ASHTON COURT
CAMDEN ROAD, LONDON

ENERGY REPORT

FOR

ORIGIN HOUSING

Final

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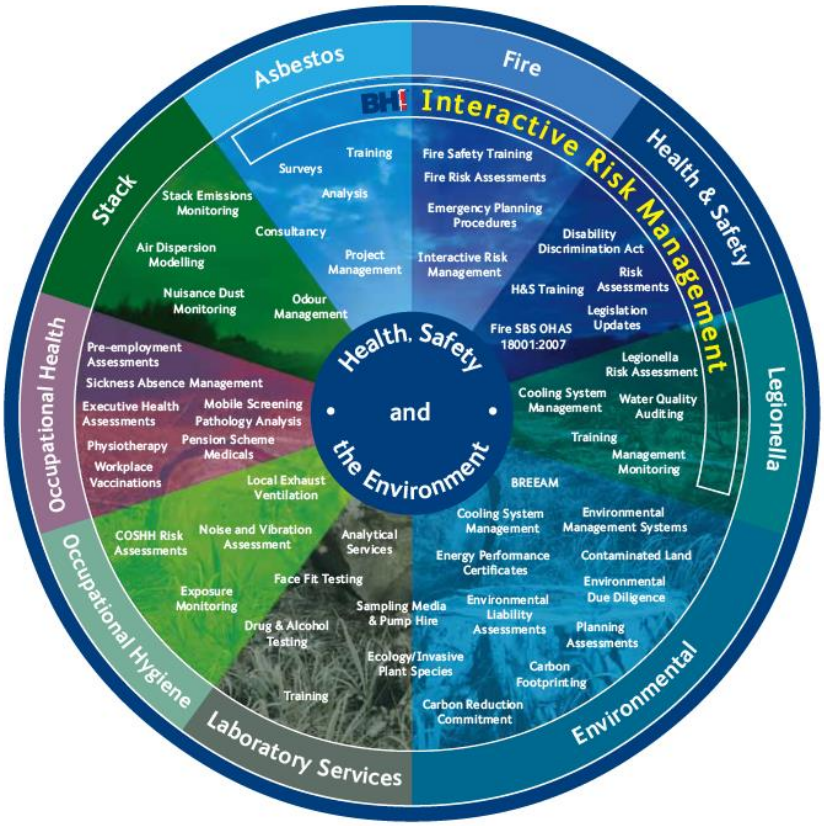

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EXECUTIVE SUMMARY

This Energy Strategy has been carried out for the proposed development at Ashton Court, Camden Road, London, NW1 9HE. It establishes how the site will achieve compliance with Building Regulations and Local Authority requirements. This has been achieved by following best practice procedure of the London Plan's Energy Hierarchy: be lean (improved building performance); be clean (centralised heating and cooling systems); and be green (use of low or zero carbon technologies).

The proposed redevelopment consists of the refurbishment/conversion/extension of the existing dwellings to 24 flats and the construction of 5 new town houses. The refurbished/converted units will comply with Part L1B for all the building fabric elements and openings as detailed in Section 3 of this report. In addition the new houses will comply with Part L1A 2013 of the Building Regulations and Domestic Building Services Compliance Guide 2013, as detailed in Section 4 of this report.

Reducing carbon emissions through lean measures

To maximise the energy efficiency of both the refurbishment and the new houses and thus reduce the energy demands, the following design principles and features have been incorporated:

- Low U-value Building fabrics, above minimum requirements under Building Regulations;
- High specification glazing (optimized to meet the needs to minimise heat escape (low U-values) and to allow natural light in (high G value);
- Reduced air permeability under maximum required standards;
- Specification of efficient heating services and control systems; and
- Energy efficient lighting through the development.

Reducing carbon emissions through clean measures

The inclusion of a site-wide heating system was investigated. Potential options at the site included either connection to an area-wide low carbon heat distribution network, or a site-wide heat network or a Combined Heat and Power (CHP) system. Due to the size and type of the developments being proposed, a CHP engine was considered as a non-viable solution, as analysed in Section 4.3.

Reducing carbon emissions through green measures

A Low or Zero Carbon (LZC) technologies feasibility study was completed as part of this Energy Strategy which compared the feasibility of different technologies based on the proposed energy demands of the development. Based on this, it was identified that the most appropriate technology for both the refurbished and the new dwellings to meet their energy targets, is the installation of photovoltaic (PV) panels.

In more detail, for the refurbishment approximately 24 PV panels, with an output of 327W each and total required roof area of 40m^2 and 7.85kWp capacity are specified. More specifically, each flat should be assigned with 1 PV panel of a total peak of 0.327kWp/flat. In addition, it is proposed to install approximately 8m^2 of PV panels (5 PV panels) on each new house's roof for a total peak of 1.635kWp/house. For all 5 mews houses, it will be required the installation of a total peak of 8.18kWp.This is based on installing approximately 25 PV panels, with an output of 327W each. It is proposed that the panels will be laid horizontally on the flat part of the roof of each plot, given the conservation area location.

Specifically for the 5 new houses, through the use of lean and green measures, a total reduction of the regulated carbon dioxide emissions of **38.9%** over Part L 2013 can be achieved, which exceeds the London Plan target of 35% improvement over current Building Regulations.

Table 1 illustrates the reductions in CO_2 emissions for the proposed development including both regulated and unregulated emissions. Regulated emissions alone are covered by Part L; and include emissions associated with fixed components of the building (i.e. fixed lighting, ventilation, space heating and water heating). Unregulated emissions are not covered by Part L and include emissions associated with plug-in appliances (i.e. cooking and appliances).

Carbon Dioxide Emissions (Tonnes CO_2 per annum)			
	Regulated	**Unregulated**	**Total**
Baseline: Building regulations 2013 Part L Compliant Development	10.19	6.89	17.08
After energy demand reduction	9.89	6.89	16.78
After Renewable energy	6.23	6.89	13.12

Table 1: Carbon dioxide emissions after each stage of the energy hierarchy

Table 2 demonstrates the CO_2 savings for each stage of the Energy Hierarchy. The total savings across the proposed development have also been identified.

	Regulated Carbon Dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Savings from energy demand reduction	0.3	2.9%
Savings from renewable energy	3.7	37.0%
Total cumulative savings	**4.0**	38.9%
Total target savings	**3.6**	**35%**
Annual Surplus	**0.4**	

Table 2: Regulated carbon dioxide savings from each stage of the energy hierarchy

Based on the robust approach to the energy hierarchy, the proposed new build units have exceeded the required energy targets.

Finally, for both the converted and new build units the total average weighted reduction in carbon dioxide emissions after the incorporation of the LZC technologies, are provided in Table 3. The total savings through the use of renewable technologies onsite, across the proposed development, are equal to a 17% reduction in CO_2 over regulated emissions compared to the lean measures (be lean) scenario. It is understood that the Council's target of 20% reduction in CO_2 emissions through renewables onsite is not feasible to be achieved. This is mainly due to the limited roof area, taking under consideration the space required for the PV operation / maintenance, the overshadowing issues from existing trees and the viability of the proposed scheme.

	Regulated Carbon Dioxide savings (Tonnes CO_2 per annum)			
	Converted Units	New Units	TOTAL	(%)
Savings from energy demand reduction	32.37	9.89	42.26	
Savings from renewable energy	28.85	6.23	35.08	
Total cumulative savings				**17%**

Table 3: Regulated carbon dioxide savings from each stage of the energy hierarchy

1 INTRODUCTION

RPS Health, Safety & Environment (RPS) was commissioned by *Origin Housing* to undertake an Energy Strategy and produce a statement in support of a planning application for the proposed developments at Ashton Court, Camden Road, London, NW1 9HE. This report will form part of the planning submission to London Borough of Camden.

This report outlines the proposed development scheme and current planning context and assesses likely energy demands of the development prior to consideration of Low and Zero Carbon (LZC) technology options. The report concludes with the proposed Energy Strategy.

This Energy Report comprises:

(i) A scheme overview;

(ii) A review of the planning policy context;

(iii) A review of any applicable legislation or sustainability targets;

(iv) An energy assessment of the project, following the London Plan's Energy Hierarchy; and

(v) A presentation of results and recommendations.

1.1 Scheme Overview

The site is located in the London Borough of Camden. The proposed redevelopment consists of the refurbishment/conversion/extension of the existing dwellings to 24 one bedroom flats. In addition to the refurbished/extended dwellings, 5 new two bedroom town houses are to be built. The proposed development is shown in Figure 1.

Figure 1: Proposed development

1.2 Report Structure & Methodology

The report has been written in accordance with the London Plan planning requirements for an Energy Strategy. A summary of these planning requirements relevant to energy consumption within the development are provided in Section 2 of the report.

