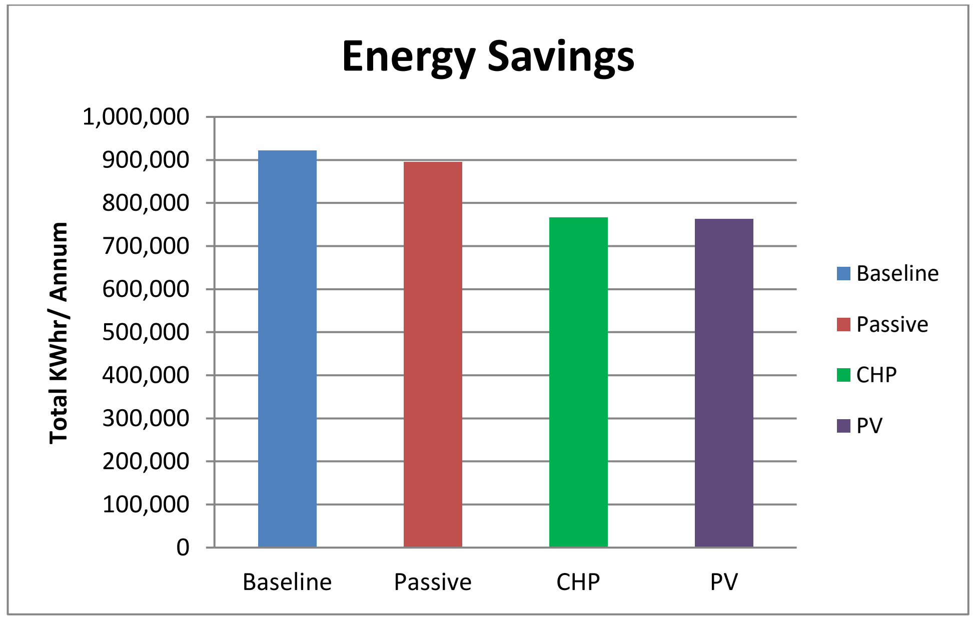
	Carbon Dioxide Emissions (Tonnes CO_2 per annum)	
	Regulated	**Unregulated**
Baseline : Part L 2013 of the Building Regulations Compliant Development	303.17	198.52
After Energy Demand Reduction	294.14	It is anticipated that a circa 3% saving can be achieved through the use of energy efficient equipment, for example A or A+ appliances. This would reduce the unregulated carbon emissions to: 192.56
After CHP	228.16	
After PV	226.44	

Table 10.1 Carbon Dioxide Emissions

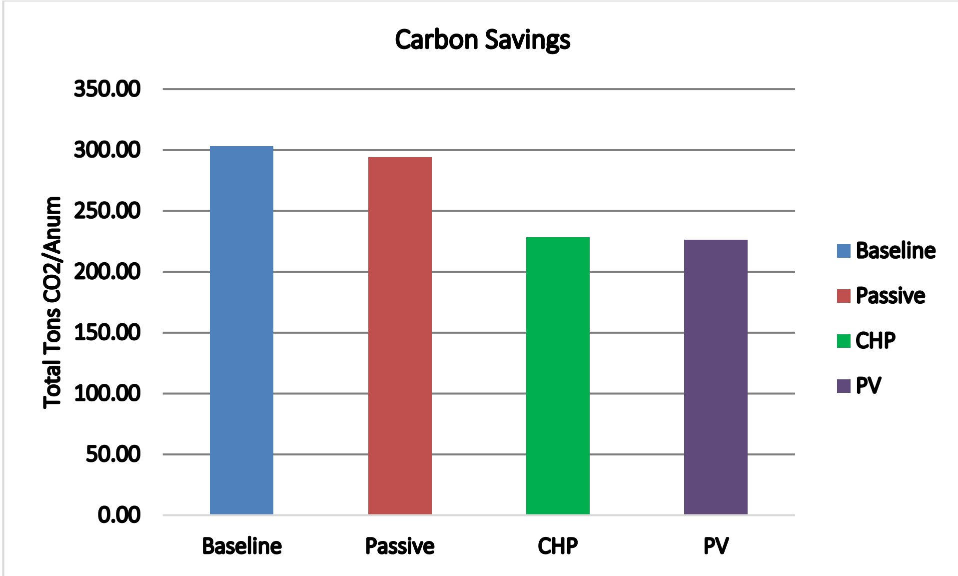
	Regulated Carbon Dioxide Savings	
	Tonnes CO_2 per annum	%
Savings from energy demand reduction	9.03	2.98
Savings from CHP	65.98	21.76
Savings from PV	1.72	0.57
Total Cumulative Savings	**76.73**	**25.31**
Total Target Savings	**106.11**	**35%**
Annual Shortfall	**29.38**	**9.69%**

