77-79 CHARLOTTE STREET

ENERGY STATEMENT

CHARLOTTE STREET PROPERTY LTD

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Revision 00

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1 EXECUTIVE SUMMARY

1.1 INTRODUCTION

This energy statement has been carried out in line with the Camden energy guidance detailed in 'Camden Planning Guidance – CPG 3 Sustainability'. It considers a wide range of CO_2 reduction measures, recommends those most appropriate for the 77-79 Charlotte Street Development and outlines the proposed energy strategy to comply with Building Regulations Part L 2013, the appropriate planning requirements and the requirements of Code for Sustainable Homes 'Level 4'.

1.2 CARBON SAVINGS

CO_2 reduction measures have been considered following the hierarchical methodology of 'Be Lean, Be Clean, Be Green'.

1.2.1 LEAN – REDUCE ENERGY DEMAND

Energy demand reduction measures include both passive and active design features including building fabric performance, glazing strategy, air tightness, thermal mass, increased ventilation, low energy lighting and controls and mechanical ventilation with heat recovery. Through the application of these measures a CO_2 emissions reduction of 11% is achieved when compared to the baseline Building Regulations Part L complaint Development.

1.2.2 CLEAN – SUPPLY ENERGY EFFICIENTLY

Although there is an existing district heating network in the area on Euston road it has been determined that the Development should not be connected to it for a number of reasons:

1. At its closest point this potential network is 600m from the Development.
2. The demand for heat and electricity for the Development (as it only consists of 4 apartments and a small commercial element) is relatively small in comparison to a large district heating network.
3. Requirement to lay additional network piping along busy London roads.

As the requirement for heat and electricity is relatively low and would not provide a consistent base load, an on-site CHP system is not suitable for the Development.

1.2.3 GREEN – USE RENEWABLE ENERGY

Renewable energy technologies considered include:

- Wind turbines
- Solar photovoltaics (PV)
- Biomass
- Ground source heat pumps (GSHP)
- Air source heat pumps (ASHP)
- Solar water heating

An analysis of the building energy demands after Lean measures have been applied showed that the greatest contributor to CO_2 emissions was the demand for space heating and hot water. For this reason a water based renewable system is best suited to the Development. Air source heat pumps offer a solution which can provide both hot water and space heating, when an air to water system is specified. Significant additional savings can be achieved with individual air to water heat pumps provided to each apartment when used in combination with 2no. solar hot water panels per apartment to supplement hot water demand when the heat pumps operate in cooling mode.

The figure below shows the regulated CO_2 emission reduction achieved at each stage of the energy hierarchy.

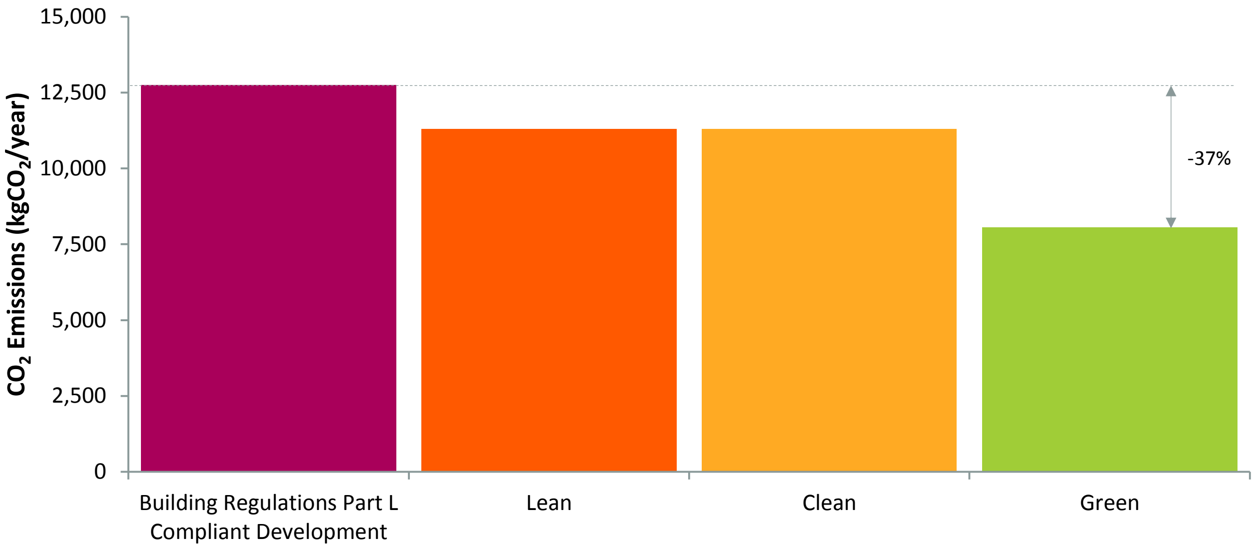

Figure 1 – CO_2 Emissions for Development at each stage of energy hierarchy

The table below shows CO_2 emission figures at each stage of the energy hierarchy.

Table 1 – Comparison of CO_2 emissions savings

	CO_2 Emission Rate ($kgCO_2/m^2/year$)	Cumulative change in CO_2 Emissions
Baseline	24.67	0%
Lean	21.87	-11%
Clean	21.87	-11%
Green	15.57	-37%

1.3 COMPLIANCE WITH PLANNING POLICIES

The Development meets all of the planning policy requirements through the application of passive and active design features, air to water heat pumps and solar hot water systems.