The proposed redevelopment is required to achieve a BREEAM Domestic Refurbishment 'Excellent' rating for the converted/extended units as a planning requirement. The potential for the development to meet the BREEAM requirements are considered within the BREEAM Domestic Refurbishment pre-assessment report.

Under planning requirements, the proposed development is required to achieve compliance with Building Regulations and London Plan. The method preferred by London Borough of Camden towards the site wide energy strategy is the adoption of a hierarchical approach which ensures that the energy requirements and associated emissions are reduced as far as possible before applying renewable energy options. In Section 3 the proposed strategy for the refurbishment works is analysed. Sections 4 and 5 of this report detail the steps taken to follow the energy hierarchy (be lean, be clean, be green). A summary of findings and a suggested approach for the development is presented in Section 6.

2 PLANNING CONTEXT

The relevant authority for the site is the London Borough of Camden. The energy requirements of this Council and other relevant authorities have been taken into account within this feasibility study. The key planning polices applicable to the energy aspects of the development are outlined below:

2.1 National level policies

There are a number of national policies and regulations related to energy; those most relevant to the energy assessment of new developments are detailed below.

National Planning Policy Framework – NPPF (2012)

The National Planning Policy Framework (NPPF) was published in March 2012, and superseded the former planning policy statement (PPS) documents. The NPPF is designed to make the planning system less complex and more accessible; to protect the environment and promote sustainable growth. It provides a framework within which local people and their respective Councils can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities.

At the heart of the NPPF is a presumption in favour of sustainable development. The three dimensions of sustainable development can be defined as the economic, social and environmental.

There are twelve core planning principles in the NPPF. Within these, there is a strong support for the transition to a low carbon future in a climate change context, taking full account of a number of different factors. There is also an aim to contribute to conserving and enhancing the natural environment and reducing pollution.

The NPPF aims to strengthen local decision making, with the use of decision-taking in a positive way, as a means of fostering the delivery of sustainable development.

However, the NPPF (paragraph 173) also highlights that pursuing sustainable development requires careful attention to the viability and costs in plan-making and decision-taking. Plans should be deliverable. Therefore, the sites and the scale of development should not be subject to such a scale of obligations and policy burdens, that their ability to be developed viably is threatened.

Climate Change Act 2008

The Government has introduced legislation and a number of policies during recent years focusing on the reduction of CO_2 emissions. The Climate Change Act (2008) sets a legally binding target for the reduction in UK carbon dioxide emissions. Upon ratification of the Kyoto Protocol, the UK committed to

a reduction in its CO_2 emissions by 80% compared to 1990 levels (by 2050). In addition, under the Climate Change Act an interim target of a 34% reduction by 2020 was set.

In order to enforce these targets, the Government is using the Building Regulations: Part L 2010 – (Conservation of Fuel and Power) which set the standards to which all new and existing buildings must comply.

Building Regulations 2013 Part L

Building Regulations are statutory instruments that seek to ensure that the policies set out within any relevant UK legislation are carried out. Building regulations approval is required for the majority of building work carried out in the United Kingdom.

Part L of these regulations covers the requirements with respect to the conservation of fuel and power in all building types. It controls the insulation values of building fabric elements and openings, the air permeability of the structure, the heating efficiency of heating, ventilation and air conditioning systems together with hot water storage and lighting efficiency. It also sets out the requirements for calculating the carbon dioxide emissions and the Carbon Emission Targets for each building type.

Part L is split into four sections:

- L1A New Dwellings,
- L1B Existing Dwellings,
- L2A New Buildings other than Dwellings, and
- L2B Existing Buildings other than Dwellings.

The proposed development needs to comply with Part L1A 2013 for new dwellings and Part L1B 2013 for existing dwellings.

2.2 Regional level planning policies – The Greater London Authority – London Plan 2015

Planning policy for London is set out in the Mayor's London Plan 2015. This sets out an integrated social, economic and environmental framework for the future development of Greater London. The London Plan contains a number of policies relating to energy; those most relevant to the energy assessment of new developments are detailed below.

Policy 5.2 Minimising Carbon Dioxide Emissions

Development proposals should make the fullest contribution to minimising carbon dioxide emissions. All Stage 1 applications received by the Mayor on or after 1st October 2013 will have to achieve a 35% improvement over 2013 Part L Building Regulations in accordance with the following energy hierarchy:

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

Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emission reductions are to be met within the framework of the energy hierarchy. The calculation within the energy assessment should include the energy demand and carbon dioxide emissions covered by the Building Regulations; and separately, the energy demand and carbon dioxide emissions from any other part of the development. This includes plant, equipment, cooking or appliances that are not covered by the Building Regulations at each stage of the energy hierarchy.

Policy 5.4 Retrofitting

The environmental impact of existing urban areas should be reduced through policies and programmes that bring existing buildings up to the Mayor's standards on sustainable design and construction. In particular, programmes should reduce carbon dioxide emissions, improve the efficiency of resource use (such as water) and minimise the generation of pollution and waste from existing building stock.

Policy 5.6 Decentralised Energy in Development Proposals

Development proposals should evaluate the feasibility of connection to a Decentralised Energy Heating System and Combined Heat and Power (CHP) systems. In cases where a new CHP system is appropriate, development proposals should 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:

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

Policy 5.7 Renewable Energy

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. Within the framework of the energy hierarchy (see Policy 5.2), there is a presumption that all major development proposals will seek to reduce carbon dioxide emissions by at least 20% through the use of on-site renewable energy generation wherever feasible.

Development proposals should seek to utilise renewable energy technologies such as: biomass heating; cooling and electricity; renewable energy from waste; photovoltaics; solar water heating; wind and heat pumps. 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.

Policy 5.9 Overheating and Cooling

Major development proposals should reduce potential overheating and reliance on air conditioning systems through consideration of principles of the following cooling hierarchy:

- Minimise internal heat generation through energy efficient design,
- Reduce the amount of heat entering a building during summer months 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.
- Use passive ventilation,
- Use mechanical ventilation, and
- Use active cooling systems (ensuring they are the lowest carbon options).

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 where feasible.

2.3 Local level planning policies – London Borough of Camden

The Planning and Energy Act 2008 enables a local planning authority in England, through their development plan documents, to include policies imposing reasonable requirements for:

- a proportion of energy used in development in their area to be energy from renewable sources in the locality of the development;
- a proportion of energy used in development in their area to be low carbon energy from sources in the locality of the development;
- development in their area to comply with energy efficiency standards that exceed the energy requirements of building regulations

The London Borough of Camden requirements regarding energy are, in the main, reflecting those highlighted in the Mayor's London Plan. The Local Development Framework – Camden Core Strategy 2010-2025, the Camden Development Policies 2010-2025 and the Camden Planning Guidance – Sustainability (CPG3) cover the issues raised in the London Plan.

Policy CS13 - Tackling climate change through promoting higher environmental standards

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

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

All new developments involving 5 or more dwellings and/or 500m^2 (gross internal) floorspace or more are required to demonstrate how carbon dioxide emissions will be reduced in line with the energy hierarchy and must achieve a minimum 35% improvement over Part L 2013 in line with the London Plan.

All existing buildings, whether being updated or refurbished, are expected to reduce their carbon emissions by making improvements. Work involving a change of use or an extension to an existing property is included. At least 10% of the project cost should be spent on the improvements. Development involving a change of use or a conversion of 5 or more dwellings or 500m^2 of any floorspace, will be expected to achieve 60% of the un-weighted credits in the Energy category in the BREEAM assessment. Special consideration will be given to buildings that are protected e.g. listed buildings to ensure that their historic and architectural features are preserved.

Decentralised energy networks and combined heat and power

Where feasible and viable all developments will be required to connect to a decentralised energy network or include CHP.

Renewable Energy

All developments are to target at least a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation (which can include sources of site-related decentralised renewable energy) unless it can be demonstrated that such provision is not feasible.

Policy DP22 – Promoting sustainable design and construction

The Council will promote and measure sustainable design and construction by expecting developments (except new build) of 500m^2 of residential floorspace or above or 5 or more dwellings to achieve “Very Good” in BREEAM assessments and aspiring an “Excellent” rating. Developments will be expected to achieve 60% of the un-weighted credits in the Energy category, 60% in Water category and 40% in Materials category of their BREEAM assessment.

3 REFURBISHEMENT STRATEGY

According to Part L1B (4.1), the extension of a dwelling refers to the incorporation of the following:

- Newly constructed thermal elements that meet the standards set out in paragraphs 5.1 to 5.6 of the Part L1B document;
- Doors, windows, roof windows and rooflights that meet the standards set out in paragraphs 4.19 to 4.23;
- Improvements to fabric elements that are to become thermal elements.