Table 10.2 Regulated Carbon Savings

The London Plan requires all major developments to achieve a 40% carbon reduction beyond Part L 2010 and the GLA Supplementary Planning Guidance, April 2014, requires all major developments to achieve 35% carbon reduction beyond Part L 2013. The Housing Supplementary Planning Guidance, March 2016, Standard 35, requires residential development proposals to achieve zero carbon from the 1st of October 2016. The Mayor's Housing Standards' Viability Assessment assumed a carbon off-set price of £60 per tonne of carbon dioxide for a period of 30 years. The Development has an anticipated CO_2 improvement of 25.31% beyond Part L 2013. This provides a shortfall of 9.69% with The London Plan, March 2016; therefore a contribution shall be required. The Development achieves a 22.33% carbon saving from the use of combined heat and power and photovoltaics. The energy and carbon savings achieved can be visually represented as per Graphs 10.1 and 10.2 below:



Graph 10.1: Cumulative Annual Energy Savings



Graph 10.2: Cumulative Annual Carbon Savings

The use of further/emerging technologies may be included for use within this development if their feasibility increases in the future, also in accordance with best practice.

Appendix A – SBEM

Landlord Areas

Building Rating

	Heating	Cooling	Auxiliary	Lighting	Hot water	Total	
Actual	2.96	9.29	25.76	15.91	49.33	103.24	**kWh/m²**
Notional	5.45	11.06	23.03	17.38	48.91	105.83	**kWh/m²**

CO2 emissions mandatory requirement		
BER	37.8	**kgCO2/m²**
Notional	37.8	**kgCO2/m²**
TER	37.8	**kgCO2/m²**
Pass CO2	**Yes**	

Baseline

Building Rating

	Heating	Cooling	Auxiliary	Lighting	Hot water	Total	
Actual	2.38	8.79	24.79	15.27	49.33	100.55	**kWh/m²**
Notional	5.45	11.06	23.03	17.38	48.91	105.83	**kWh/m²**

CO2 emissions mandatory requirement		
BER	36.6	**kgCO2/m²**
Notional	37.8	**kgCO2/m²**
TER	37.8	**kgCO2/m²**
Pass CO2	**Yes**	

Baseline + Passive

Building Rating

	Heating	Cooling	Auxiliary	Lighting	Hot water	Total	
Actual	2.77	6.17	24.79	15.27	94.34	114.89	**kWh/m²**
Notional	5.45	11.06	23.03	17.38	48.91	105.83	**kWh/m²**

CO2 emissions mandatory requirement		
BER	30.2	**kgCO2/m²**
Notional	37.8	**kgCO2/m²**
TER	37.8	**kgCO2/m²**
Pass CO2	**Yes**	

Baseline + Passive + CHP

Building Rating

	Heating	Cooling	Auxiliary	Lighting	Hot water	Total	
Actual	2.77	6.17	24.79	15.27	94.34	114.89	kWh/m²
Notional	5.45	11.06	23.03	17.38	48.91	105.83	kWh/m²

CO2 emissions mandatory requirement		
BER	29.8	kgCO2/m²
Notional	37.8	kgCO2/m²
TER	37.8	kgCO2/m²
Pass CO2	Yes	

