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51 Calthorpe Street, London, WC1X 0HH
Energy Efficiency Plan

51 CALTHORPE STREET, LONDON WC1X 0HH

Energy Efficiency Plan

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REGISTRATION OF AMENDMENTS

Revision and Date	Amendment Details	Revision Prepared By	Revision Approved By

EXECUTIVE SUMMARY

Create Consulting Engineers Ltd has been appointed to provide an Energy Efficiency Plan to support the forthcoming planning application for the proposed development at 51 Calthorpe Street, London, WC1X 0HH (the Site) in the London Borough of Camden. The scheme consists of the refurbishment of the existing building and a change of its use from offices to residential. The scheme will lead to the creation of 17 flats over six floors.

This report has been developed to detail the energy strategy of the development and demonstrate how they relate to the following guidance documents:

- London Plan 2011 (with 2015 amendments);
- Greater London Authority (GLA) guidance on preparing energy assessments (April 2015);
- London Borough of Camden Core Strategy (2010)- Policy CS13: 'Tackling climate change through promoting higher environmental standards';
- Camden Development Policies (2010-2015) – Policy DP22: 'Promoting Sustainable Design and Construction';
- London Borough of Camden Planning Guidance CPG 3 – Sustainability (2013);
- BREEAM Domestic Refurbishment assessment tool (2014) - Sustainability Assessment Tool.

This Energy Assessment has been prepared following the principles of the London Plan Energy Hierarchy: 'Be Lean', 'Be Clean' and 'Be Green'. The overriding objective in the formulation of the Energy Assessment has been to maximise the viable reductions in total carbon dioxide emissions from the development within the framework of the energy hierarchy.

'Be Lean'

The strategy aims to reduce energy demands by first incorporating suitable passive design measures, followed by proposed enhancements to provide an efficient building fabric, and highly efficient Heating and Ventilation systems. The proposed energy conservation measures will reduce the carbon dioxide emissions in comparison to the existing building by **65.60%** (regulated emissions) and **47.63%** (whole emissions). The 'Be Lean' measures will reduce carbon emissions compared to the 2013 Building Regulations compliant case by **4.81%** (regulated emissions) and **2.35%** (whole emissions).

'Be Clean' & 'Be Green'

The London Heat Map tool indicates that there is no proposed decentralised heat network within proximity of the site. However to facilitate future connection to an energy network in the future, the development will include a central energy generation centre to deliver the space and hot water demand through the use of gas Combined Heat and Power (CHP) heat generator systems in sequence with communal gas boilers. The design and layout of the building's plant room will be such that it will facilitate the possible future connection of the development to an energy network.

A feasibility study has been undertaken to establish the most suitable renewable energy technology for integration at the proposed development. Due to the constraints of the site, a photovoltaics array on the south orientated unshaded tilted part of the roof of the scheme is considered the most viable and practical option for the scheme.

A gas CHP providing 45% of the heating demand of the scheme and a 2.97 kWp (22.3 m²) monocrystalline silicon photovoltaic system mounted on the tilted south-orientated roof of the scheme combined with the 'Be Lean' measures will lead to a reduction in CO_2 emissions of **25.84%** compared to a Part L 2013 compliant residential development.

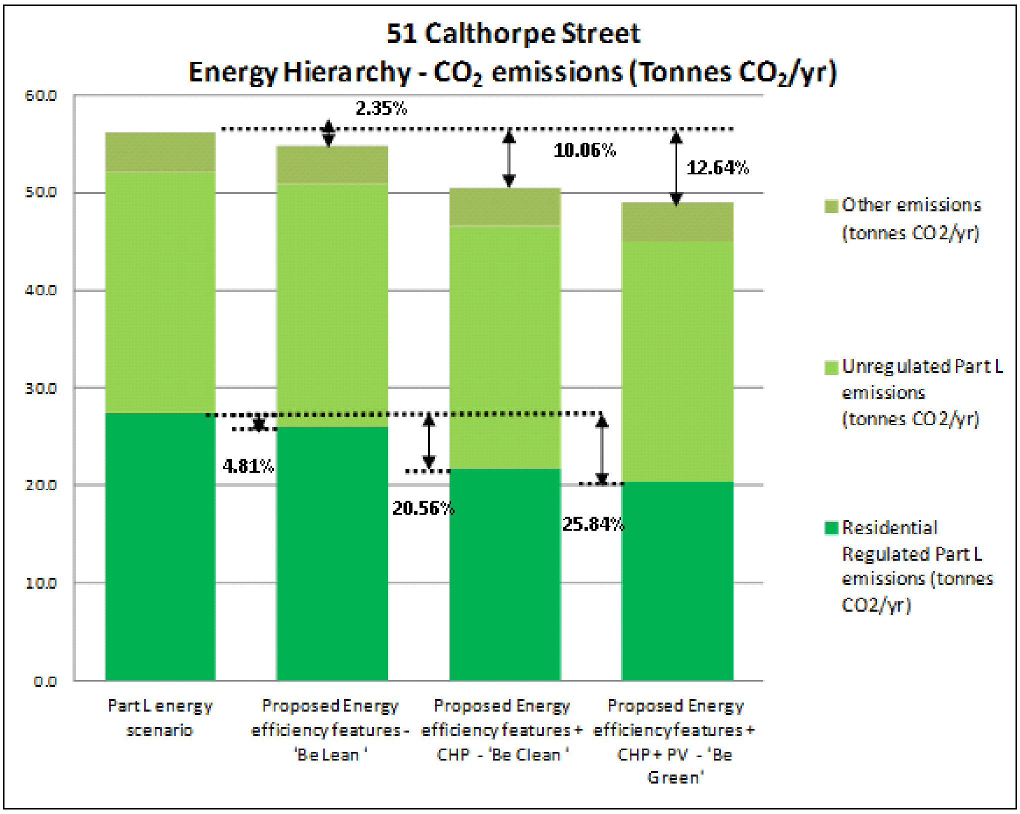
The table below summarises the energy and CO_2 emission reductions for the stages of the energy hierarchy for the proposed development of the Calthorpe Street site. Please note we have also added a scenario representing the existing scheme, to demonstrate the savings achieved by the proposal.