According to Part L1B (4.11), material changes of use are any refurbishment works where as a result:

- The building is used as a dwelling where previously it was not;
- The building contains a flat where previously it did not; or
- The building which contains at least one dwelling contains a greater or lesser number of dwellings than it did previously.

Part of the proposed works for this project is the conversion and extension of the existing dwellings into residential flats (24 apartments). Therefore it is clear that according to Building Regulations, the converted units are classed as 'material changes of use', while the extended units are classed as 'extension'; hence all 24 converted/ extended residential units must comply with Part L1B.

For the purpose of this report, 9 dwelling types have been identified for the conversion/extension as can be seen on Table 4. The table describes the different types of dwellings assessed for the development, their bedrooms and their total floor area.

Dwelling	No. of Units	Bedrooms	Floor Area (m^2)
Type 1	4	1	51.0
Type 2	4	1	52.6
Type 3	4	1	41.8
Type 4	4	1	50.7
Type 5	3	1	44.7
Type 6	1	1	50.2
Type 7	1	1	51.6
Type 8	1	1	54.0
Type 9	2	1	53.0

Table 4: Proposed converted/extended dwellings for SAP calculations

For all building fabric thermal elements that are retained, reasonable provision should be made for any elements that have a worse U-value than the threshold U-value shown in the table below, to achieve the target U-value shown in the second column of Table 5. In particular for the floors, a lesser provision may be appropriate if meeting the targeted U-value would create significant problems in relation to adjoining floor levels.

Element	Threshold U-value	Target U-value	Proposed U-value
Wall – cavity insulation	0.7 W/m^{2}K	0.55 W/m^{2}K	0.54 W/m^{2}K
Floor	0.7 W/m^{2}K	0.25 W/m^{2}K	0.25 W/m^{2}K
Pitched roof – insulation at rafter level	0.35 W/m^{2}K	0.18 W/m^{2}K	0.17 W/m^{2}K

Table 5: Upgrading retained thermal elements

Similarly reasonable provisions should be made for all new thermal elements which are applicable for the 2 extended residential units on the first floor. The standards for the new thermal elements and the proposed u-values are presented in Table 6.

Element	Target U-value	Proposed U-value
Wall	0.28 W/m^{2}K	0.17 W/m^{2}K
Flat roof or roof with integral insulation	0.18 W/m^{2}K	0.12 W/m^{2}K

Table 6: Standards for new thermal elements

Regarding building openings (windows and doors) which separate the proposed dwellings from an unconditioned space or the external environment these should be replaced if they have a U-value worse than 3.3 W/m^{2}K. Where new building openings are provided the installation for draught-proof units with a performance not worse than given in Table 7 will be ensured.

Element	Target U-value	Proposed U-value for converted units	Proposed U-value for extended units
Window/ Rooflight	1.6 W/m^{2}K	1.4 W/m^{2}K and 0.9 W/m^{2}K (Camden road)	1.3 W/m^{2}K and 0.9 W/m^{2}K (Camden road)
Door	1.8 W/m^{2}K	1.5 W/m^{2}K	1.1 W/m^{2}K

Table 7: Standards for new controlled fittings

As shown in Table 7, all the windows facing Camden Road are proposed to achieve a lower U-value of 0.9 W/m^{2}K. These windows will be triple glazed, in order to reduce the noise pollution from Camden Road.

According to Part L1B where a fixed building service is extended or provided on refurbishment works, it needs to comply with Domestic Building Services Compliance Guide. For all 24 flats the following services will be provided:

- Using the existing high efficient gas communal heating system (90.5% efficiency).
- Hot water will be provided by the existing hot water tank
- Air pressure testing will be carried out and an air permeability of 10m^3/hm^2 @ 50Pa will be achieved.
- Mechanical extract in all units meeting Part F requirements.
- Low energy lighting with luminous efficacy of at least 45 lamp lumens per circuit watt and a total output of at least 400 lamp lumens in all flats.

From the modelling undertaken for the converted units, the total carbon dioxide emissions, after the inclusion of improved building fabric and systems (i.e. lean measures) are estimated as **39,509.38kgCO_2/yr**. This can be seen in Table 8.

Be Lean CO_2 emissions	
Dwellings	**Total CO_2 (kgCO_2/year)**
Heating	19,610.13
Auxiliary	-
Lighting	2,169.20
Domestic Hot Water (DHW)	9,801.87
Total (regulated)	32,367.92
Unregulated	7,141.46
Total (regulated & unregulated)	39,509.38

Table 8: Be Lean CO_2 emissions per energy use

Finally, after taking into consideration a number of different factors, including local authority requirements, the fact that the development is located in a conservation area, land use, potential noise impacts and available space within the development, it was concluded that the best strategy for the refurbishment, conversion and extension to meet a further reduction in CO_2 emissions is the installation of approximately **7.85kWp** (in total) of photovoltaic panels for all 24 residential units. This is based on installing approximately 24PV panels in total, with an output of 327W each and total required roof area of 40m^2. More specifically, each flat should be assigned with 1 PV panel of a total

peak of 0.327kWp/flat. It is proposed that the panels will be laid on the pitched roof (southeast facing) of the main building in order to be very discreet, due to the conservation area location. Also, Figure 2 shows the maximum available roof area (50m^2) on the main building, taking under consideration the space required for the PV operation / maintenance as well as the overshadowing from the existing tree (Figure 3). It is worth mentioning that the pitched roof of the link building and the small pitched roof of the main building cannot be counted for the PV allocation due to overshadowing from the 5 new build houses and the existing tree. In addition, Figure 2 shows the PV allocation for the 5 new build houses.

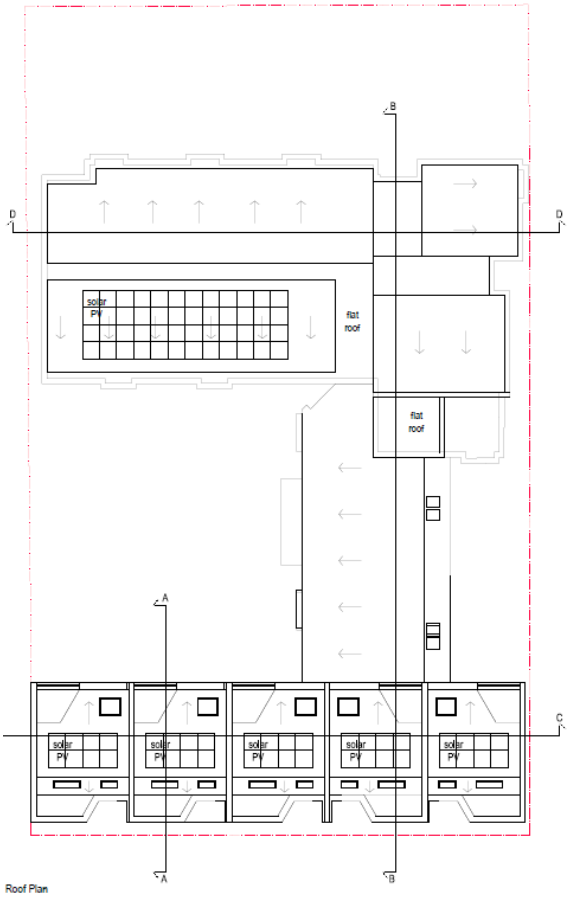

Figure 2: Photovoltaic panels' layout plan

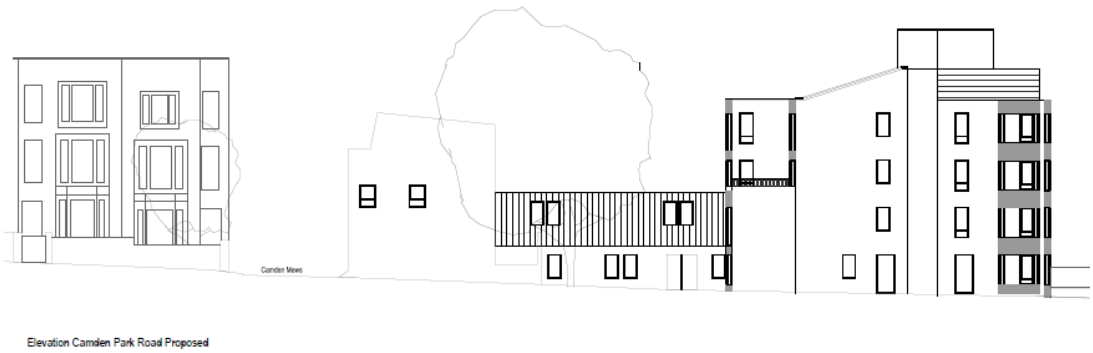

Figure 3: Proposed elevation Camden Park Road

Upon consideration of the LZC technology, the modelling identified that a further reduction of **3,517.6kgCO_2/yr** has been achieved for the regulated emissions. The total CO_2 emissions for the proposed development after the incorporation of the LZC technologies are illustrated in Table 9. This equates to a 10.9% reduction in CO_2 over regulated emissions compared to the lean measures (be lean) scenario. When both regulated and unregulated emissions are considered the reduction of the carbon dioxide emissions through the use of renewable technologies onsite is 8.9%.