Baseline + Passive + CHP + 5kWp PV

Building Rating

	Heating	Cooling	Auxiliary	Lighting	Hot water	Total	
Actual	3.73	9.79	25.69	13.53	100.9	153.64	kWh/m²
Notional	5.92	13.75	19.48	18.01	99.42	156.58	kWh/m²

CO2 emissions mandatory requirement		
BER	47.4	kgCO2/m²
Notional	48.7	kgCO2/m²
TER	48.7	kgCO2/m²
Pass CO2	Yes	

Baseline + Passive

Nursing Home

Building Rating

	Heating	Cooling	Auxiliary	Lighting	Hot water	Total	
Actual	4.41	10.33	27.14	13.9	100.9	156.67	kWh/m²
Notional	5.92	13.75	19.48	18.01	99.42	156.58	kWh/m²

CO2 emissions mandatory requirement		
BER	48.7	kgCO2/m²
Notional	48.7	kgCO2/m²
TER	48.7	kgCO2/m²
Pass CO2	Yes	

Baseline

Building Rating

	Heating	Cooling	Auxiliary	Lighting	Hot water	Total	
Actual	4.24	5.85	25.69	13.53	192.48	184.15	kWh/m²
Notional	5.92	13.75	19.48	18.01	99.42	156.58	kWh/m²

CO2 emissions mandatory requirement		
BER	35.4	kgCO2/m²
Notional	48.7	kgCO2/m²
TER	48.7	kgCO2/m²
Pass CO2	Yes	

Baseline + Passive + CHP

Appendix B– Energy Calculations

Residential Units

Regulated Energy Demand

kWh/annum Baseline

Typical Unit	Area m²	Quantity	Total Area m²	DER	TER	Heating	Cooling	Auxillary	Lighitng	Hot Water	Total Kwh/Annum	Carbon kg Co2 / Annum	Tonnes
1 Bed Ground Floor	61.5	2	123	17.15	17.15	1465.98	88.69	34.62	278.22	1831.02	7397.06	2109.45	2.11
1 Bed Mid Floor	61.5	4	246	15.58	15.58	1114	99.15	30.92	278.22	1831.02	13413.24	3832.68	3.83
2 Bed Mid Floor	87.4	62	5418.8	14.65	14.65	1876.65	74.56	41.15	368.82	2042.04	272999.64	79385.42	79.39
2 Bed Top Floor	87.4	5	437	16.6	16.6	2342.46	67.97	46.04	368.82	2042.04	24336.65	7254.2	7.25
3 Bed Mid Floor	122	8	976	13.7	13.7	3122.99	92.02	55.34	453.11	2147.53	46967.92	13371.2	13.37
3 Bed Top Floor	122	4	488	15.67	15.67	3769.16	83.72	62.13	453.11	2147.53	26062.6	7646.96	7.65
Total		85	7688.8								391177.11	113599.91	113.60

kWh/annum Baseline + Passive/Energy Efficiency Measures

Typical Unit	Area m²	Quantity	Total Area m²	DER	TER	Heating	Cooling	Auxillary	Lighitng	Hot Water	Total Kwh/Annum	Carbon kg Co2 / Annum	Tonnes
1 Bed Ground Floor	61.5	2	123	16.8	17.15	1377.73	89.77	33.69	278.22	1377.73	6134.74	2066.40	2.07
1 Bed Mid Floor	61.5	4	246	15.39	15.58	1065.9	99.79	30.42	278.22	1831.02	13221.4	3785.94	3.79
2 Bed Mid Floor	87.4	62	5418.8	14.24	14.65	1732.56	75.99	39.63	368.82	2042.04	264060.48	77163.71	77.16
2 Bed Top Floor	87.4	5	437	16.12	16.6	2178.31	69.36	44.31	368.82	2042.04	23514.2	7044.44	7.04
3 Bed Mid Floor	122	8	976	13.27	13.7	2901.13	93.98	53.01	453.11	2147.53	45190.08	12951.52	12.95
3 Bed Top Floor	122	4	488	15.24	15.67	3560.34	85.3	59.93	453.11	2147.53	25224.84	7437.12	7.44
Total		85	7688.8			151888.18				10079.54	377345.74	110449.132	110.45