Table 2 – Compliance check

Authority	Policy	Compliant
Government	NPPF	Yes
London Borough of Camden	'Camden Core Strategy' Policy CS13	Yes
Code for Sustainable Homes ENE01	'Level 4', credits targeted – 4 Credits	Yes
Code for Sustainable Homes ENE02	'Level 4', credits targeted – 3 Credits	Yes
Code for Sustainable Homes ENE07	'Level 4', credits targeted – 2 Credits	Yes

2 INTRODUCTION

2.1 BACKGROUND

This energy statement details the proposed design strategies that have been adopted by the project team for the 77-79 Charlotte Street Development, hereafter referred to as 'the Development', to minimise primary energy consumption and carbon dioxide emissions to the atmosphere. This report details the outcomes of analysis and calculations performed for a number of energy efficiency measures that have been considered for the Development and describes the resulting energy strategy.

This energy statement should be read in the context of the other planning documents forming the 77-79 Charlotte Street planning submission.

2.2 DEVELOPMENT OVERVIEW

The applicant is seeking consent for the proposed development at 77-79 Charlotte Street which includes the demolition of the existing building and erection of a new part four, part five and part six storey building plus double basement to provide 4no.dwellings and replacement commercial space.

2.3 CARBON EMISSION FACTORS

The carbon emission factors used in this report are based on those within the Governments Standard Assessment Procedure (SAP) 2012 and referenced within Building Regulations Part L 2013 and are detailed in the Table 3.

Table 3 – Carbon emission factors (DECC, 2012)

Fuel	Emission Factor
Natural Gas	0.216 kgCO_2/kWh
Grid Supplied Electricity	0.519 kgCO_2/kWh
Grid Displaced Electricity	0.519 kgCO_2/kWh

2.4 PLANNING POLICIES

The planning policies that are addressed by the 77-79 Charlotte Street Development energy statement are as follows:

2.4.1 NATIONAL POLICY

The National Planning Policy Framework (NPPF) replaced the suite of Planning Policy Statements and Guidance in 2012. The NPPF identifies three dimensions to sustainable development - economic, social and environmental – which should be applied jointly and simultaneously:

Economic role – contributing to building a strong, responsive and competitive economy by identifying and coordinating development requirements;

Social role – supporting strong, vibrant and healthy communities by creating a high quality built environment, with accessible local services that reflect the community's needs and support its health, social and cultural well-being;

Environmental role – contributing to protecting and enhancing our natural, built and historic environment. This includes helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change.

2.4.2 LOCAL PLANNING POLICY – THE LONDON BOROUGH OF CAMDEN

On 8th November 2010 the London Borough of Camden adopted the 'Camden Core Strategy', which sets out the updated criteria to take into account for all developments in the Borough. The specific policy relating to energy and CO_2 emissions is Policy CS13 – Tackling climate change through promoting higher environmental standards. The relevant policy states:

> *The council will require all developments 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:*
>   1. *Ensuring developments use less energy;*
>   2. *Making use of energy from efficient sources such as the Kings Cross, Gower Street, Bloomsbury and proposed Euston Road decentralised energy networks;*
>   3. *Generating renewable energy on-site;*
> d) *Ensure buildings and spaces are designed to cope with, and minimise the effects of, climate change.*
>
> *The council will have regard to the cost of installing measures to tackle climate change as well as the cumulative future costs of delaying reductions in carbon dioxide emissions.*

(London Borough of Camden, 2010)

To meet these criteria the Development has adopted the energy hierarchy methodology:

- **Be Lean**: use less energy
- **Be Clean**: supply energy efficiently
- **Be Green**: use renewable energy

Section 13.11 of this document sets out that:

> *"Buildings can also generate energy, for example, by using photovoltaic panels to produce electricity, or solar thermal panels, which produce hot water. Once a building and its services have been designed to make sure energy consumption will be as low as possible and the used of energy efficient sources has been considered, the Council will expect developments to achieve 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."*

2.4.3 CODE FOR SUSTAINABLE HOMES

In accordance with the London Borough of Camden document 'Promoting sustainability and tackling climate change' Policy DP22, the Development is expected to achieve a Code for Sustainable Homes 'Level 4' rating for the apartments. To support achievement of the overall score required for a 'Level 4' rating, credits are being sought under 'ENE 1 – Dwelling Emission Rate', 'ENE 2 – Fabric Energy Efficiency' and 'ENE 7 – Low and Zero Carbon Technologies'.

2.5 EMISSIONS REDUCTION TARGETS

The only specific numerical policy targets for reducing CO_2 emissions is the reference in section 13.11 of the Camden Core Strategy to achieve a reduction in CO_2 emissions of 20% from on-site renewable energy generation where feasible. This will be targeted as far as practicable alongside the targeting of the Code for Sustainable Homes credits outline in section 2.4.3.

Policy DP22 of 'Promoting sustainability and tackling climate change' "expects non-domestic developments of 500sqm of floorspace or above to achieve a 'very good' in BREEAM assessments and 'excellent' from 2016 and encouraging zero carbon from 2019." As the non-domestic element of the Development is less than $500m^2$ a BREEAM assessment is not required, however the non-domestic elements of the Development will be targeting an improvement over Building Regulations Part L2A 2013 compliance through the specification of good fabric performance in line with the domestic elements.

3 BASELINE BUILDING

3.1 BASELINE BUILDING CO_2 EMISSIONS

The 'baseline' residential building is a representative model in which the Development meets the minimum requirements for CO_2 emissions reduction, but goes no further. This is equal to the Target Emissions Rate (TER) defined in Building Regulations Part L 2013. Regulated energy use and the associated CO_2 emissions have been calculated using NHER Plan Assessor version 6.1.

All residential units were modelled individually to obtain the TER for each unit. These results were then combined and weighted to give a result for the calculation of the whole Development CO_2 emissions.