CO_2 emissions after LZC (Be Green)		
Dwellings	**Be Lean Total CO_2 (kgCO_2/year)**	**Be Green Total CO_2 (kgCO_2/year)**
Heating	19,610.13	19,610.13
Auxiliary	-	-
Lighting	2,169.20	2,169.20
Domestic Hot Water (DHW)	9,801.87	9,801.87
LZC	-	-3,517.6
Total (regulated)	32,367.92	28,850.34
Unregulated	7,141.46	7,141.46
Total (regulated & unregulated)	39,509.38	35,991.80

Table 9: CO_2 emissions after LZC

Table 9 shows that a significant amount of the CO_2 emissions is down to unregulated emissions. These consist of emissions related to cooking and appliances and are not accounted for in the Building Regulations, hence they are known as unregulated emissions.

Be Lean (tonnes CO_2/year)	**Be Green (tonnes CO_2/year)**	**Reduction in CO_2 emissions (%)**
32.37	28.85	10.9%

Table 10: Reduction in CO_2 emissions against to 'Be Green' scenario

4 ENERGY MODELLING – NEW HOUSES

The Standard Assessment Procedure (SAP) is the Government's recommended system for the energy rating of residential dwellings. It is a tool which enables qualified energy assessors to calculate the energy demand and the CO_2 emissions of a dwelling. The energy demand calculated using the SAP methodology is relative to the Regulated Emissions which include the energy consumed to power space heating, domestic hot water, ventilation and internal lighting systems. The unregulated emissions (i.e. cooking and appliances) are calculated using BREDEM (BRE Domestic Energy Model). For the purposes of this strategy, a SAP assessment was carried out on each dwelling type present within the development in order to identify each dwelling's potential CO_2 emissions.

It is understood that 5 new build mews houses will be built at the Ashton Court redevelopment. Table 11 describes the assessed house, their total number of bedrooms and their total floor area. The energy and CO_2 emissions reduction have been calculated for the assessed houses.

Dwelling	Bedrooms	Floor Area (m^2)
House 1	2	126.30
House 2	2	140.40
House 3	2	140.40
House 4	2	140.40
House 5	2	140.40
Total	**10**	**687.90**

Table 11: Proposed new dwellings for SAP calculations

The results of the indicative calculations should not be used for any other purpose other than those for which they are intended (namely as a basis for this energy statement). Formal assessments will be required at a later stage of the development process to satisfy Building Control requirements.

The proposed energy strategy approach is based on a recognised structure of reduction in carbon dioxide emissions through (Figure 4):

1. Reducing the building energy consumption (Be Lean) by optimising the design and construction of the building to ensure less energy is required;
2. Supplying the energy required in an efficient manner (Be Clean); and
3. Supplying the energy from Low Zero Carbon and Renewable Energy Sources (Be Green).

Figure 4: The three stages of the energy hierarchy

On the whole, it becomes more expensive to implement both carbon reduction and sustainability measures the further along the design process, as the opportunities available diminish. This highlights the importance of early consideration of these measures within the design process (Figure 5).

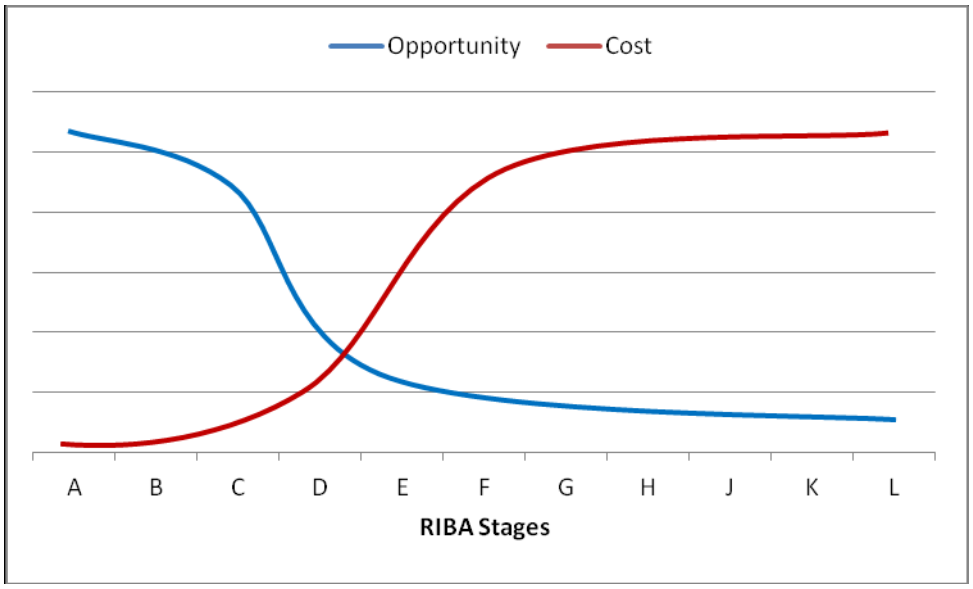

Figure 5: Opportunities to reduce CO_2 emissions and associated cost during the construction phases

A passive, well insulated envelope will last for the life of the building; with this being difficult to upgrade once building work is complete. The services installed within the building have a shorter life span and can be replaced / upgraded at a later date, when their lifetime will have expired and new more efficient services will be available. Once the most efficient building envelope and services are provided, the installation of Low and Zero Carbon (LZC) technologies should be considered.

The design for this project will attain a final carbon emission reduction that goes beyond the one required to comply with Part L 2013 of the Building Regulations. This reduction has been achieved in

line with the requirements of the Energy Hierarchy, which the London Borough of Camden follow for all new developments.

4.1 Baseline scenario

In order to establish the baseline carbon dioxide emissions for the proposed development, the Government approved software SAP 2012 was used to model the dwellings.

The baseline scenario assumes the minimum values required to meet Building Regulation 2013 Part L1A. The modelling undertaken identified the total CO_2 emissions across the site as **17,087.95 $kgCO_2$/yr**. This is broken down to 10,189.2 $kgCO_2$/yr from regulated emissions (covered by Building Regulations) and 6,898.676 $kgCO_2$/yr from unregulated emissions (cooking and other plug-in appliances). The total baseline CO_2 emissions for the development are illustrated in Table 12 and Figure 6.

Baseline CO_2 emissions	
Dwellings	**Total CO_2 ($kgCO_2$/year)**
Heating	5,856.37
Auxiliary	194.63
Lighting	1,295.38
Domestic Hot Water (DHW)	2,842.82
Total (regulated)	10,189.2
Unregulated	6,898.76
Total (regulated & unregulated)	17,087.95

Table 12: Baseline CO_2 emissions per energy use

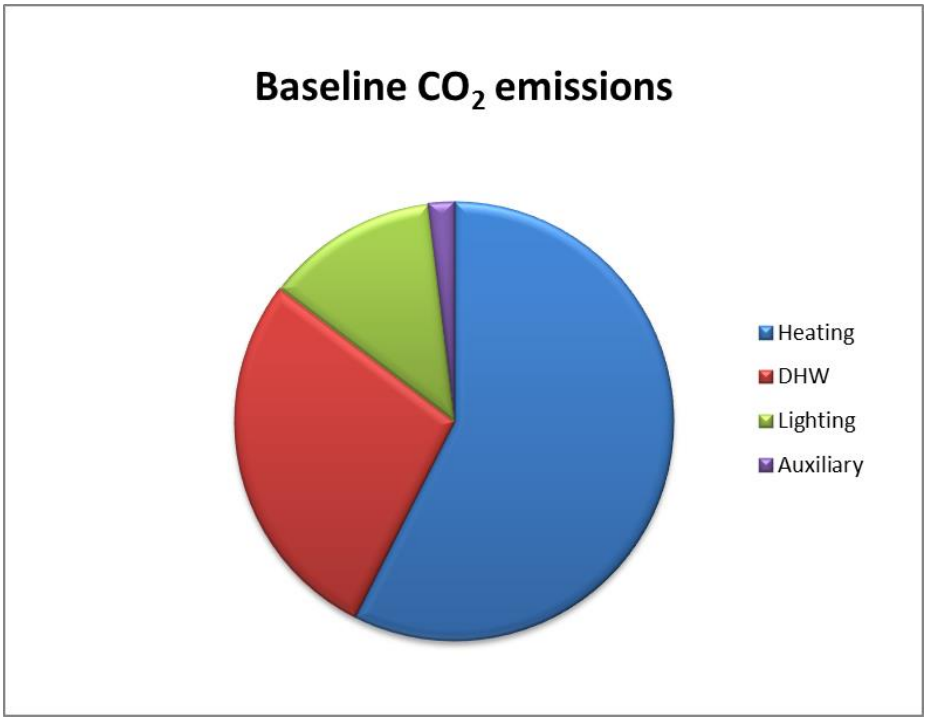

Figure 6: Baseline CO_2 emissions per energy use type

4.2 Energy Saving Measures (Lean)

Energy demand reduction within the building can be utilised to improve compliance with Part L1A 2013. This development has been reviewed to maximise both passive and active design measures to reduce the energy demand within the building.