kWh/annum Baseline + Passive/Energy Efficiency Measures + CHP

Typical Unit	Area m²	Quantity	Total Area m²	DER	TER	Heating	Cooling	Auxillary	Lighitng	Hot Water	Total Kwh/Annum	Carbon kg Co2 / Annum	Tonnes
1 Bed Ground Floor	61.5	2	123	12.01	17.15	1377.73	89.77	33.69	278.22	1377.73	5108.239301	1477.23	1.48
1 Bed Mid Floor	61.5	4	246	11.01	15.58	1065.9	99.79	30.42	278.22	1831.02	11063.00147	2708.46	2.71
2 Bed Mid Floor	87.4	62	5418.8	10.19	14.65	1732.56	75.99	39.63	368.82	2042.04	220469.3861	55217.57	55.22
2 Bed Top Floor	87.4	5	437	11.04	16.6	2178.31	69.36	44.31	368.82	2042.04	19583.64737	4824.48	4.82
3 Bed Mid Floor	122	8	976	9.56	13.7	2901.13	93.98	53.01	453.11	2147.53	37666.90345	9330.56	9.33
3 Bed Top Floor	122	4	488	10.44	15.67	3560.34	85.3	59.93	453.11	2147.53	20972.09633	5094.72	5.09
Total		85	7688.8								314863.27	78653.022	78.65

Unregulated Energy Demand

Typical Unit	Area m^2	Quantity	Total Area	No of Occupants	Carbon from Appliances & Cooking per flat Tonnes Co2/Annum	Total Tonnes Co2 / Annum Cooking	Total kWH cooking	Total kWh Appliances	Total Tonnes Co2 / Annum Appliances
1 Bed Ground Floor	61.5	2	123	1.17	0.15	0.29	1500.82	2856.04	1.50
1 Bed Mid Floor	61.5	4	246	1.17	0.15	0.59	3001.63	5712.08	3.00
2 Bed Mid Floor	87.4	62	5418.8	2.26	0.17	10.74	54800.41	88537.24	46.45
2 Bed Top Floor	87.4	5	437	2.26	0.17	0.87	4419.39	7140.1	3.75
3 Bed Mid Floor	122	8	976	3.89	0.21	1.70	8667.76	11424.16	5.99
3 Bed Top Floor	122	4	488	3.89	0.21	0.85	4333.88	5712.08	3.00
Total		**85**	**7,689**			**15**	**76,724**	**121,382**	**64**

Typical Unit	Total Area	Quantity	Total Area	BaselineTotal kWh/annum	Baseline kgCO2/annum	Improved Emissions after Passive Energy Efficiency kgCO2 /annum	Improved Emissions after CHP kgCO2/annum	Total kgCO2/annum displaced	Total TonsCO2/annum displaced	Total % TonsCO2/annum displaced	kgCO2/annum displaced by CHP	TonsCO2/annum displaced by CHP	% TonsCO2/annum displaced by CHP
1 Bed Ground Floor	61.5	2	123	7,397	2,109	2066.40	1,477	632.22	0.63	29.97	589.17	0.58	27.93
1 Bed Mid Floor	61.5	4	246	13,413	3,833	3785.94	2,708	1124.22	1.12	29.33	1077.48	1.06	28.11
2 Bed Mid Floor	87.4	62	5418.8	273,000	79,385	77163.71	55,218	24167.85	24.17	30.44	21946.14	21.60	27.65
2 Bed Top Floor	87.4	5	437	24,337	7,254	7044.44	4,824	2429.72	2.43	33.49	2219.96	2.18	30.60
3 Bed Mid Floor	122	8	976	46,968	13,371	12951.52	9,331	4040.64	4.04	30.22	3620.96	3.56	27.08
3 Bed Top Floor	122	4	488	26,063	7,647	7437.12	5,095	2552.24	2.55	33.38	2342.40	2.30	30.63
Total		**85**	**7,689**	**391,177.11**	**113,599.91**	**110,449.13**	**78,653**	**34,947**	**34.95**	**30.76**	**31,796**	**0.58**	**27.99**