	Regulated (Tonnes CO_2/Yr)	Improve-Ment Over Existing - Regulated Emissions	Improve-Ment Over Part L - Regulated Emissions	Unregulated Part L Emissions (Tonnes CO_2/Yr)	Other Emissions (Tonnes CO_2/Yr)	Total Emissions (Tonnes CO_2/Yr)	Improve-Ment Over Existing - Total Emissions	Improve-Ment Over Part L - Total Emissions
Existing Energy Scenario	75.9			24.7	3.9	104.6		
Part L Energy Scenario	27.4	63.86%		24.7	3.9	56.1	46.36%	
Proposed Energy Efficiency Features - 'Be Lean '	26.1	65.60%	4.81%	24.7	3.9	54.8	47.63%	2.35%
Proposed Energy Efficiency Features + CHP - 'Be Clean '	21.8	71.30%	20.56%	24.7	3.9	50.4	51.76%	10.06%
Proposed Energy Efficiency Features + CHP + PV - 'Be Green'	20.3	73.20%	25.84%	24.7	3.9	49.0	53.14%	12.64%

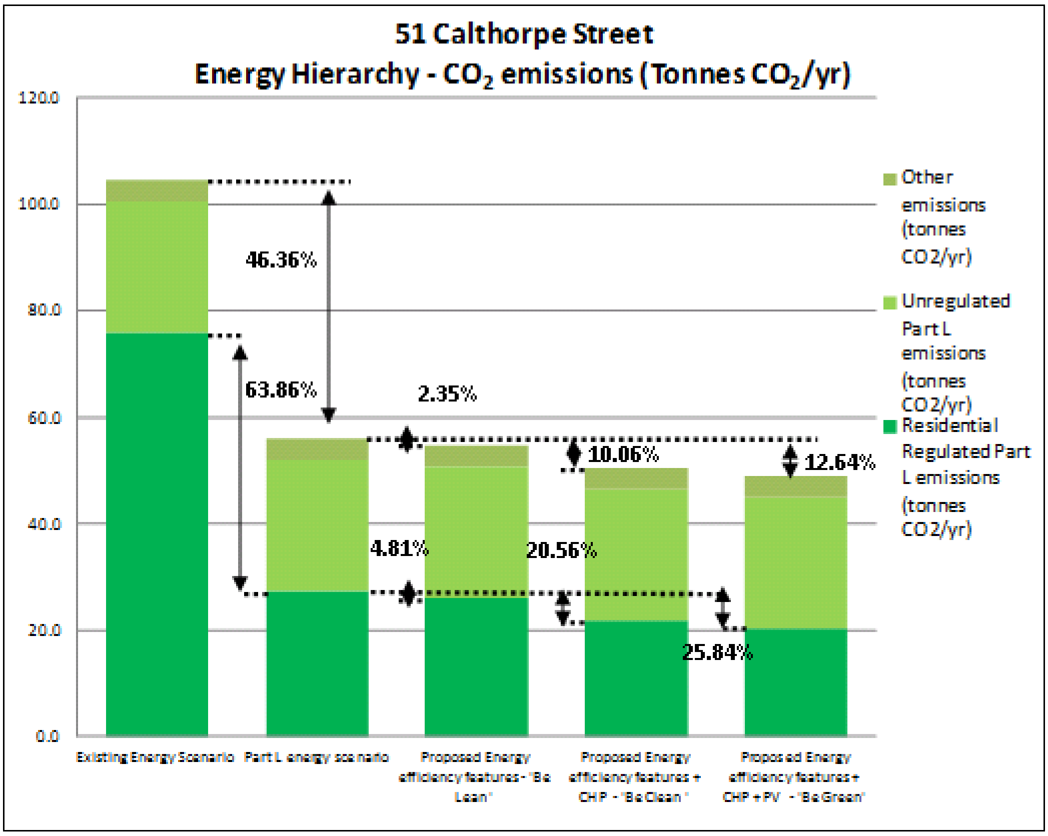
Copy of Table 9.3: London Plan -Energy Hierarchy - CO_2 emissions reductions

A highly optimised energy strategy based on passive design, building fabric performance and building services systems and controls, and suitable Low and Zero Carbon systems will allow the scheme to achieve an **improvement over Part L 2013 of approximately of 25.84 %.**
21.03% CO_2 emissions reduction is achieved by the proposed LZC for the scheme: Combined Heat and Power (CHP) and array of Photovoltaics (PV) modules.

The scheme also achieves a reduction in regulated CO_2 emissions compared to the existing building of 73.20%



Copy of Figure 7.2: London Plan - Energy Hierarchy - CO_2 emissions reductions



Copy of Figure 9.1: London Plan - Energy Hierarchy - CO_2 emissions reductions including existing scenario

INTRODUCTION

1.1 Create Consulting Engineers Ltd has been commissioned by Mr. Simon Firth to provide an Energy Efficiency Plan in support of the planning application for the proposed development at 51 Calthorpe Street, London, WC1X 0HH (the Site) in the London Borough of Camden.