To reduce the CO_2 emissions of the development, it is important to minimise the heat losses through the building fabric. In order to achieve this, U-values for all building fabric elements and openings have been specified to exceed the levels required by Building Regulations. In addition, heat losses from infiltration have been minimised and a low air permeability target has been set. The details of these measures are summarised in Table 13.

Element	Maximum values under Part L1A 2013 (dwelling)	Proposed values
Roof	0.20 W/m^{2}K	0.12 W/m^{2}K
External wall	0.30 W/m^{2}K	0.17 W/m^{2}K
Party walls (between dwellings)	0.20 W/m^{2}K	0 W/m^{2}K
Ground floor	0.25 W/m^{2}K	0.11 W/m^{2}K
Upper floors	0.25 W/m^{2}K	0.11 W/m^{2}K
Windows & Rooflights	2.0 W/m^{2}K	1.3 W/m^{2}K
Doors	2.0 W/m^{2}K	1.1 W/m^{2}K
Thermal bridging (average)	0.15	0.07 (Accredited Construction Details)
Air permeability	10 m^3/hm^2 @50Pa	4 m^3/hm^2 @50Pa

Table 13: Passive design energy saving measures

In addition to upgrading the insulation standards, it is important that the energy used within the building is used efficiently. To achieve this, energy efficient heating services have been specified with a very efficient heating control system (time and temperature zone control).

The air quality within a dwelling is significantly influenced by the ventilation system specified. To ensure high air quality within the dwellings, a natural ventilation system with extract fans in kitchens and bathrooms will be implemented to each dwelling, to ensure that energy losses are minimised.

Electrical lighting also represents a significant energy use within a building. To maximise energy savings the installation of low energy lighting across the proposed development has been specified.

From the modelling undertaken, the total site wide carbon dioxide emissions, after the inclusion of improved building fabric and systems (i.e. lean measures) are estimated as **16,790.48 kgCO_2/yr**. This can be seen in Table 14. This is a reduction of 297.47 kgCO_2/yr compared to the baseline scenario, which equates to a saving of 2.9% over the regulated emissions (Table 15 and Figure 7).

CO_2 emissions after ESM (Be Lean)		
Dwellings	**Baseline Total CO_2 ($kgCO_2$/year)**	**Be Lean Total CO_2 ($kgCO_2$/year)**
Heating	5,856.37	5,614.27
Auxiliary	194.63	194.63
Lighting	1,295.38	1,295.38
Domestic Hot Water (DHW)	2,842.82	2,787.45
Total (regulated)	10,189.2	9,891.73
Unregulated	6,898.76	6,898.76
Total (regulated & unregulated)	17,087.95	16,790.48

Table 14: CO_2 emissions after energy saving measures

Total Baseline (tonnes CO_2/year)	Total Be Lean (tonnes CO_2/year)	Reduction in CO_2 emissions (%)
10.19	9.89	2.9%

Table 15: Reduction in CO_2 emissions against to 'Baseline' scenario

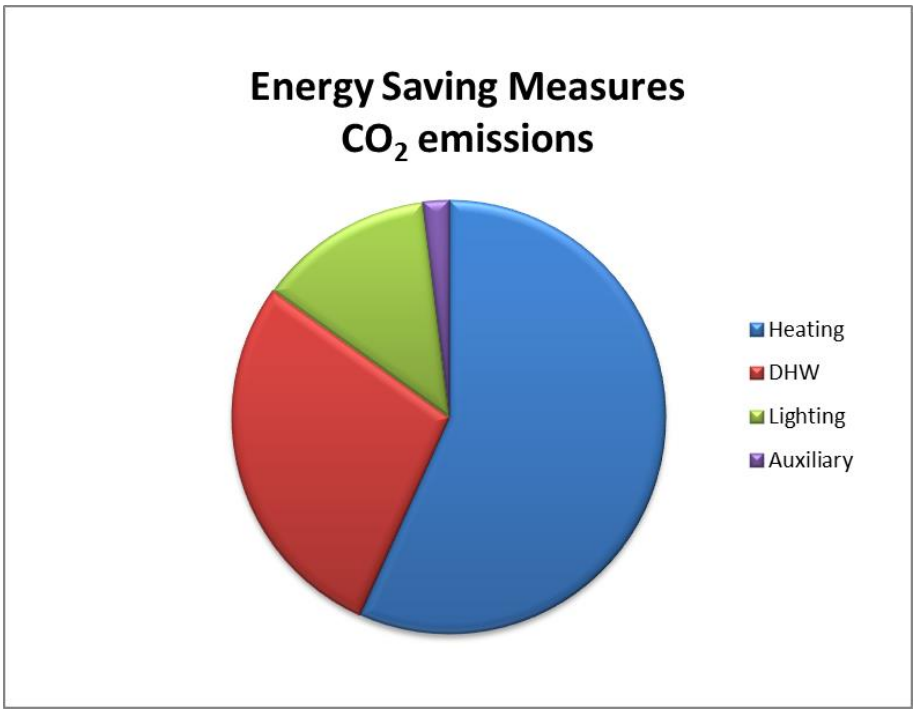

Figure 7: CO_2 emissions per energy use type after the application of the energy saving measures

4.3 Decentralised Energy – CHP (Clean)

Consideration was given to the possible connection to an existing or proposed area-wide decentralised energy network. However, following a review of the London Heat Map (Figure 8), it has been established that there are currently no existing district heating networks located in the vicinity that the development could link to. It is also highlighted that the site is not located within a proposed network or focus area for future consideration of heat distribution networks. Given the absence of any suitable systems, connection to an area wide district heating system has not been considered further.