As there are no specific targets for the commercial elements of the Development it has been assumed that these areas will improve on Building Regulations compliance requirements through the specification of good fabric performance and building services in line with the residential elements.

Table 4 – Individual CO_2 emissions of Baseline Development

	Fabric Energy Efficiency ($kWh/m^2/year$)	CO_2 Emission Rate ($kgCO_2/m^2/year$)	Change in CO_2 Emissions ($kgCO_2/m^2/year$)	Cumulative change in CO_2 Emissions ($kgCO_2/m^2/year$)
Unit 1	55.0	27.33	0 (0%)	0 (0%)
Unit 2	51.9	22.00	0 (0%)	0 (0%)
Unit 3	60.3	24.97	0 (0%)	0 (0%)
Unit 4	64.0	25.77	0 (0%)	0 (0%)

Table 5 – Total CO_2 emissions of Baseline Development

	Fabric Energy Efficiency ($kWh/m^2/year$)	CO_2 Emission Rate ($kgCO_2/m^2/annum$)	Change in CO_2 Emissions ($kgCO_2/m^2/year$)	Cumulative change in CO_2 Emissions ($kgCO_2/m^2/year$)
Baseline	58.05	24.67	0 (0%)	0 (0%)

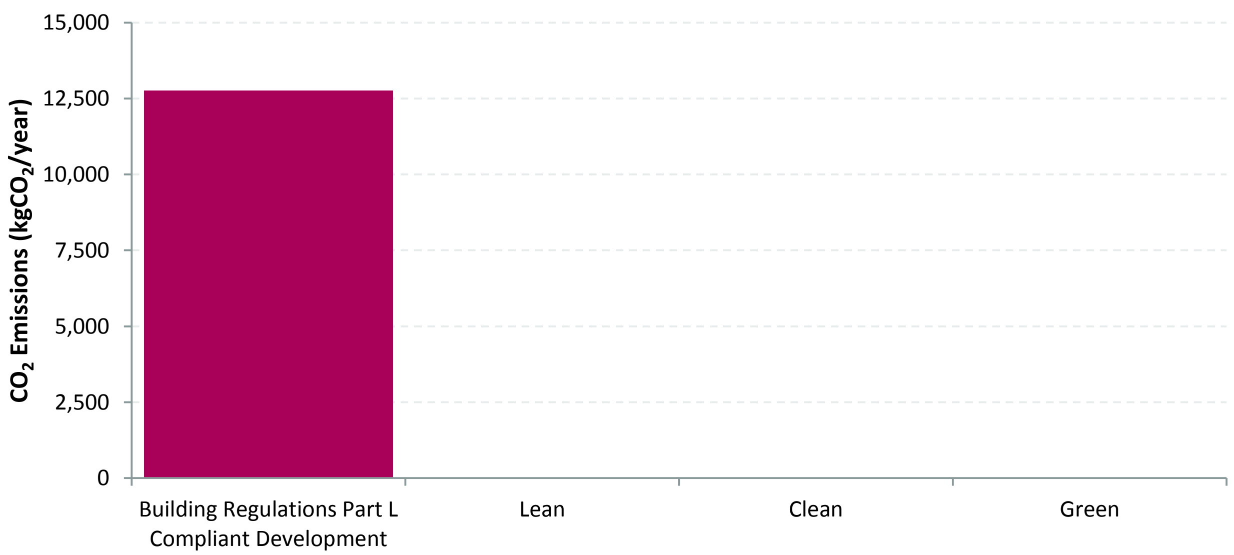

Figure 2 – CO_2 Emissions for residential Development – Building Regulations Part L compliant

3.2 TARGET BUILDING CO_2 EMISSIONS

In terms of numerical targets the Development is expected to achieve a Code for Sustainable Homes ‘Level 4’ rating. To support this, the Development is targeting the credits detailed in Table 6.

Table 6 – Emissions targets

Credit	Credits Targeted	Requirement
ENE01 Dwelling Emission Rate	4	≥32% improvement in DER/TER
ENE02 Fabric Energy Efficiency	3	FEE ≤48kWh/m^2/year
ENE07 Low and Zero Carbon Technologies	2	≤140 kWh/m^2/year

4 BE LEAN – USING LESS ENERGY

4.1 OVERVIEW

Energy efficiency is a key factor in reducing CO_2 emissions from both new and existing developments. The project team recognises the need to reduce the energy demand of the building as far as practicable through the use of both passive and active design measures.

4.2 PASSIVE DESIGN FEATURES

Passive design features incorporate the use of the building structure and façade to minimise heating, cooling and lighting demand through measures such as high performance thermal insulation, improving air tightness and utilising thermal mass.

4.2.1 BUILDING FABRIC PERFORMANCE

Building fabric standards are important in reducing heat demand and Building Regulations have successively improved insulations standards. Table 7 provides a summary of the limiting U-values as required by Building Regulations Part L 2013 along with the U-values that are used to determine the baseline notional target emissions rate (TER).

Table 7 – Baseline building U value summary

Element	New Build Part L1A 2013 Limiting Fabric Performance	New Build SAP 2012 TER Reference Values for Compliance
Roof	0.20	0.13
External Wall	0.30	0.18
Ground Floor	0.25	0.13
Windows (including frame)	2.00	1.40
External Door	2.00	1.00

Improvements in building fabric will reduce the heating requirements and contribute to achieving a Lean development. It should be noted that a balance is required between reducing heating requirements and increasing summer cooling requirements and this needs to be recognised when setting insulation levels. Table 8 provides an indication of the U-values that have been assumed for the Development.