Figure 1.1 London Borough of Camden, Location Map

Current Site Use

1.2 The site is located at 51 Calthorpe Street, London, WC1X 0HH, and comprises an existing three storey Victorian-era building that is currently used as offices and storage. The building's eastern side is located adjacent to the Holiday Inn Hotel and the western side abuts other residential buildings on Calthorpe Street. The front of the existing development faces south-east over Calthorpe Street and is opposite the Mount Pleasant Royal Mail sorting centre. The rear north-west elevation of the development faces the Cubitt Street play centre. The site is accessed solely via Calthorpe Street.

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Figures 1.2 & 1.3: Site Location Plans

Proposed Development

1.3 The development proposals includes the partial demolition and removal of some existing structures (including the roof) with the retention of the external walls and some floors followed by the construction of 17 new flats over six storeys, including a new basement level below the footprint of the building, and the excavation of the forecourt.

1.4 The assessment has been based on drawings prepared by Brooks/Murray Architects (April 2015).

Objectives

1.5 The objectives of this report are to:

- Demonstrate how the proposed development will meet the policy requirements of the London Borough of Camden and of the London Plan, including its associated Energy Hierarchy (Policy 5.2 'Minimising carbon dioxide emissions' and Policy 5.7 'Renewable Energy') and Cooling Hierarchy (Policy 5.9 'Overheating and Cooling') relevant to the scale and nature of the development.

- Identify the most suitable passive and energy efficient design approach for the scheme, the feasibility of Low and Zero Carbon technologies and operational Best Practice.

- Identify the drivers relating to an energy efficient design over and above minimum compliance with current Building Regulations and other appropriate regional and national policies.

Structure

1.6 The introductory section is followed by a review of national and local current and future policies on energy, good practice review and project requirements. A detailed assessment of the estimated energy consumption and associated carbon dioxide emissions is provided, with passive design measures along with energy efficient plant and equipment. This relates to the 'Be Lean' element of the proposed Energy Hierarchy. Low and Zero Carbon technologies are reviewed in detail for feasibility within the scheme, relating to the 'Be Clean' and 'Be Green' elements of the Energy Hierarchy. A summary of the Energy Strategy for the scheme is provided at the end of this document.

2.0 CURRENT AND FUTURE PLANNING POLICIES / GOOD PRACTICE REVIEW AND PROJECT REQUIREMENTS

National Planning Policy Framework (March 2012)

2.1 This framework sets out the Government's planning policies for England and how these are expected to be applied. Taken together, these policies articulate the Government's vision of sustainable development, which should be interpreted and applied locally to meet local aspirations. The main relevant sections are:

- *'Paragraph 17: Support the transition to a low carbon future in a changing climate, taking full account of flood risk and coastal change, and encourage the reuse of existing resources, including conversion of existing buildings, and encourage the use of renewable resources (for example, by the development of renewable energy)';*

- *'Paragraph 93: Planning plays a key role in helping shape places to secure radical reductions in greenhouse gas emissions, minimising vulnerability and providing resilience to the impacts of climate change, and supporting the delivery of renewable and low carbon energy and associated infrastructure. This is central to the economic, social and environmental dimensions of sustainable development.'*

- *'Paragraph 95: To support the move to a low carbon future, local planning authorities should:*
    - *Plan for new development in locations and ways which reduce greenhouse gas emissions;*
    - *Actively support energy efficiency improvements to existing buildings; and*
    - *When setting any local requirement for a building's sustainability, do so in a way consistent with the Government's zero carbon buildings policy and adopt nationally described standards.'*

- *'Paragraph 96: In determining planning applications, local planning authorities should expect new development to:*

- *Comply with adopted Local Plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and*
    - *Take account of landform, layout, building orientation'*

- *'Paragraph 97: To help increase the use and supply of renewable and low-carbon energy,* local *planning authorities should recognise the responsibility on all communities to contribute to energy generation from renewable or low-carbon sources. They should:*

  - *Have a positive strategy to promote energy from renewable and low-carbon sources, including deep geothermal energy;*
  - *Design their policies to maximise renewable and low-carbon energy development while ensuring that adverse impacts are addressed satisfactorily;*
  - *Consider identifying suitable areas for renewable and low-carbon energy sources, and supporting infrastructure, where this would help secure the development of such sources;*
  - *Support community-led initiatives for renewable and low carbon energy, including developments outside such areas being taken forward through neighbourhood planning;*
  - *Identify opportunities where development can draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers'.*

- *'Paragraph 98: When determining planning applications, local planning authorities should:*
  - *Not require applicants for energy development to demonstrate the overall need for renewable or low carbon energy and also recognise that even small-scale projects provide a valuable contribution to cutting greenhouse gas emissions; and*
  - *Approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should also expect subsequent applications for commercial scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas.'*

The London Plan (2011) with 2015 amendments

2.2 This Spatial Development Strategy for Greater London includes objectives to reduce the capital's impact on, and exposure to, the effect of climate change. Policies that are appropriate to the scale of the proposed development at 51 Calthorpe Street include:

<u>Policy 5.2: Minimising Carbon Dioxide Emissions</u>

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

- *'Be Lean'*: reduction of the energy demand and associated emissions using a passive design approach and high specification plant;

- *'Be Clean'*: further reducing energy demand and associated emissions by incorporating viable Low Carbon technologies;

- '*Be Green*': meeting a proportion of the residual demand via renewable energy technologies, where feasible.