Typical Unit	Total Area	Quantity	Total Area	BaselineTotal kWh/annum	Baseline kgCO2/annum	Passive Energy Efficiency kwh /annum	Improved Emissions after CHP kwh/ annum	Total kwh/annum displaced	Total % kwh/annum displaced	Total Kwh / annum displaced by CHP	Total % kwh/annum displaced by CHP
1 Bed Ground Floor	61.5	2	123	7,397	2,109	6135	5,108	2,289	30.94	1027	13.88
1 Bed Mid Floor	61.5	4	246	13,413	3,833	13221	11,063	2,350	17.52	2158	16.09
2 Bed Mid Floor	87.4	62	5418.8	273,000	79,385	264060	220,469	52,530	19.24	43591	15.97
2 Bed Top Floor	87.4	5	437	24,337	7,254	23514	19,584	4,753	19.53	3931	16.15
3 Bed Mid Floor	122	8	976	46,968	13,371	45190	37,667	9,301	19.80	7523	16.02
3 Bed Top Floor	122	4	488	26,063	7,647	25225	20,972	5,091	19.53	4253	16.32
Total		**85**	**7,689**	**391,177**	**113,600**	**377346**	**314,863**	**76,314**	**19.51**	**62482**	**15.97**

Cudd Bentley Consulting

Commercial Units

Regulated Energy Demand

kWh/m²/annum Baseline											
Typical Unit	Area	Heating	Cooling	Auxillary	Lighting	Hotwater	Total	kWh/Annum	kgCO2/m²/ Annum	Total kgCO2/ Annum	Total TonsCO2/ Annum
FOH	4300.00m²	2.96	9.29	25.76	15.91	49.33	103.24	443932.00	37.8	162540.00	162.54
Nursing Home	555.00m²	4.41	10.33	27.14	13.90	100.9	156.67	86951.85	48.70	27028.50	27.03
Total	**4,855**							**530,884**		**189,569**	**189.57**

kWh/m²/annum Baseline with Passive/Energy Efficiency Measures											
Typical Unit	Area	Heating	Cooling	Auxillary	Lighting	Hotwater	Total	kWh/Annum	kgCO2/m²/ Annum	Total kgCO2/ Annum	Total TonsCO2/ Annum
FOH	4300.00m²	2.38	8.79	24.79	15.27	49.33	100.55	432365.00	36.6	157380.00	157.38
Nursing Home	555.00m²	3.73	9.79	25.69	13.53	100.9	153.64	85270.20	47.4	26307.00	26.31
Total	**4,855**							**517,635**		**183,687**	**183.69**

kWh/m²/annum Baseline with Passive/Energy Efficiency Measures & CHP											
Typical Unit	Area	Heating	Cooling	Auxillary	Lighting	Hotwater	Total	kWh/Annum	kgCO2/m²/ Annum	Total kgCO2/ Annum	Total TonsCO2/ Annum
FOH	4300.00m²	2.77	8.79	24.79	15.27	76.32	110.77	379339.95	30.2	129860.00	129.86
Nursing Home	555.00m²	4.24	12.43	25.69	13.53	155.84	177.02	72437.83	35.40	19647.00	19.65
Total	**4,855**							**451,778**		**149,507**	**149.51**

kWh/m²/annum Baseline with Passive/Energy Efficiency Measures & CHP & PV											
Typical Unit	Area	Heating	Cooling	Auxillary	Lighting	Hotwater	Total	kWh/Annum	kgCO2/m²/ Annum	Total kgCO2/ Annum	Total TonsCO2/ Annum
FOH	4300.00m²	2.77	8.79	24.79	15.27	76.32	110.77	375297.95	29.8	128140.00	128.14
Nursing Home	555.00m²	4.24	12.43	25.69	13.53	155.84	177.02	72437.83	35.40	19647.00	19.65
Total	**4,855**							**447,736**		**147,787**	**147.79**