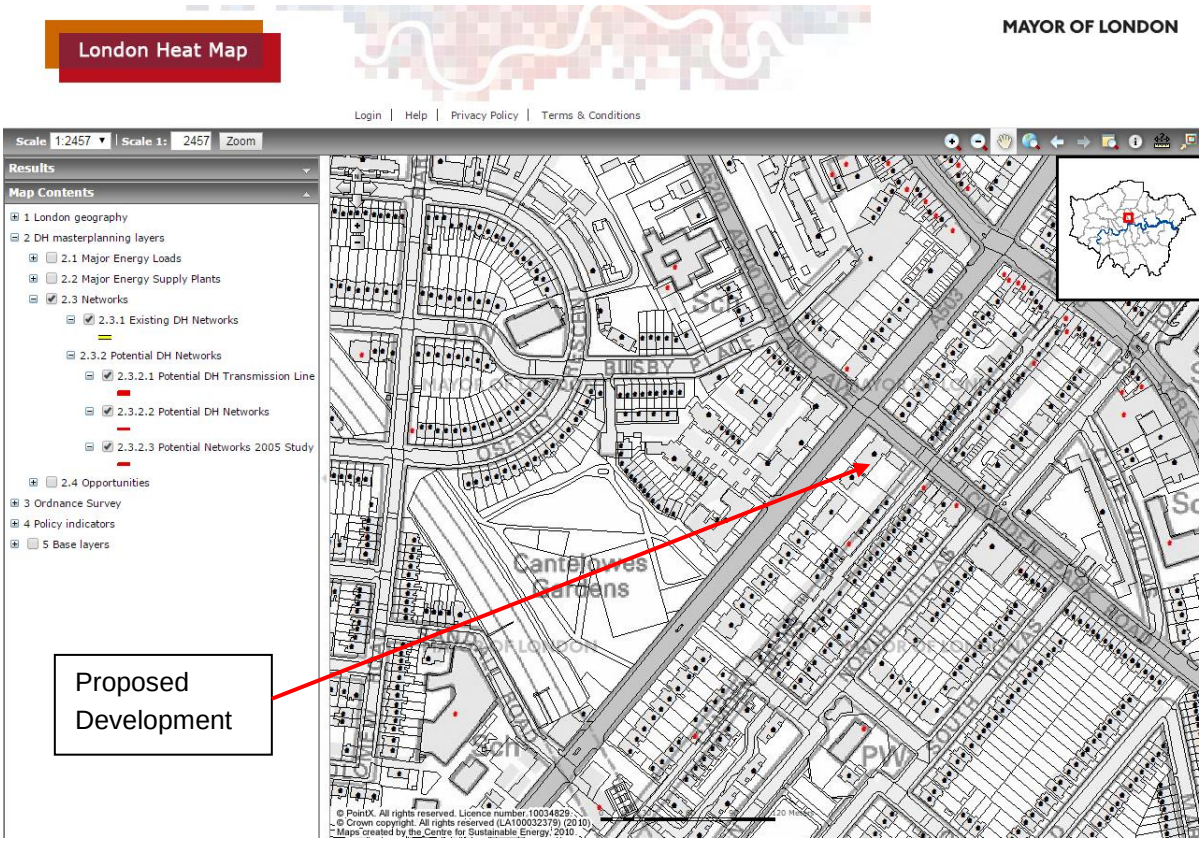

Figure 8: London Heat Map for the area

The installation of a Combined Heat and Power (CHP) unit for the development has also been considered. CHP units can achieve considerable savings in CO_2 emissions when installed and utilised correctly. To maximise the performance of a CHP, long operating hours are required and the heating demand of the development needs to match the power generation. However, the heating demand of the development typically will not be constant enough throughout the day, as the majority of tenants are likely to be out of the house some part of the day. Furthermore, the heating requirement during the summer period is limited. Given the long operating hours required and the size of the proposed development, the installation of CHP within the proposed development would not be optimal in terms of CHP operation; therefore the installation of a CHP system will not be considered any further for this proposed development.

4.4 Low and Zero Carbon Technologies (Green)

This section discusses the feasibility of using low and zero carbon (LZC) technologies for the proposed scheme. The London Plan, aspires that all major developments reduce their carbon dioxide emissions by at least 20% through the use of on-site renewable energy generation, where feasible.

By implementing the energy efficiency measures of the energy hierarchy (be lean), the development has reduced its total carbon dioxide emissions to 16,790.48kgCO_2/yr.

In order to address the planning requirement for the integration of LZC technologies on site, the installation of solar thermal panels, photovoltaics, wind turbines, biomass and heat pumps was investigated. These technologies meet all requirements as defined by Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. Full details of these technologies can be found in Appendix A.

After taking into consideration a number of different factors, including local authority requirements, the fact that the development is located in a conservation area, land use, potential noise impacts and available space within the development, it was concluded that the best strategy for this development to meet its targets is the installation of approximately **8.18kWp** (in total) of photovoltaic panels for all 5 new build mews houses. This is based on installing approximately 25 PV panels in total, with an output of 327W each. More specifically, each house should be supplied with 5 PV panels for a total peak of 1.635kWp/house, which equates to a required roof area of approximately 8m^2. It is proposed that the panels will be laid horizontally on the flat part of the roof of each plot in order to be very discreet.

Photovoltaics (PV) panels are an established form of renewable technology which converts solar energy into electricity. The electricity is fed into an inverter which converts it from a direct current supply to an alternating current supply, which can then be used to supply the demands within the development / dwelling.

Upon consideration of the LZC technology, the modelling identified that a further reduction of **3,664.19kgCO_2/yr** has been achieved for the regulated emissions. The total CO_2 emissions for the proposed development after the incorporation of the LZC technologies are illustrated in Table 16. This equates to a 37.0% reduction in CO_2 over regulated emissions compared to the lean measures (be lean) scenario (Table 17). When both regulated and unregulated emissions are considered the reduction of the carbon dioxide emissions through the use of renewable technologies onsite is 21.8%.

CO_2 emissions after LZC (Be Green)		
Dwellings	**Be Lean Total CO_2 ($kgCO_2$/year)**	**Be Green Total CO_2 ($kgCO_2$/year)**
Heating	5,614.27	5,614.27
Auxiliary	194.63	194.63
Lighting	1,295.38	1,295.38
Domestic Hot Water (DHW)	2,787.45	2,787.45
LZC	-	-3,664.19
Total (regulated)	9,891.73	6,227.54
Unregulated	6,898.76	6,898.76
Total (regulated & unregulated)	16,790.48	13,126.29

Table 16: CO_2 emissions after LZC

Table 16 shows that a significant amount of the CO_2 emissions is down to unregulated emissions. These consist of emissions related to cooking and appliances and are not accounted for in the Building Regulations, hence they are known as unregulated emissions.

Be Lean (tonnes CO_2/year)	Be Green (tonnes CO_2/year)	Reduction in CO_2 emissions (%)
9.89	6.23	37.0%

Table 17: Reduction in CO_2 emissions against to 'Be Green' scenario

5 ENERGY REDUCTION ANALYSIS – NEW HOUSES

The London Borough of Camden adopts the objectives of the London Plan for the sustainable design and construction of all minor and major developments within its borough.

The following specifications for this development have been assumed:

Feature	Description	Technical Values Residential
External walls		U=0.17 W/m^{2}K
Party walls (dwellings and unheated areas)		U=0.17 W/m^{2}K
Party walls (between dwellings)	Fully filled cavity with sealed edges	U=0 W/m^{2}K
Ground and upper floors		U=0.11 W/m^{2}K
Roofs		U=0.12 W/m^{2}K
Windows		U=1.3 W/m2K
Doors		U=1.1 W/m2K
Air permeability		4 m^3/m^{2}h @50Pa
Thermal Bridging		Accredited Construction Details
Ventilation		Natural
Heating System	Individual regular condensing gas boilers	Gas boilers η= 90%
Heating Control System		Time and temperature zone control
Hot Water System	From main, individual hot water cylinder	210lt cylinder
Lighting		Low energy lighting fittings (LED etc.)
LZC Technologies	Monocrystalline PV panels	8.18kWp in total

Table 18: Performance specifications for building fabric and services

Policy 5.2 of the London Plan requires development to achieve a 35% improvement on Building Regulations 2013, following the energy hierarchy (be lean, be clean, be green). Moreover, Policy 5.7 requires all major development proposals to seek reducing carbon dioxide emissions by at least 20% through on-site renewable energy generation, where feasible.

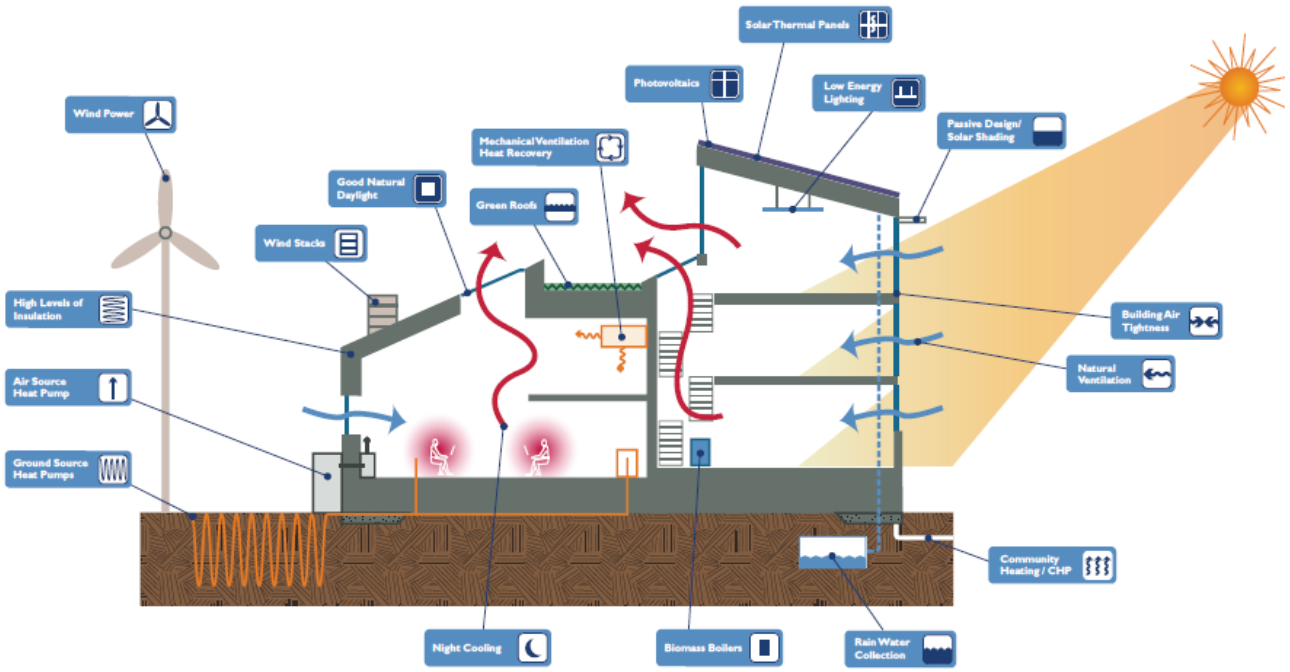

Figure 9: Energy saving measures and technologies

This Energy Strategy has been produced in line with the London Plan's energy hierarchy. Carbon dioxide emission savings (Figure 9) have been achieved through the following step process. The specified 'Be Lean' measures include improved building fabric and high specification systems. Moreover, 'Be Clean' measures on site include the installation of a CHP on site and communal heating system OR connection to a decentralised energy system. As explained in Section 3, the use of decentralised energy was deemed not to be appropriate for this project. The remaining carbon dioxide savings have been achieved through the inclusion of renewable energy technologies 'Be Green'.