2.4 Buildings constructed between the years 2013 – 2016 are required to achieve a 40 per cent improvement over the Target Emission Rate (TER) outlined within the 2010 Building Regulations. Please note this target has been superseded for schemes being assessed under the latest revision of the Building Regulations. Indeed, the Greater London Authority (GLA) Supplementary Planning Guidance (SPG) on Sustainable Design and Construction (April 2014) confirms that the Mayor will now expect these schemes to achieve a carbon emissions reduction of 35 % beyond the Target Emission Rate (TER) outlined within the 2013 Building Regulations.

2.5 Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction are to be met within the framework of the energy hierarchy. As a minimum, energy assessments should include the following details:

- Calculation of 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, including plant or equipment, that are not covered by the Building Regulations at each stage of the energy hierarchy.

- Proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings and services.

- Proposals to further reduce carbon dioxide emissions through the use of decentralised energy, where feasible, such as district heating and cooling and combined heat and power (CHP).

- Proposals to further reduce carbon dioxide emissions through the use of on-site renewable energy technologies.

<u>Policy 5.5: Decentralised Energy in Development Proposals</u>

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

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

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

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

Policy 5.7: Renewable Energy

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

Policy 5.9: Overheating and Cooling

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

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

2.11 Major development proposals should demonstrate how the design, materials, construction and operation of the development would minimise overheating and also meet its cooling needs. New development in London should also be designed to avoid the need for energy intensive air conditioning systems as much as possible.

Greater London Authority (GLA) guidance on preparing energy assessments (April 2015)

2.12 This GLA guidance note provides further details on how to prepare an energy assessment to accompany strategic planning applications as set out in London Plan Policy 5.2. The guidance note reiterates that the purpose of energy assessments is: '*to demonstrate that climate change mitigation measures comply with London Plan energy policies, including the energy hierarchy*'.

2.13 The energy assessment carried out for the scheme (Please refer to Sections 3-7), follows the principles of this GLA guidance note.

London Borough of Camden Policies

Camden Core Strategy (2010)

2.14 Camden's Core Strategy set out the key elements of the Council's planning vision and strategy for the borough. It is the central part of the Local Development Framework (LDF), a group of documents setting out Camden's planning strategy and policies. The most relevant policy for this report is:

- Policy CS13: 'Tackling climate change through promoting higher environmental standards' provides the overarching policy requirements with respect to minimising the effects of climate change, adaptation measures and improved environmental standards during construction and occupation. The main requirements are:
    - Ensuring patterns of land use that minimise the need to travel by car and help support local energy networks;
    - Promoting the efficient use of land and buildings;
    - Minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing, in order, all of the elements of the energy hierarchy;
    - Ensuring buildings and spaces are designed to cope with, and minimise the effects of climate change.

Camden Development Policies (2010-2015)

2.15 Camden Development Policies form part of the Council's Local Development Framework (LDF) and contribute towards delivering Camden's Core Strategy. The most relevant development policies for this scheme relating to Energy is:

- Policy DP22: 'Promoting Sustainable Design and Construction'
    - Residential Developments (except new build) to achieve an Ecohomes 'Excellent rating by 2013 (replaced by BREEAM Domestic Refurbishment);
    - Developments are required to be resilient to climate change;
    - Developments are required to incorporate green or brown roofs and green walls wherever suitable.

2.16 Further details on the BREEAM Domestic Refurbishment assessment and an appraisal of the wider sustainability issues can be found within the Sustainability Plan (Report Reference: AK/CC/P12-385/18) prepared by Create Consulting Engineers Ltd in support of the planning application.

Camden Planning Guidance CPG 3 – Sustainability (2013)

2.17 Camden Planning Guidance has been prepared to support the policies of the London Borough of Camden Local Development Framework (LDF). This guidance is therefore consistent with the Core Strategy and the Development Policies, and forms a Supplementary Planning Document (SPD) which is an additional “material consideration” in planning decisions. This guidance provides information on ways to achieve carbon reductions and more sustainable developments. It also highlights the Council’s requirements and guidelines which support the relevant Local Development Framework (LDF) policies:

- CS13: ‘Tackling climate change through promoting higher environmental standards’;
- DP22: ‘Promoting sustainable design and construction’;
- DP23: ‘Water’.

2.18 This planning guidance outlines the specific targets and policy requirements relating to the energy performance and sustainable design and construction of new and existing buildings, and provides detailed information on how the requirements of the Core Strategy Policy CS13 are to be implemented along with preferred calculations methodologies for inclusion within the Energy Statement.

2.19 This planning guidance requires developments of 5 or more dwellings and/or 500 m^2 (gross internal floor space) to demonstrate how the development’s carbon dioxide emissions are to be reduced in accordance with the London Plan ‘Energy Hierarchy’.

2.20 Development proposals should be supported by an energy statement to demonstrate how the targets for carbon dioxide emissions reduction are to be met within the framework of the energy hierarchy of Be Lean, Be Clean and Be Green. The Energy Statement will provide calculations for the carbon dioxide emissions covered by Part L Conservation of Fuel and Power of the 2013 Building Regulations, referred to as regulated energy, and separate calculations covering the carbon dioxide emissions not covered by the Building Regulations, referred to as unregulated energy at each stage of the energy hierarchy.

Sustainability Assessment Methods – BREEAM Domestic Refurbishment

2.21 The BREEAM Domestic Refurbishment scheme was released in June 2012 as an independent, transparent, environmental labelling scheme for refurbished homes and replaces the previous Ecohomes scheme. Under the new BREEAM Domestic Refurbishment scheme, the issues assessed are grouped into seven categories: Management; Health & Wellbeing, Energy, Water, Materials, Waste and Pollution. The scheme was updated in 2014.