Table 8 – Lean building U value summary

Element	New Build Lean Building Fabric Performance
Roof	0.13
External Wall	0.15
Ground Floor	0.11
Windows (including frame)	1.40 (1.10 to penthouse)
External Door	1.00

4.2.2 AIR TIGHTNESS

A second key fabric performance parameter is air permeability, i.e. the rate at which air moves through the building envelope to the outside. Part L 2013 sets a limit of 10 $m^3/m^2/hr$ at 50 Pa. A more stringent standard is expected to be adopted for the domestic dwellings of $3m^3/m^2/hr$ at 50 Pa. This will greatly reduce the heat loss associated with air infiltration.

4.2.3 GLAZING STRATEGY

The building façade balances the factors of daylighting, summertime overheating, beneficial winter solar gains and thermal performance.

4.2.4 THERMAL MASS

The use of internal thermal mass within the apartments will help support reductions in heating and cooling related CO_2 emissions by limiting temperature peaks and allowing summertime heat build-up to be rejected during the night when external temperatures are lower.

4.2.5 INCREASED VENTILATION

A secure means of increased natural ventilation will be provided to apartments through openable windows from first floor upwards.

4.3 ACTIVE DESIGN FEATURES

4.3.1 LOW ENERGY LIGHTING AND CONTROLS

Low energy linear fluorescent, compact fluorescent and potentially LED lighting will be specified throughout the building to both apartments and commercial units (depending on extent of fit-out) and also landlord areas to minimise the electrical demand for lighting and additional summer cooling load. It is anticipated that 100% of the light fittings will only be capable of accepting low energy lamps. Intelligent lighting control will be provided where appropriate incorporating PIR absence detection and potentially photoelectric dimming.

4.3.2 MECHANICAL VENTILATION WITH HEAT RECOVERY

Improved air tightness reduces the amount of heat (and therefore CO_2 emissions) required to heat the apartments. However this also means that apartments are generally less well ventilated. Increased natural ventilation is proposed and offers fresh air but can introduce heat loss and is not easily controllable. Mechanical ventilation offers the controlled introduction of fresh air and heat recovery prevents heat loss associated with ventilation.

The primary source of ventilation is proposed to be through individual MVHR (mechanical ventilation with heat recovery) units provided to each dwelling. The specified units extract air which is passed through a high efficiency cross flow heat exchanger to provide a balancing tempered supply to the living areas. The units operate in trickle/boost configuration ensuring that only the required quantity of air is delivered to the apartment at any given time. The specified heat exchangers are to be highly efficient to maximise the energy transfer and minimise heat exhausted to the atmosphere.

4.4 'LEAN' BUILDING CO_2 EMISSONS

The 'lean' building takes into account all of the passive and active design features outlined in the previous sections and represents the likely performance of the Development using only Lean measures.

The following tables detail the lean fabric energy efficiency and CO_2 emissions for each apartment of the Development and the residential element as a whole. Successive improvements to Building Regulations Part L requirements has resulted in more stringent baseline CO_2 emission rates.

Table 9 – Individual CO_2 emissions of Lean Development

	Fabric Energy Efficiency (kWh/m^2/year)	CO_2 Emission Rate (kgCO$_2$/m^2/year)	Change in CO_2 Emissions (kgCO$_2$/m^2/year)	Cumulative change in CO_2 Emissions (kgCO$_2$/m^2/year)
Unit 1	46.3	23.83	-3.50 (-13%)	-3.50 (-13%)
Unit 2	42.2	19.60	-2.40 (-11%)	-2.40 (-11%)
Unit 3	51.9	22.87	-2.10 (-8%)	-2.10 (-8%)
Unit 4	49.5	22.28	-3.49 (-14%)	-3.49 (-14%)

Table 10 – Total CO_2 emissions of Lean Development

	Fabric Energy Efficiency (kWh/m^2/year)	CO_2 Emission Rate (kgCO$_2$/m^2/annum)	Change in CO_2 Emissions (kgCO$_2$/m^2/year)	Cumulative change in CO_2 Emissions (kgCO$_2$/m^2/year)
Baseline	58.05	24.67	0 (0%)	0 (0%)
Lean	47.48	21.87	-2.80 (-11%)	-2.80 (-11%)

A comparison between the CO_2 emissions of the Building Regulations Part L compliant Development and the 'Lean' Development is shown in Figure 3.