In order to achieve compliance with Part L1A 2013, the actual Dwelling Emissions Rating (DER) for every dwelling, must be less than the Target Emissions Rating (TER). Finally according to London Plan, the percentage of improvement of DER over TER for each house must be at least 35%, across the entire development. All these are presented in Table 19.

Dwelling	TER ($kgCO_2/m^2yr$)	35% improvement ($kgCO_2/m^2yr$)	DER ($kgCO_2/m^2yr$)
House 1	16.30	10.60	10.11
House 2	14.43	9.38	8.80
House 3	14.31	9.30	8.67
House 4	13.91	9.04	8.17
House 5	15.26	9.92	9.62

Table 19: SAP results

The reduction in carbon dioxide emissions at each stage of the Energy Hierarchy process, are provided in Table 20. The table presents both the regulated and unregulated CO_2 emissions.

Carbon Dioxide Emissions (Tonnes CO_2 per annum)			
	Regulated	**Unregulated**	**Total**
Baseline: Building regulations 2013 Part L Compliant Development	10.19	6.89	17.08
After energy demand reduction	9.89	6.89	16.78
After Renewable energy	6.23	6.89	13.12

Table 20: Carbon dioxide emissions after each stage of the energy hierarchy

Table 21 demonstrates the CO_2 savings for each stage of the Energy Hierarchy. The total savings across the proposed development have also been identified.

	Regulated Carbon Dioxide savings	
	(Tonnes CO_2 per annum)	**(%)**
Savings from energy demand reduction	0.3	2.9%
Savings from renewable energy	3.7	37.0%
Total cumulative savings	**4.0**	38.9%
Total target savings	**3.6**	**35%**
Annual Surplus	**0.4**	

Table 21: Regulated carbon dioxide savings from each stage of the energy hierarchy

6 CONCLUSIONS

In conclusion, based on the measures outlined in the report, the development achieves its energy targets.

The converted and extended units will comply with Part L1B for all the building fabric elements and openings that are been retained or replaced. In addition, the existing highly efficient communal heating system will be retained and a total of 7.85kWp of photovoltaics on the pitched roof area of the main building will be incorporated. This option achieves compliance with Building Regulations 2013, Local Authority planning requirements and maximises the energy credits under BREEAM Domestic Refurbishment.

The proposed strategy for the 5 new build mews houses includes high insulation standards, very efficient building services, individual gas boilers and 8.18kWp of photovoltaics on the flat roof area of each plot. It has been confirmed that a **38.9%** improvement on 2013 Building Regulations in line with the London Plan will be achieved and a 37% of the total regulated CO_2 emissions reduction will be achieved by the incorporation of renewable onsite.

The modelling undertaken shows that Building Regulations 2013, London Plan and local authority planning requirements have been met with respect to energy and CO_2 reduction. This can be seen in Figure 10, below.

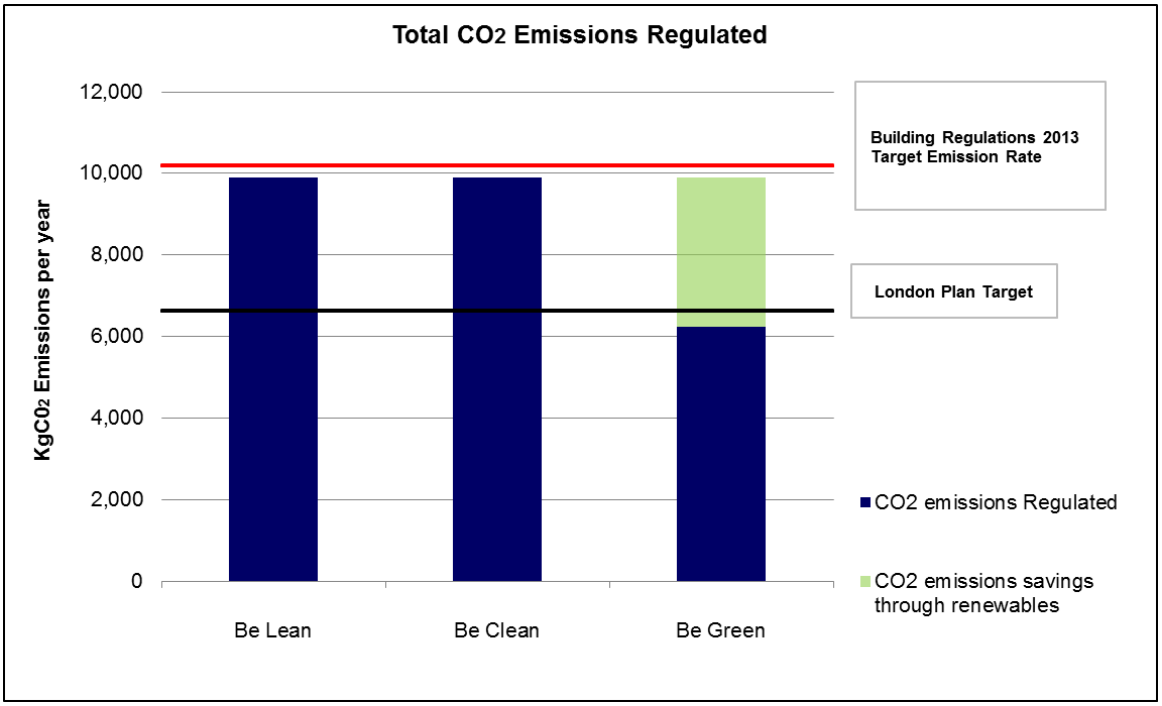

Figure 10: Step reduction in regulated CO_2 emissions

The total average weighted reduction in carbon dioxide emissions after the incorporation of the LZC technologies, are provided in Table 22. The total savings through the use of renewable technologies onsite, across the proposed development, are equal to a 17% reduction in CO_2 over regulated emissions compared to the lean measures (be lean) scenario. It is understood that the Council's target of 20% reduction in CO_2 emissions through renewables onsite is not feasible to be achieved. This is mainly due to the limited roof area, taking under consideration the space required for the PV operation / maintenance, the overshadowing issues from existing trees and the viability of the proposed scheme.

	Regulated Carbon Dioxide savings (Tonnes CO_2 per annum)			
	Converted Units	**New Units**	**TOTAL**	**(%)**
Savings from energy demand reduction	32.37	9.89	42.26	
Savings from renewable energy	28.85	6.23	35.08	
Total cumulative savings				**17%**

Table 22: Regulated carbon dioxide savings from each stage of the energy hierarchy

APPENDIX A

Site specific analysis of Low and Zero Carbon Technologies

Solar Thermal

Solar thermal generates energy for the provision of domestic hot water; this system typically works in tandem with a conventional boiler in the event that the hot water demand cannot be solely met by the renewable technology. The two types of solar thermal technology suitable for inclusion are flat plate collectors and evacuated tubes; with the latter typically being more efficient. The panels are most efficient when they face south at 30^{o}.

Figure A1: Flat plate and Evacuated tubes Solar Panels

Solar thermal is mostly suited to houses. Providing solar panels and associated pipework to each flat within the main block would not be a practical approach.

Photovoltaic panels

The word photovoltaic is a marriage of the words 'photo', which means light in Greek, and 'voltaic', which refers to the production of electricity. Photovoltaic technology is similar to Solar Water Heating (SWH) but it generates electricity and not heat from light.