2.22 The scheme will be assessed under the latest version of the BREEAM Domestic Refurbishment scheme (2014) and will aim at achieving an ‘Excellent’ rating in line with the requirement of London Borough of Camden Development Policy DP22: Promoting Sustainable Design and Construction.

Building Regulations Approved Document Part L1A 2013 and L1B 2010 with 2013 Amendments to Approved Documents

2.23 Part L of the current Building Regulations considers the reduction of carbon emissions in new and existing buildings. As the proposals consist of the creation of new dwellings and the change of use from non-residential use as offices to residential units, they fall under Part L1A and L1B of the Building Regulations (Conservation of fuel and power in new and existing dwellings).

2.24 The overall structure of compliance with the 2013 Building Regulations includes five criteria to comply with for all new residential dwellings:

- **Criterion 1** - Dwelling Emission Rate (DER) should be better than the Target Emission Rate (TER) and Target Fabric Energy Efficiency (TFEE);
- **Criterion 2** - Limit on design flexibility;
- **Criterion 3** - Limiting effects of heat gain in summer;
- **Criterion 4** - Commissioning and air-tightness;
- **Criterion 5** - Efficient operation of buildings.

2.25 The new Building Regulations came into force on 6th April 2014. The changes, which involve a strengthening of the Building Regulation requirements, represent the next step towards the Government's ambitions for all new build dwellings to be zero carbon by 2016, and will contribute to the achievement of national emission reduction targets. For new homes, the changes introduced within the new version of Part L1A:2013 will deliver a 6% improvement on the previous 2010 standards across the build mix, with compliance targets differentiated by home type to take advantage of the most cost effective savings.

2.26 The 2010 version of Part L1B of Building Regulations has been retained with some minor amendments (2013 Amendments to Approved Documents). In contrast to Part L1A for new residential buildings, Part L1B does not use a 'Dwelling Emission Rate' (DER) and 'Target Emissions Rate' (TER) as a measure of energy efficiency performance; rather it requires consequential improvements to the thermal performance of the building fabric and the incorporation of additional energy efficiency measures where practicable and economically feasible.

2.27 The detailed energy strategy for the scheme will be developed to ensure the scheme meets the relevant requirements of the Building Regulations.

3.0 CALCULATION METHODOLOGY

Baseline Energy and Carbon Dioxide Emissions

3.1 A total baseline energy demand and carbon dioxide emissions of the entire development, including the energy demand of the 17 apartments, will be established prior to the inclusion of any measures to reduce carbon dioxide emissions. Camden's guidance document CPG 3 - Sustainability confirms that the baseline energy demand should include both the regulated energy associated with lighting, heating and hot water systems, covered by the Building Regulations, and unregulated energy sources not covered by the Building Regulations such as cooking and appliances. In addition to the regulated and unregulated energy sources, the baseline calculations will also consider the energy consumption associated with the communal lighting and lift.

3.2 In accordance with the London Plan, the Greater London Authority (GLA) guidance on preparing energy assessments and London Borough of Camden's CPG 3, the baseline for the calculations will be a 2013 Building Regulations compliant development. A scenario representing the existing scheme has also been included within this energy statement to demonstrate the savings achieved compared to the existing building.

3.3 The estimated regulated annual energy demand and carbon dioxide emissions for the apartments within the proposed development have been calculated using the Standard Assessment Procedure (SAP 2012), which is the national calculation methodology accepted for the energy rating of domestic buildings.

Calculation and Site Constraints

3.4 This development is at the pre planning stage and as such this report has made several assumptions. The assumptions made and their impacts are detailed below.

3.5 Building geometric information has been based upon the drawings provided by Brooks/Murray Architects. At the time of writing no specific construction methods have been determined. This report assumes a low thermal mass for all the proposed flats, with assumption that all retained concrete and solid brick elements will be internally insulated, resulting in reduction in their thermal mass.

3.6 This report has used a representative number of apartments to determine the overall site wide CO_2 emissions and energy requirements. The representative apartments used were those judged to be an average to worst case, with higher than average areas of exposed wall or roof areas. This selection is intended to give a robust calculation of the energy requirements and associated CO_2 emissions.

3.7 At the time of writing no details are available for the proposed lift system to be fitted. The energy consumption and guidance given in CIBSE Guide D 'Transport systems in buildings' has been used to inform the calculations.

3.8 The air permeability for of the new flats has been based upon a presumed value of 4 $m^3/hr/m^2$@50Pa. This is slightly higher than the standard detailed within Camden guidance document CPG 3. Low levels of air permeability reduce space heating energy demand but also result in a corresponding requirement for mechanical ventilation to provide adequate fresh air to ensure occupiers' comfort. The energy saved with a lower level of air permeability must be weighed against the energy required to operate a mechanical ventilation system and the added complexity and cost of installing such a system. It has been decided that all the flats constructed within the refurbished part of the building and those newly built will utilise natural ventilation throughout.

3.9 The base case development is assumed to use individual gas combination boilers with interlock, delayed start thermostat and load or weather compensator for newly constructed flats and gas combination boilers with minimum acceptable efficiencies and controls as described in 'Domestic Heating Services Compliance Guide' in flats built within the existing building envelope.

Existing and Part L Baseline Emissions and Energy Consumption

3.10 The existing and baseline development CO_2 emissions and energy requirements have been determined and detailed within the following tables (Please refer to Tables 3.1 & 3.2 overleaf).

3.11 The existing development CO_2 emissions and energy requirements have been determined following discussion with the design team, using RdSAP for existing dwellings using Band A – building fabric characteristics and 1982 heating system.