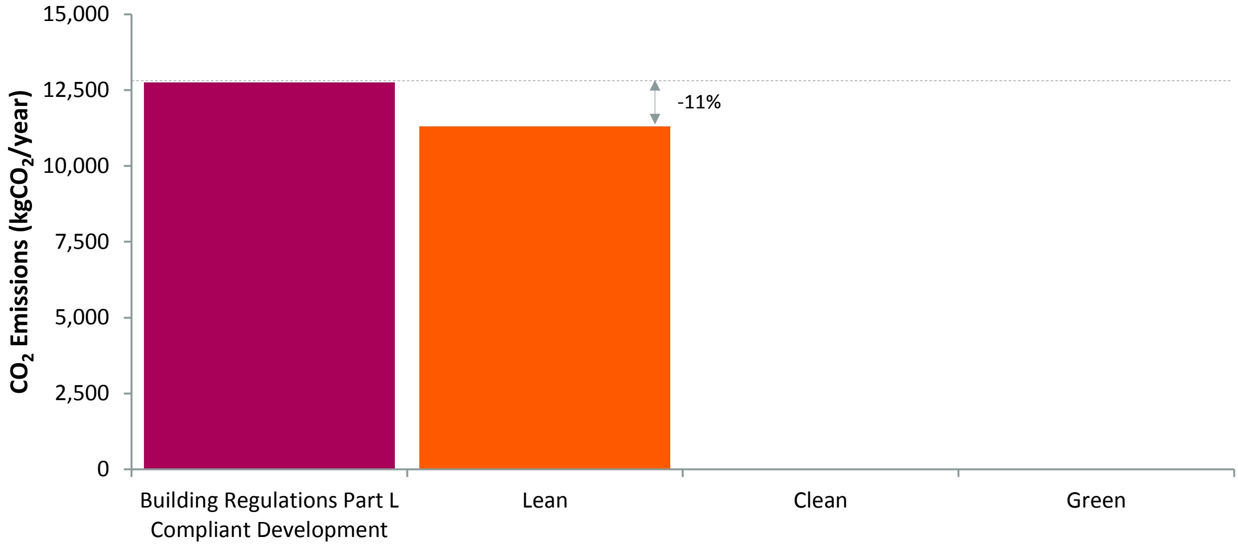

Figure 3 – CO_2 Emissions for residential Development – Lean

Table 11 shows the credits achieved under Code for Sustainable Homes after only 'Lean' measures have been applied.

Table 11 – Code for Sustainable Homes Credits achieved - Lean

Credit	Credits Targeted	Credits Achieved
ENE01 Dwelling Emission Rate	4	1
ENE02 Fabric Energy Efficiency	3	3
ENE07 Low and Zero Carbon Technologies	2	0

5 BE CLEAN – SUPPLYING ENERGY EFFICIENTLY

5.1 CONNECTION TO EXISTING DISTRICT HEATING NETWORKS

In accordance with Camden Core Strategy 2010 Policy CS13 an assessment of the current and proposed heat networks in the area has been carried out to establish the feasibility of connecting the Development to a district heating network. With reference to the London Heat Map it has been determined that the closest heat network to the Development is the potential UCL network. At its closest point this potential network is 600m from the Development.

The map below shows the Development location and the heat networks in the area, obtained from the London Heat Map and the site location. Red lines indicate a potential future heat network.

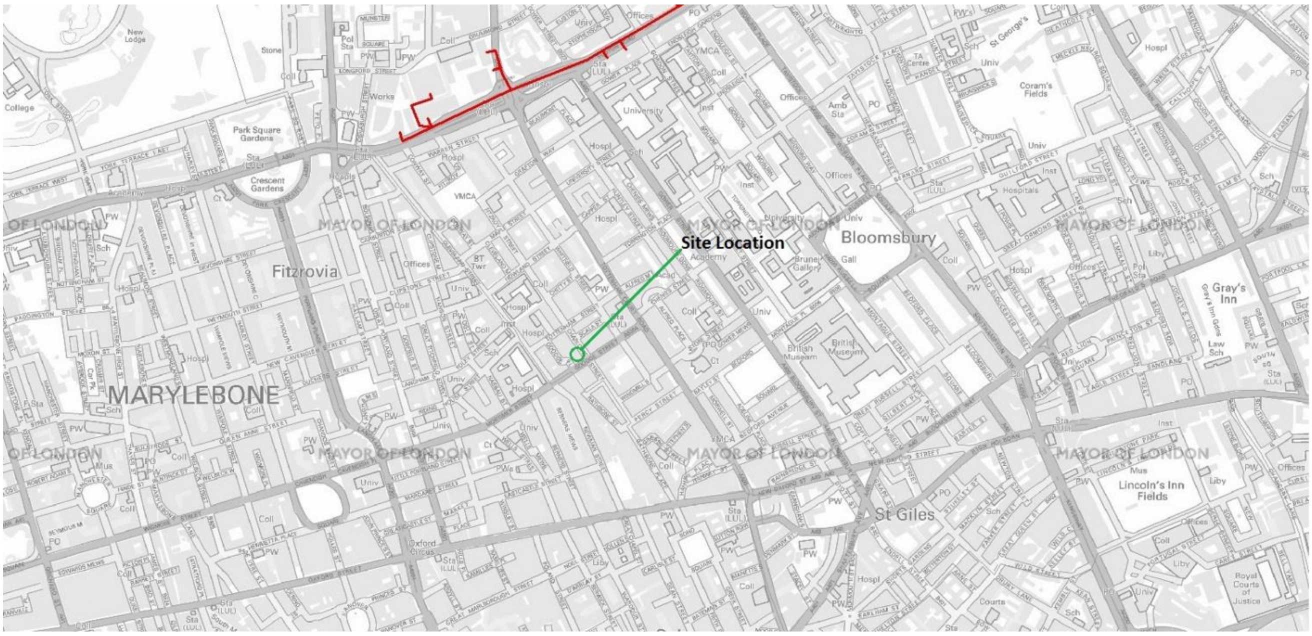

Figure 4 – Heat network data for area surrounding 77-79 Charlotte Street (Centre for Sustainable Energy, 2010)

According to more recent data the Development is within 1km of an existing/emerging network, in the form of the aforementioned UCL network. The Development is also within 500m of a potential network at the British Museum. It is unlikely to be feasible to connect the Development to the existing network as it is a significant distance away. Its location in central London would mean connecting to this network would be very disruptive to traffic during any laying of piping, considering the distance of pipe would be required. As the potential network is not yet confirmed and the demand for heat and electricity for the Development is relatively small, it is also not likely to be feasible to connect the Development to it. For these reasons the Development is not proposed to be connected to an existing district heating network.

If the existing heat network serving University College London is extended to the British Museum it may be possible to explore the potential of connecting the Development to this network. As it is proposed to provide heat via a wet underfloor heating system this would be compatible with a future district heating network.