Unregulated Energy Demand

Typical Unit	Total Area	Energy from Equipment kWh/m2/ Annum	Total Energy kWh/annum	Gas %	Electricity %	KgCO2/m2	Total KgCO2/m2	Total TonsCO2/m^2
FOH	4300.00m²	100	430000.00	80	20	26.56	114208.00	114.21
Nursing Home	555.00m²	38	21090.00	80	20	10.09	5601.50	5.60
Total	**4,855**		**451,090**				**119,810**	**119.81**

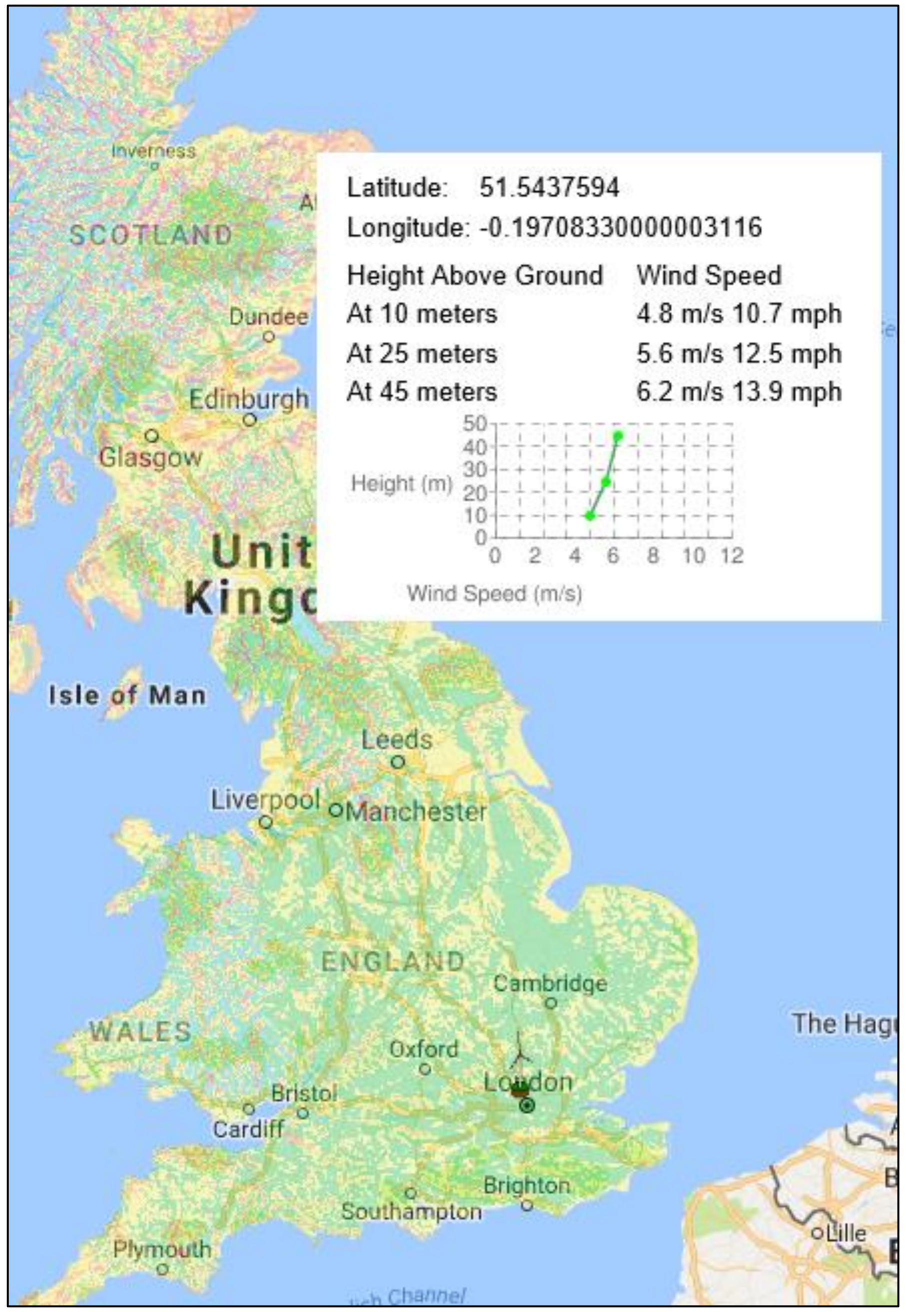
Energy Calculations (Regulated Energy Demands) Carbon