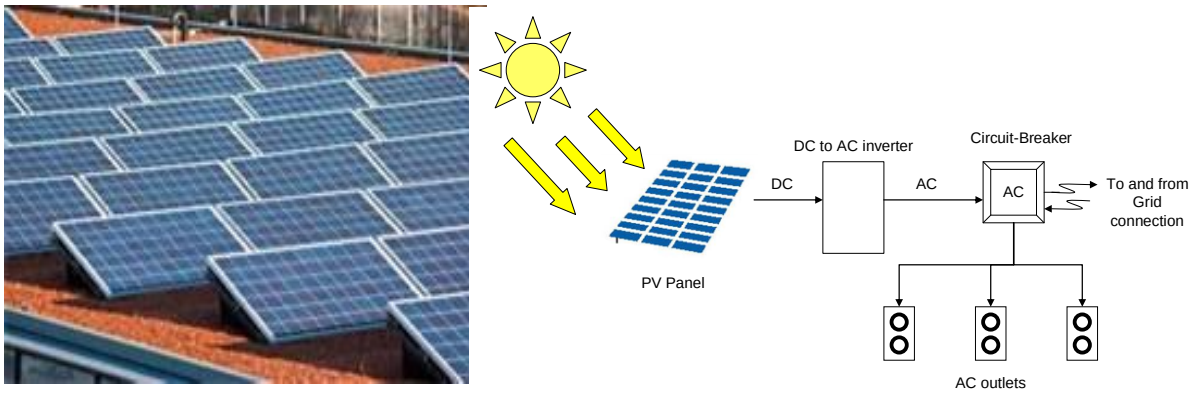

Figure A2: Photovoltaic panels

The photovoltaic panel converts free solar energy directly into electricity. The electricity produced is on direct current (DC). Therefore inverters are used to convert the output into alternating current (AC) for connection to the building's supply board. The electricity generated can either be used to supply communal (landlord) areas or for individual dwellings, the latter configuration tending to be more complex and costly owing to the need for multiple meters.

The panels are most efficient when they face south at 30^{o}. Photovoltaic panels should not be considered in cases with significant overshadow (i.e. next to taller buildings)

Biomass

Biomass is a term used to describe all plant and animal material. A range of biomass material can be burnt to generate energy including wood, straw, poultry litter and energy crops such as willow or poplar. Biomass material is considered carbon neutral if the fuel comes from a sustainably managed source.

Figure A3: Biomass boiler

The primary disadvantage for any biomass installation is that it requires large amounts of fuel storage (which will need to be fed by deliveries of biomass fuel). Developments that use biomass need to secure constant delivery of wood chips or wood pellets, from a local supplier. Finally biomass requires a suitable flue design to address air quality issues.

Wind Turbines

Wind technology is now a well established technology for the generation of electricity in large scale projects. Small scale wind projects within built up areas however is less common.

Figure A4: Wind turbine

The lower uptake of wind turbines in urban settings is due to the reduced efficiency of smaller scale turbines as a result of the high surface roughness reducing wind speeds. According to the Department of Energy and Climate Change Windspeed Database, the average wind speed at 10m agl (above ground level) is 5.1m/s in the vicinity of the site. At 25m agl the average speed is 5.8m/s. These speeds are towards the lower end of what would be considered economical for a turbine. Furthermore, it is likely that the surrounding buildings will create turbulence and locally reduce near surface wind speeds thus further reducing the potential of good wind speeds. In addition wind turbines integrated on buildings might cause other problems, like vibrations. Wind turbines are therefore not considered a viable renewable technology for the development given the setting within a built up area and lack of consistent adequate winds.

Heat Pumps

A heat pump is a machine that moves heat from one location (the 'source') at a lower temperature to another location (the 'sink' or 'heat sink') at a higher temperature using mechanical work or a high-temperature heat source. There are two main categories of heat pumps, the Ground Source Heat Pump (GSHP) and the Air Source Heat Pump (ASHP). They operate very similarly; the difference is on the source of the heat.

Several options are possible for a GSHP, depending on local geology and hydrology. Various types of ground source heat pump arrangements are available including: vertical boreholes, horizontal coils and slinky coils, e.g. around perimeter of building.

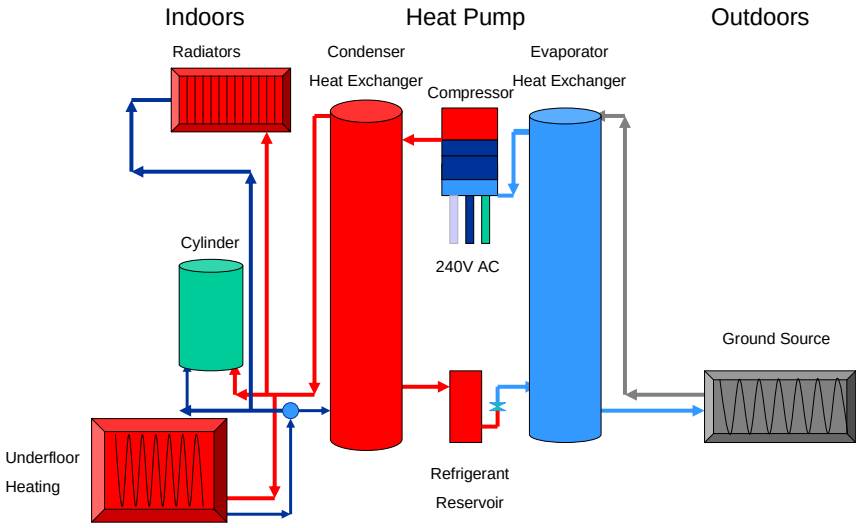

Figure A6: Typical GSHP diagram

The ASHP is an alternative system of the GSHP but they operate with the same physics. Their only difference is that the ASHP uses the ambient outdoor air to provide the low grade source heat instead of the ground. Owing to the greater seasonal variation in air temperatures, air-source heat pumps are unable to provide year-round heating requirements alone; hence they operate less efficiently, the running costs are higher and CO_2 savings lower than for a ground source heat pump.

Figure A7: ASHP

The main advantage of a heat pump over a conventional heating system is that very high efficiencies can be achieved; typically up to around 350% compared to 90% for a modern gas boiler. However, they use electricity as a fuel and the CO_2 emissions that are emitted for each kWh burnt for electricity, are more than double for the same kWh produced by gas.

APPENDIX B:

General Notes

RPS HEALTH, SAFETY & ENVIRONMENT

Sustainability and Energy Assessments

General Notes

General

1. The report is based on information available at the time of the writing and discussions with the client during project meetings. Where any data supplied by the client or from other sources have been used it has been assumed that the information is correct. No responsibility can be accepted by RPS for inaccuracies in the data supplied by any other party.
2. The review of local and regional policy does not constitute a detailed review. It is simply used as a guide to provide the context for the development and to determine the likely requirements of the Local Authority.
3. No site visits have been carried out as any part thereof, unless otherwise specified.
4. This report is prepared and written in the context of an agreed scope of work and should not be used in a different context. Furthermore, new information, improved practices and changes in guidance may necessitate a re-interpretation of the report in whole or in part after its original submission.
5. The copyright in the written materials shall remain the property of the RPS Company but with a royalty-free perpetual licence to the client deemed to be granted on payment in full to the RPS Company by the client of the outstanding amounts.
6. The report is provided for sole use by the Client and is confidential to them and their professional advisors. No responsibility whatsoever for the contents of the report will be accepted to any person other than the client. [Unless otherwise agreed]
7. These terms apply in addition to the RPS Group "Standard Terms of Business" (or in addition to another written contract which may be in place instead thereof) unless specifically agreed in writing. (In the event of a conflict between these terms and the said Standard Terms of Business the said Standard Terms of Business shall prevail.) In the absence of such a written contract the Standard Terms of Business will apply.

8. Energy Feasibility Studies are intended as a guide as to potential technologies considered feasible for the proposed scheme. The Studies should not be used in place of other energy assessments typically required during the design process (e.g. SAP / SBEM, Part L compliance, M&E Design etc).
9. Energy Feasibility Studies are typically undertaken at an early stage of the design process and therefore make a number of assumptions about the ultimate design. All assumptions are agreed with the client prior to their inclusion. Should any of the assumptions ultimately prove false, the client should be aware that this may have implications with regards to the inclusion of the technology.
10. Consideration is given to a range of zero and low carbon technology solutions. Whilst due care has been taken to ensure that the information is accurate, it should be noted that there may be some discrepancy between actual performance and predicted performance on the basis that environmental factors play a significant role in affecting performance.
11. Energy demand is calculated on the basis of best available information at the time of writing the report.
12. System sizes are indicative and based upon manufacturer information and appropriate guidance values. CO_2 emissions are based upon published benchmarks and guidance documents.