5.2 ON SITE HEATING NETWORK

The small, generally residential-led nature of the Development results in little diversity in the demands for heat and electricity. CHP systems rely on a diversity of loads and a consistent demand for both heat and electricity in order to operate at optimum efficiency. For this reason an on-site CHP system is not suitable for the Development.

5.3 CLEAN BUILDING CO_2 EMISSIONS

Since Clean measures are not applicable in this instance (it is not feasible or suitable to connect to an existing district heating network or to provide and on-site CHP system) the modelling carried out on each apartment and commercial elements results in the same energy performance as those in section 4.4.

For consistency, the following tables detail the fabric energy efficiency, energy demand and CO_2 emissions for each apartment of the Development and the residential element as a whole at the Clean stage of the energy hierarchy.

Table 12 – Individual CO_2 emissions of Clean Development

	Fabric Energy Efficiency ($kWh/m^2/year$)	CO_2 Emission Rate ($kgCO_2/m^2/year$)	Change in CO_2 Emissions ($kgCO_2/m^2/year$)	Cumulative change in CO_2 Emissions ($kgCO_2/m^2/year$)
Unit 1	46.3	23.83	-3.50 (-13%)	-3.50 (-13%)
Unit 2	42.2	19.60	-2.40 (-11%)	-2.40 (-11%)
Unit 3	51.9	22.87	-2.10 (-8%)	-2.10 (-8%)
Unit 4	49.5	22.28	-3.49 (-14%)	-3.49 (-14%)

Table 13 – Total CO_2 emissions of Clean Development

	Fabric Energy Efficiency ($kWh/m^2/year$)	CO_2 Emission Rate ($kgCO_2/m^2/annum$)	Change in CO_2 Emissions ($kgCO_2/m^2/year$)	Cumulative change in CO_2 Emissions ($kgCO_2/m^2/year$)
Baseline	58.05	24.67	0 (0%)	0 (0%)
Lean	47.48	21.87	-2.80 (-11%)	-2.80 (-11%)
Clean	47.48	21.87	0 (0%)	-2.80 (-11%)

A comparison between the CO_2 emissions of the Building Regulations Part L compliant Development, the Lean Development and the Clean Development is shown in Figure 5.

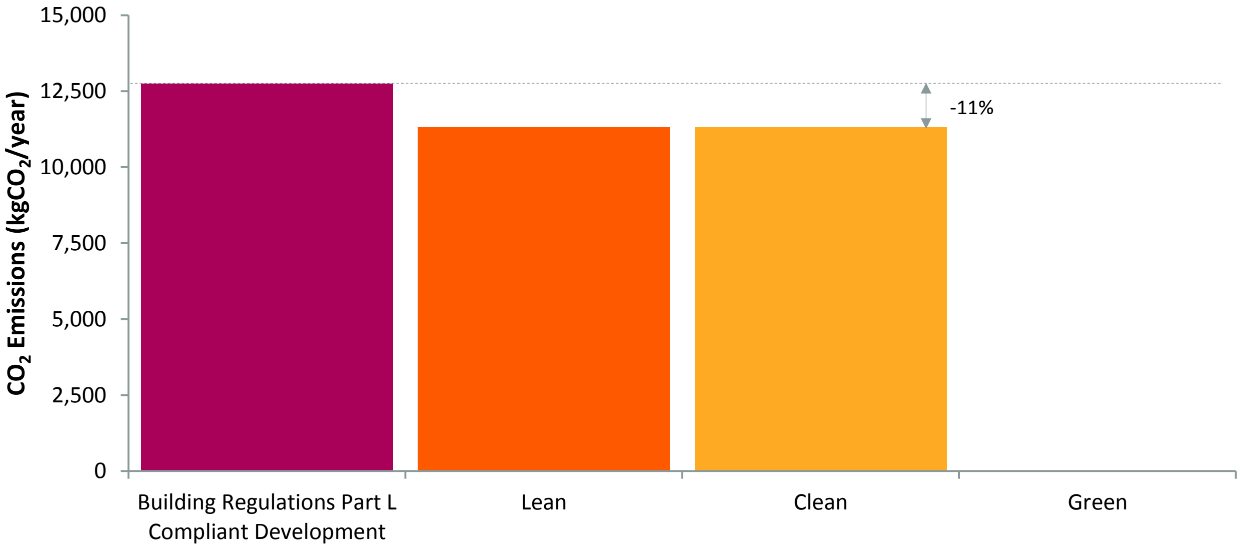

Figure 5 – CO_2 Emissions for residential Development – Clean

Table 14 shows the credits achieved under Code for Sustainable Homes after Lean and Clean measures have been applied.

Table 14 – Code for Sustainable Homes Credits achieved - Clean

Credit	Credits Targeted	Credits Achieved
ENE01 Dwelling Emission Rate	4	1
ENE02 Fabric Energy Efficiency	3	3
ENE07 Low and Zero Carbon Technologies	2	0

6 BE GREEN – USING RENEWABLE ENERGY

A feasibility study has been carried out to assess the suitability of various renewable technologies. The following renewable energy sources have been considered:

- Wind turbines
- Solar photovoltaics (PV)
- Biomass
- Ground source heat pumps (GSHP)
- Air source heat pumps (ASHP)
- Solar water heating

6.1 WIND TURBINES

Wind turbines harness the power in the wind to generate electricity, which can then be fed to the building or exported to the national grid. There are two main types of wind turbines: horizontal axis and vertical axis. Horizontal turbines are more suited to rural areas with high wind speeds to operate at optimal efficiency. Vertical turbines are generally much smaller and can be sited on buildings; however they are typically more expensive and less efficient.