Typical Unit	Total Area	BaselineTotal kWh/annum	Baseline kgCO2/annum	Improved Emissions after Passive Energy Efficiency kgCO2 /annum	Improved Emissions after CHP kgCO2/annum	Improved Emissions after PV kgCO2/ annum	Total kgCO2/ annum displaced	Total TonsCO2/ annum displaced	Total % TonsCO2/ annum displaced
FOH	4300.00m²	443,932	162540.00	157380.00	129860.00	128140.00	34400.00	34.40	21.16
Nursing Home	555.00m²	86,952	27028.50	26307.00	19647.00	19647.00	7381.50	7.38	27.31
Total	**4,855**	**530,884**	**189,569**	**183,687**	**149,507**	**147,787**	**41,782**	**41.78**	**22.04**

Energy Calculations (Regulated Energy Demands) Energy

Typical Unit	Total Area	BaselineTotal kWh/annum	Baseline kgCO2/annum	Passive Energy Efficiency kwh /annum	Energy provided by CHP kwh/annum	Improved Emissions after PV kwh/annum	Total displaced kwh/annum after CHP & PV	Total % kwh/annum displaced
FOH	4300.00m²	443,932	162540.00	432365.00	379339.95	375297.95	68634.05	15.46
Nursing Home	555.00m²	86,952	27028.50	85270.20	72437.83	72437.83	14514.02	16.69
Total	**4,855**	**530,884**	**189,569**	**517,635**	**451,778**	**447736**	**83,148**	**15.66**