3.12 The base case CO_2 emissions and energy demand values for new flats, constructed in the basement, lower ground level and on the third floor, were taken from the TER worksheets for these flats. These values represent Building Regulations compliant dwellings. The base case CO_2 emissions and energy demand figures for the refurbished units cannot be calculated the same way. The DER/TER target does not apply to refurbished dwellings; therefore the reconstructed flats were modelled with the minimum acceptable values required by the Building Regulations Part L1B for building fabric and services. CO_2 emissions and energy demand values were then extracted from the DER Worksheets available for these plots.

3.13 Five different dwellings have been modelled representing the different type of dwellings present in the scheme:

- Flat 2 – Basement;

- Flat 7 – Mid-floor;
- Flat 9 – Mid-floor;
- Flat 13 – Mid-floor;
- Flat 17 – Top-floor.

Residential Energy demand Existing development	Total energy delivered (kWh/year/m^2)	Total energy delivered (kWh/year)	Total CO_2 emissions ($kgCO_2$/year)
Space and water heating	229.6	322,319	69,621
Pumps and Fans	1.5	2,041	1,059
Lighting	7.2	10,060	5,221
Electrical appliances	29.1	40,814	21,182
Cooking	6.8	9,607	3,530
Lift and communal lighting	5.4	7,585	3,937
Gas	233.1	327,123	70,658
Electricity	46.5	65,303	33,892
Total	279.6	392,426	104,551

Table 3.1 'Existing Case' development CO_2 emissions and energy requirements

Residential Energy demand Proposed development Part L compliant development	Total energy delivered (kWh/year/m^2)	Total energy delivered (kWh/year)	Total CO_2 emissions ($kgCO_2$/year)
Space and water heating	78.0	109,531	23,659
Pumps and Fans	0.9	1,275	662
Lighting	4.3	5,987	3,107
Electrical appliances	29.1	40,814	21,182
Cooking	6.8	9,607	3,530
Lift and communal lighting	5.4	7,585	3,937
Gas	81.5	114,334	24,696
Electricity	43.1	60,464	31,381
Total	124.5	174,798	56,077

Table 3.2 'Part L Compliant- Base Case' development CO_2 emissions and energy requirements

4.0 ENERGY HIERARCHY

4.1 The energy hierarchy as detailed by the London Plan and Camden Core Strategy CS13 outlines a series of sequential steps that should be assessed in order for any new development. The steps and the order in which they are to be assessed are as follows:

1. 'Be Lean': use less energy;
2. 'Be Clean': supply energy more efficiently;
3. 'Be Green': use renewable energy.

4.2 These steps are examined in the context of this development below.

5.0 'BE LEAN': USE LESS ENERGY

5.1 Minimising the requirement for energy is the first step that should be considered. The rate at which heat energy is lost from a building greatly influences the annual heat load, and therefore the CO_2 emissions and energy requirements of that building. Energy requirements for hot water applications are essentially independent of improvements to the building's fabric efficiency as these are functions of occupancy and usage rather than rate of heat loss. The main areas where the efficiency of a building can be improved are detailed below.

Building Fabric's Thermal Transmittance

5.2 Building fabric thermal transmittance is measured by the U-value of each building element in Watts/m^2/K. The U-value is a measure of the rate at which energy is lost through a building element; the greater the U-value, the higher the rate of energy loss.

5.3 The building fabric performance will be mostly improved compared to the values recommended by Camden within their guidance document CPG 3.Table 5.1 below shows the fabric performance levels assumed in relation to the values stated in guidance document CPG 3 and the minimum requirements of the Building Regulations.

Building Element/Characteristic	Proposed Development New Flats Basement	Proposed Development New Flats Top Floors	Camden Document CPG 3	Proposed Development Refurbished Flats	Building Regulations Part L1B Requirements
Exterior Wall U values	**0.15** W/m^{2}K	**0.14** W/m^{2}K	0.2 W/m^{2}K	**0.23** W/m^{2}K	0.30 W/m^{2}K (for refurbished element)
Dormers	**N/A**	**0.2**	N/A	**N/A**	
Semi-exposed walls (to corridors and stairwells)	**0.18** W/m^{2}K	**0.14** W/m^{2}K	0.2 W/m^{2}K	**0.18** W/m^{2}K	
Floor U value	**0.1** W/m^{2}K	**0.1** W/m^{2}K	0.2 W/m^{2}K	**0.1** W/m^{2}K	0.25 W/m^{2}K (for refurbished element)
Roof U value	**N/A**	**0.15** W/m^{2}K	0.13 W/m^{2}K	**0.15** W/m^{2}K	0.18 W/m^{2}K (for refurbished element)
Window U value (Dwellings)	**1.1** W/m^{2}K	**1.1** W/m^{2}K	1.5 W/m^{2}K	**1.1** W/m^{2}K	1.6 W/m^{2}K (for provision of new elements)
Door U value (solid)	**0.85** W/m^{2}K	**0.85** W/m^{2}K	1.0 W/m^{2}K	**0.85** W/m^{2}K	1.8 W/m^{2}K (for provision of new elements)
Design Air Permeability	**4** m^3/hr/m^2 @50Pa	**4** m^3/hr/m^2 @50Pa	3 m^3/hr/m^2 @50Pa	**N/A**	N/A
Thermal Bridges	**ACD/Default**	**ACD/Default**	N/A	**ACD/Default**	N/A

Table 5.1: Proposed Fabric Efficiency Standards vs. LB Camden, Part L Standards

Air Permeability

5.4 Air permeability is a measure of infiltration. It indicates how often the entire air quantity in a building is exchanged with outside air within 1 hour without any ventilation in place. Any air exchanged with outside air is carrying heat energy away from the building, resulting in a higher heating load. From an efficiency perspective, lower air permeability levels are desirable; however reduced air permeability, usually below 4 $m^3/hr/m^2$@50Pa, can make natural ventilation ineffective, necessitating the use of mechanical ventilation.