Since there is inadequate space available at the site and the average wind speed is too low to make wind turbines cost effective, they have been discounted as a potential renewable energy technology for the Development.

6.2 SOLAR PHOTOVOLTAICS

Solar Photovoltaics (PV) have a well-established record in the UK as a reliable source of renewable electricity. PV output can be estimated with reasonable accuracy, and is generally guaranteed for 15 years or more. They operate by exploiting the band gap present in semiconductors to generate electricity.

Figure 6 – Monocrystalline and polycrystalline solar photovoltaic panels

The generation profile of solar PV is suited to peak energy consumption during the day. Given that the electricity demand profile of the residential Development may not be similar to the generation profile of solar PV, it may not be a viable option for this element. The commercial elements may be suitable for the use of PV. However, the available space on the roof is limited and would restrict the total collector aperture area that could be installed which may be more suited for the application of solar hot water (which offers more effective CO_2 emission reductions when applied to residential developments).

On the basis of these constraints solar PV is not proposed for the Development.

6.3 BIOMASS

Figure 7 –Domestic scale biomass boiler

A biomass boiler could be used to provide the buildings' space heating and hot water demand in place of gas fired boilers and water heaters. Biomass boilers have a reasonably established track record in the UK and modern technologies are resulting in heat generation efficiencies approaching those of natural gas boilers.

Biomass boilers require a solid fuel, usually in the form of wood chips or wood pellets for which a reliable supply would need to be identified. This should be delivered to site on a regular basis by a large delivery vehicle (adding to the indirect emissions associated with the Development): as the site is in a central London location, reliability and promptness of delivery may be an issue.

The location of the site puts it within a high risk Air Quality Management Area, with specific controls on Nitrogen Dioxide NO_2 and particulate matter PM_{10}. As biomass boilers contribute to this type of emission it would come under the GLA requirements in relation to biomass application and biomass emission standards which states:

> *'Development proposals should be at least 'air quality neutral', not lead to further deterioration of existing poor air quality (such as areas designated as Air Quality Management Areas (AQMAs)), and create opportunities to improve local air quality. They should minimise exposure to existing poor air quality and make provision to address local problems of air quality (particularly within AQMAs and where development is likely to be used by large numbers of those particularly vulnerable to poor air quality).'*

On the basis of these constraints biomass is not considered a viable option for the Development.

6.4 GROUND SOURCE HEAT PUMPS

Ground source heat pumps take heat from the ground and raise it to a higher temperature. This enables the heat pump to have a greater thermal output than the electrical energy input and typically the heat output from a GSHP is three or four times greater than the electrical input. This can result in large energy cost savings and carbon savings. The cost savings are tariff dependent and the carbon savings are dependent on the generation method.

As the Development has a relatively small building footprint and proposes no additional space for excavation or car park outside the building footprint there may be little potential opportunity for a ground source heat pump collector.

On the basis of these constraints ground source heat pumps are not considered a viable option for the Development.

6.5 AIR SOURCE HEAT PUMPS

Figure 8 –Domestic air source heat pump

Air source heat pumps extract heat from the outside air to provide heat to internal spaces. This heat can be used to heat radiators, underfloor heating and hot water, in the case of air to water heat pumps, or to a warm air convector, in the case of air to air heat pumps. Air source heat pumps could be used to offset some or all of the heating and potentially cooling demands (if required) of the Development. Unlike ground source heating and cooling ASHPs do not rely on a balanced heat transfer to and from the air as there is an essentially unlimited source of heat. This makes them more flexible and allows them to cater more effectively for unbalanced heating and cooling demands.

As the majority of the predicted CO_2 emissions are as a result of space heating and hot water air source heat pumps offer an applicable and effective method of reducing CO_2 emissions. They must be sited outside to extract heat from the outside air and as such require an amount of roof space, though this would be quite small for 4 no. apartments and a small provision of commercial space.

As the Development proposes to provide heating via underfloor heating an air to water heat pump system would be compatible. Air to water heat pumps are generally more efficient than their air to air counterparts and they work best with a large surface area to emit heat, this is because they provide lower grade heat than that produced by conventional boilers, hence the use of underfloor systems is suited to this technology.

Space heating and hot water demands to all apartments are proposed to be provided by individual air to water heat pumps appropriately sized to the demand of the apartment with a good coefficient of performance.

6.6 SOLAR WATER HEATING

Solar water heating uses solar energy to heat water as it slowly passes either through evacuated tubes or over a flat plate collector and are an effective renewable technology in the UK as they work in diffused light conditions. The water provided by solar water heating systems is generally used for domestic hot water only and not for space heating. The most efficient type of solar water heating system is the evacuated tube, however these are generally more expensive and as a result the flat plate collector systems are more widely used.

Figure 9 – Evacuated tube and flat plate solar thermal collectors

The requirement for hot water in the Development may be enough to justify a small solar hot water system, however there is limited roofspace available. Solar hot water systems compliment the application of water based air source heat pumps. During winter all heating demands are met by the air source heat pumps, however in summer these systems may need to be switched to cooling mode, in which case they cannot provide hot water simultaneously. In this scenario the solar hot water systems (which operate most effectively in summer) would supplement the hot water demand whilst the air source heat pumps are in cooling mode. This would allow greater reductions in CO_2 emissions.

On the basis of these constraints solar water heating is proposed as a potential solution for the Development, with 2 no. panels being provided per apartment.

6.7 'GREEN' BUILDING CO_2 EMISSIONS

As a result of applying an air to water ASHP system and 2 no. solar thermal panels to all apartments, additional CO_2 savings have been made.

The following tables detail the fabric energy efficiency, energy demand and CO_2 emissions for each apartment of the Development and the residential element as a whole at the Green stage of the energy hierarchy.