Appendix C – Wind Data



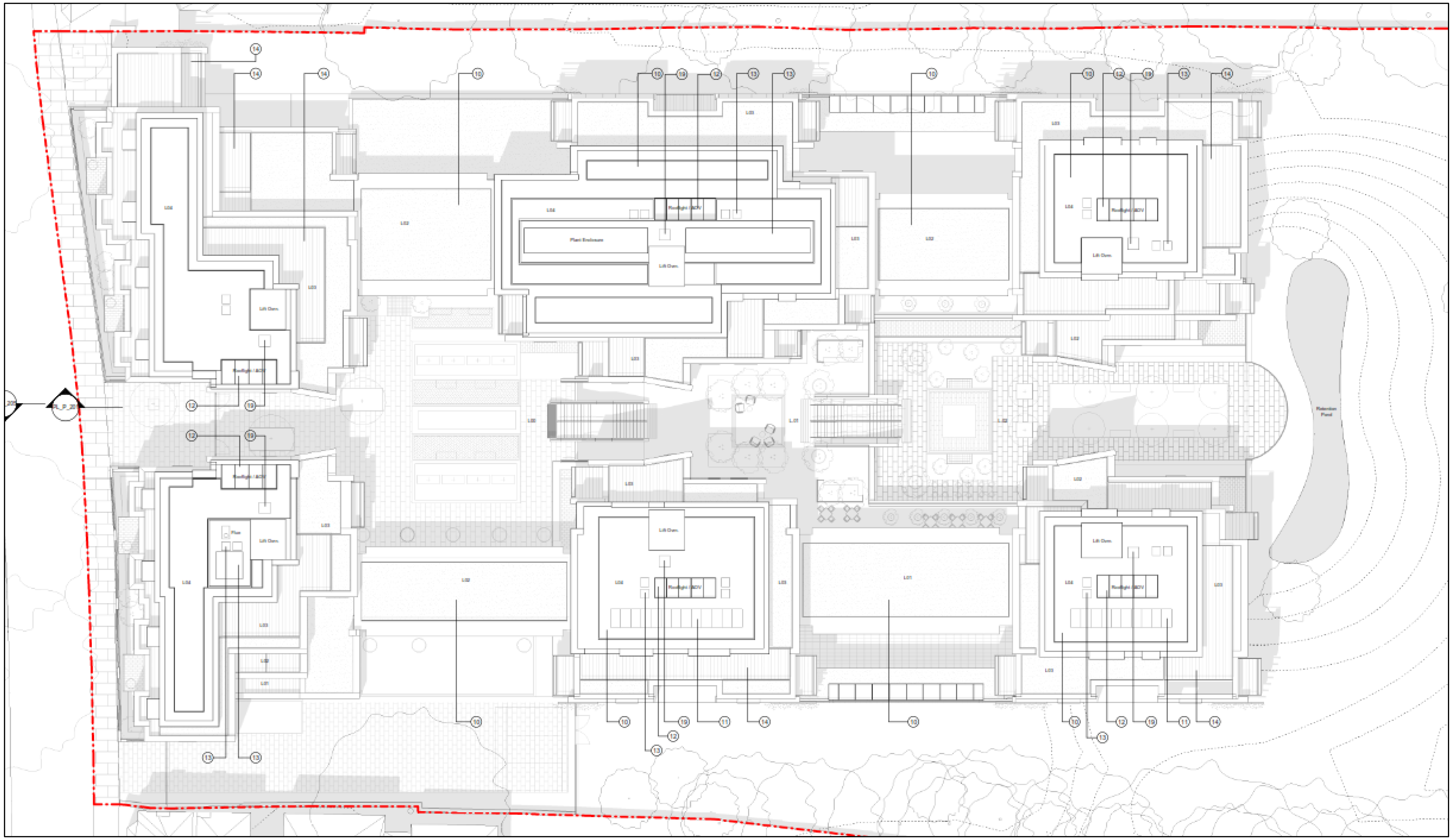
Wind data taken from NOABL Wind Map

Appendix D – Table K1 (SAP 2012)

Table K1 : Values of Ψ for different types of junctions

	Ref	Junction detail	Approved Ψ (W/m·K)	Default Ψ (W/m·K)
Junctions with an external wall	E1	Steel lintel with perforated steel base plate	0.50	1.00
	E2	Other lintels (including other steel lintels)	0.30	1.00
	E3	Sill	0.04	0.08
	E4	Jamb	0.05	0.10
	E5	Ground floor (normal)	0.16	0.32
	E19	Ground floor (inverted)		0.07
	E20	Exposed floor (normal)		0.32
	E21	Exposed floor (inverted)		0.32
	E22	Basement floor		0.07
	E6	Intermediate floor within a dwelling	0.07	0.14
	E7	Party floor between dwellings (in blocks of flats) [a]	0.07	0.14
	E8	Balcony within a dwelling, wall insulation continuous [b]	0.00	0.00
	E9	Balcony between dwellings, wall insulation continuous [b) c]	0.02	0.04
	E23	Balcony within or between dwellings, balcony support penetrates wall insulation		1.00
	E10	Eaves (insulation at ceiling level)	0.06	0.12
	E24	Eaves (insulation at ceiling level - inverted)		0.24
	E11	Eaves (insulation at rafter level)	0.04	0.08
	E12	Gable (insulation at ceiling level)	0.24	0.48
	E13	Gable (insulation at rafter level)	0.04	0.08
	E14	Flat roof		0.08
	E15	Flat roof with parapet		0.56
	E16	Corner (normal)	0.09	0.18
	E17	Corner (inverted – internal area greater than external area)	-0.09	0.00
	E18	Party wall between dwellings [c]	..0.06	0.12
	E25	Staggered party wall between dwellings [c]		0.12
Junctions with a party wall [c]	P1	Ground floor		0.16
	P6	Ground floor (inverted)		0.07
	P2	Intermediate floor within a dwelling		0.00
	P3	Intermediate floor between dwellings (in blocks of flats)		0.00
	P7	Exposed floor (normal)		0.16
	P8	Exposed floor (inverted)		0.24
	P4	Roof (insulation at ceiling level)		0.24
	P5	Roof (insulation at rafter level)		0.08

Appendix E – Proposed PV Location



Appendix F – Proposed CHP Location