5.5 As detailed in Section 3, the air permeability of the new flats within the proposed development has been assumed to be 4 $m^3/hr/m^2$@50Pa. This is to ensure that a well sealed building, with minimal air infiltration through the gaps in building fabric, provides a comfortable environment to its occupants. The flats constructed within the refurbished part of the building have no minimum air permeability requirement; they will however be dry-lined on the inside ensuring any gaps in the building envelope are sealed.

Thermal Bridging

5.6 Thermal bridging of junctions is the loss of heat energy through the junction between different building elements (such as a wall and window) or where a building element changes direction (such as a corner). Such areas can result in breaks in the continuity of insulation that can form ‘bridges’ for heat energy to escape from the building.

5.7 The proposed development will use existing front and side elevation walls and upgrade them internally to minimise heat loss through the walls. The existing basement will be excavated further to provide an additional level that will accommodate new flats. New external basement walls will be acting as retaining walls. For this reason it is not possible to assume that Accredited Construction Details (ACD) could be applied to all the elements’ junctions. Some ACD will be applied where possible. The flats on the second and third floor however, can adopt the ACD junctions as they will be newly constructed without incorporating the existing structure into their design. For the purpose of the energy calculations, a default thermal bridging value has been used for the refurbished flats and available ACD have been assumed for the new flats.

Thermal Mass and Solar Gain

5.8 Thermal mass and passive solar gains are two related aspects of efficient building design. Thermal mass is the ability of the fabric of the building to absorb excess heat. If effectively utilised, it can reduce heating and cooling loads and, in some cases, remove the requirement to provide air conditioning. Timber frame is typically a lightweight construction with low thermal mass whereas a building with external, party and internal walls made from dense blocks and with concrete lower and upper floors typically has a high thermal mass. Buildings with a high thermal mass and high level of insulation generally make better use of solar gains in the day by absorbing them and radiating the warmth later on as the level of solar radiation drops.

5.9 The proposed development does contain a significant area of south facing elevation and could potentially take advantage of passive solar gain and thermally massive building materials; however the interaction of passive solar gain, building thermal mass and the risk of overheating is a complex one beyond the scope of an initial energy assessment. At this stage it can only be determined that the development is potentially suitable; a precise determination will be reliant on more comprehensive dynamic thermal simulation of the development undertaken at the detailed design stage.

The Choice and Design of Building Systems and Plant

5.10 The building systems and plant have been designed to optimise the efficiency of the systems by matching installed capacity to anticipated building demand. Items of equipment, which make up the building's mechanical building services installation, will be specified to achieve high annual energy efficiency in operation and will be regularly serviced to maintain their performance.

5.11 The proposed method of supplying heating and hot water to the apartments will be via a combined heat and power system supplying 45% of the heating demand of the residential scheme, with a heat to power ratio of 2 and an overall efficiency of 80%. The low carbon feasibility study (Please refer to the 'Be Clean' - Section 6 of this report) concludes that CHP is very well suited to the residential development due to its relatively high constant hot water demand throughout the year. The use of CHP will lead to CO_2 savings compared to conventional systems.

5.12 The remaining load will be provided via condensing community gas boilers which will be highly efficient (89%) with low NOx emissions. Use of efficient system controls for local temperature adjustment in each occupied space such as room thermostats and TRVs will be incorporated to reflect the user demands. Energy meters for power, domestic cold water and primary hot water will be provided for each apartment and also landlord central services.

5.13 A home user guide detailing the energy design strategy of the building and the dwelling's energy features will be provided to the occupants of each dwelling. Controls will also be designed to be user-friendly

Lighting and Appliances

5.14 High efficiency low energy lighting and controls will be specified throughout. All residential spaces will utilise 100% low energy lighting. All communal spaces will utilise automatic lighting controls. The communal circulation spaces will utilise occupancy sensors.

5.15 The residential spaces will be fitted with energy display devices to allow the occupants to accurately monitor their energy consumption and to inform them of areas of high consumption to allow for effective adjustment of their usage patterns. Energy display devices will be required as part of the BREEAM Domestic Refurbishment strategy.

Limiting the Risk of Overheating - London Plan Cooling Hierarchy

5.16 The section below details how the different measures implemented have followed the London Plan cooling hierarchy developed in Policy 5.9 – 'Overheating and Cooling'. In summary:

- Minimise internal heat generation through energy efficient design & reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls
    - Recessed windows;
    - Occupant controlled blinds or curtains for all windows;
    - Optimised solar transmittance of the glazing units (g <0.63).

- Manage the heat within the building through exposed internal thermal mass and high ceilings
    - Some thermal mass effect through exposed walls;
    - Effect limited due to internal finishes (carpets);
    - During the cooling season, effective use of thermal mass through night time purge ventilation.

- Passive ventilation
    - Natural ventilation selected for the scheme.

- Mechanical ventilation
    - Mechanical extracts for kitchen and bathrooms.

- Active cooling systems (ensuring they are the lowest carbon options)
    - No active cooling system is proposed for the flats of the scheme.
    - Dwellings pass Approved Document Part L1A overheating criteria without comfort cooling.