Table 15 – Individual CO_2 emissions of Green Development

	Fabric Energy Efficiency ($kWh/m^2/year$)	CO_2 Emission Rate ($kgCO_2/m^2/year$)	Change in CO_2 Emissions ($kgCO_2/m^2/year$)	Cumulative change in CO_2 Emissions ($kgCO_2/m^2/year$)
Unit 1	46.3	17.49	-6.34 (-13%)	-9.84 (-36%)
Unit 2	42.2	14.36	-5.24 (-11%)	-7.64 (-35%)
Unit 3	51.9	16.62	-6.25 (-8%)	-8.35 (-33%)
Unit 4	49.5	14.84	-7.44 (-14%)	-10.93 (-42%)

Table 16 – Total CO_2 emissions of Green Development

	Fabric Energy Efficiency ($kWh/m^2/year$)	CO_2 Emission Rate ($kgCO_2/m^2/annum$)	Change in CO_2 Emissions ($kgCO_2/m^2/year$)	Cumulative change in CO_2 Emissions ($kgCO_2/m^2/year$)
Baseline	58.05	24.67	0 (0%)	0 (0%)
Lean	47.48	21.87	-2.80 (-11%)	-2.80 (-11%)
Clean	47.48	21.87	0 (0%)	-2.80 (-11%)
Green	47.48	15.57	-6.30 (-26%)	-9.10 (-37%)

A comparison between the CO_2 emissions of the Building Regulations Part L compliant Development, the Lean Development, the Clean Development and the Green Development is shown in Figure 10.

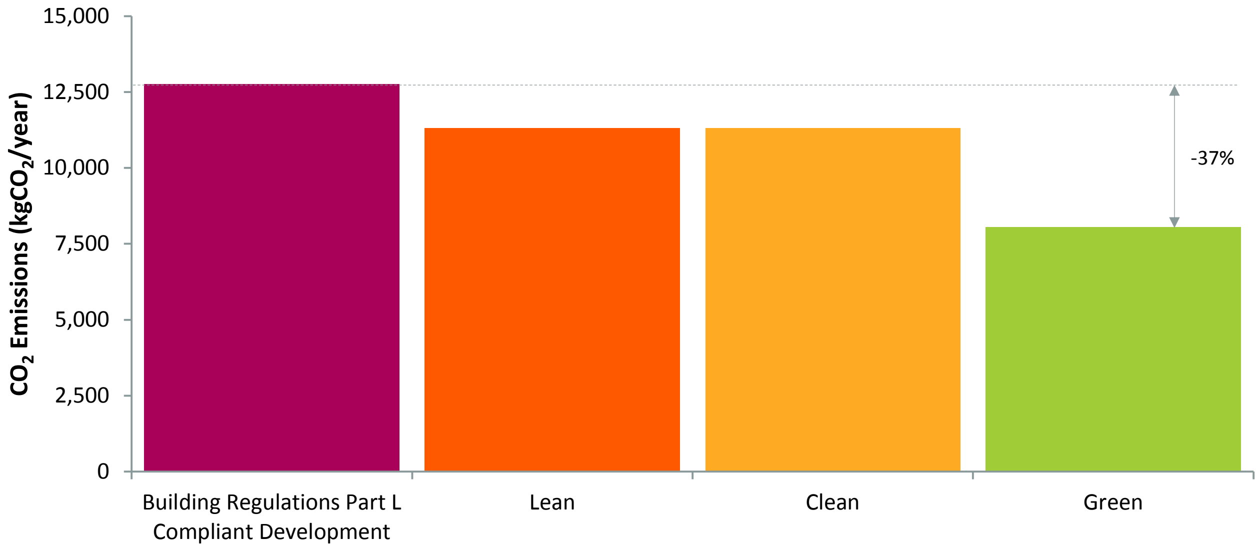

Figure 10 – CO_2 Emissions for residential Development – Green

Table 17 shows the credits achieved under Code for Sustainable Homes after Lean, Clean and Green measures have been applied.

Table 17 – Code for Sustainable Homes Credits achieved - Green

Credit	Credits Targeted	Credits Achieved
ENE01 Dwelling Emission Rate	4	4
ENE02 Fabric Energy Efficiency	3	3
ENE07 Low and Zero Carbon Technologies	2	2

7 CONCLUSION

By far the largest demand of energy (and hence contributor of CO_2 emissions) in the domestic Development is the space and water heating. As such this area has been targeted to achieve the desired reduction in CO_2 emissions.

Energy demand reduction measures are the most effective method of reducing CO_2 emissions. Through the application of a variety of active and passive measures a carbon emissions reduction of 11% is achieved when compared to the notional Building Regulations Part L compliant Development.

In order to further reduce the CO_2 emissions from the Development a system of air to water heat pumps and solar hot water panels are proposed. As the majority of the predicted CO_2 emissions are as a result of space heating and hot water the combination of air source heat pumps and solar hot water panels offer an effective method of reducing CO_2 emissions. Through the application of this system an additional reduction of 26% is achieved, taking the total CO_2 reduction to 37% when compared to the notional Building Regulations Part L compliant Development.

As a result of these measures the Development achieves the following credits targeted under Code for Sustainable Homes, supports the achievement of a 'Level 4' rating and meets the Camden Core Strategy target 20% reduction in CO_2 emissions as a result of the application of on-site renewable energy generation.

Table 18 – Code for Sustainable Homes Credits achieved

Credit	Credits Achieved
ENE01 Dwelling Emission Rate	4
ENE02 Fabric Energy Efficiency	3
ENE07 Low and Zero Carbon Technologies	2

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