5.17 Several factors have an impact on the summer internal temperature such as:

- Volume of the flat;
- Ventilation strategy;
- Size and orientation of glazed elements;
- Energy transmittance of glazing - g value of glazing;
- Opening regime;

- Frame factor;
- Blind specification;
- Overhang;
- Thermal mass

5.18 The SAP certified software NHER Plan Assessor v 6.1.1 which follows Appendix P of SAP 2012 has been used to assess the overheating risk of the flats of the development. All the flats of the development pass criterion 3 of Building Regulations Approved Document Part L1A 2013.

Lean Case CO_2 Emissions and Energy Requirements

5.19 The overall effect on the energy demand and associated CO_2 emissions of incorporating the energy efficiency measures detailed above into the proposed development would be as follows:

Residential Energy demand Proposed development Be Lean	Total energy delivered ($kWh/year/m^2$)	Total energy delivered (kWh/year)	Total CO_2 emissions ($kgCO_2$/year)
Space and water heating	73.5	103,169	22,285
Pumps and Fans	0.9	1,275	662
Lighting	4.3	6,093	3,162
Electrical appliances	29.1	40,814	21,182
Cooking	6.8	9,607	3,530
Lift and communal lighting	5.4	7,585	3,937
Gas	76.9	107,972	23,322
Electricity	43.2	60,570	31,436
Total	120.1	168,543	54,758

Table 5.2 'Lean Case' development CO_2 emissions and energy requirements

5.20 The energy efficiency strategy for the scheme has been developed following a hierarchical approach. The strategy aims to reduce energy demands by first incorporating suitable passive design measures, followed by proposed enhancements to provide an efficient building fabric, and highly efficient heating and ventilation systems.

5.21 The use of energy efficiency measures would reduce the regulated CO_2 emissions in comparison to the 2013 Building Regulations Compliant case by 4.81% (2.35% for the whole emissions) and in comparison to the existing building by 65.60% (47.63% for the whole emissions).

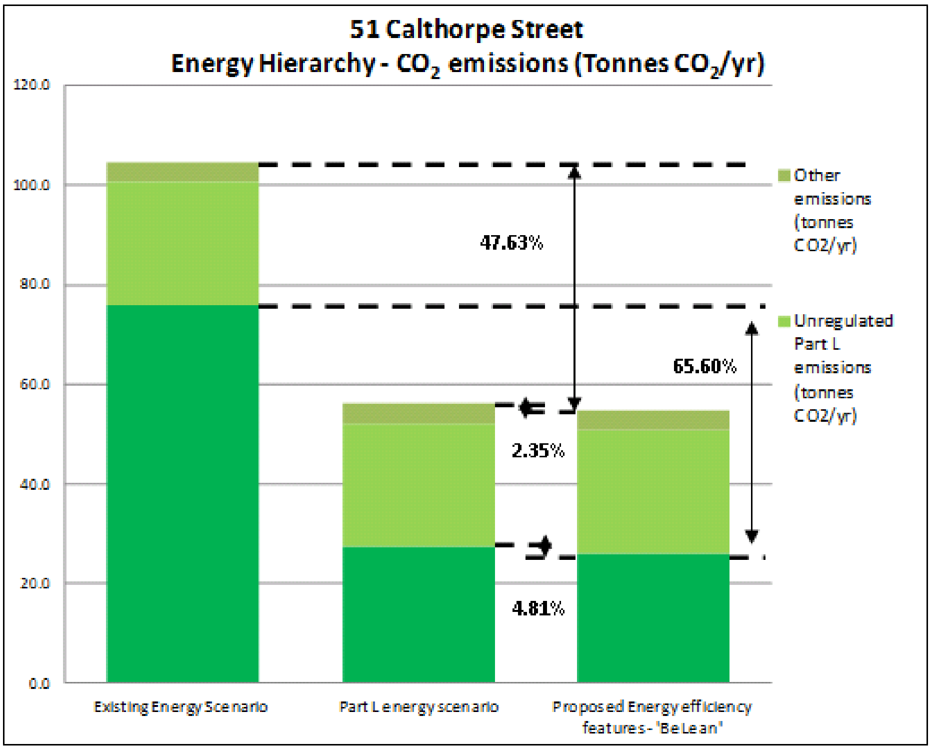

Figure 5.1 Energy Hierarchy – Existing Case, Base Case, 'Be Lean' Case– 51 Calthorpe Street

6.0 'BE CLEAN': SUPPLY ENERGY EFFICIENTLY

6.1 Connection to a decentralised energy network and the use of combined heat and power is a recognised method of generating energy more efficiently. The London Borough of Camden Core Strategy Policy CS13 and guidance document CPG 3 *Sustainability* requires development proposals to explore the opportunities to link into an existing or planned decentralised energy network using the London Heat Map tool. Where an existing decentralised energy network is not present, an assessment of the feasibility of establishing a decentralised energy system for the proposed development should be undertaken; including an assessment of the feasibility of a Combined Heat and Power (CHP) communal heating system.

6.2 The feasibility of connecting to an existing network and specification of a Combined Heat and Power system has been assessed within the following section.

Decentralised Energy Networks

6.3 The London Heat Map tool is an interactive tool that allows users to identify opportunities for decentralised energy projects in London. It builds on the 2005 London Community Heating Development Study. All information has been updated and the map is now in a user friendly format using an interactive GIS system. This tool details the existing and proposed major heat loads and supplies within London as well as existing and proposed heat distribution networks.

6.4 The London Heat Map was consulted during the writing of this report. The output from the London Heat Map indicating the location of the proposed development in relation to existing and proposed energy networks can be found in Figure 6.1 below.

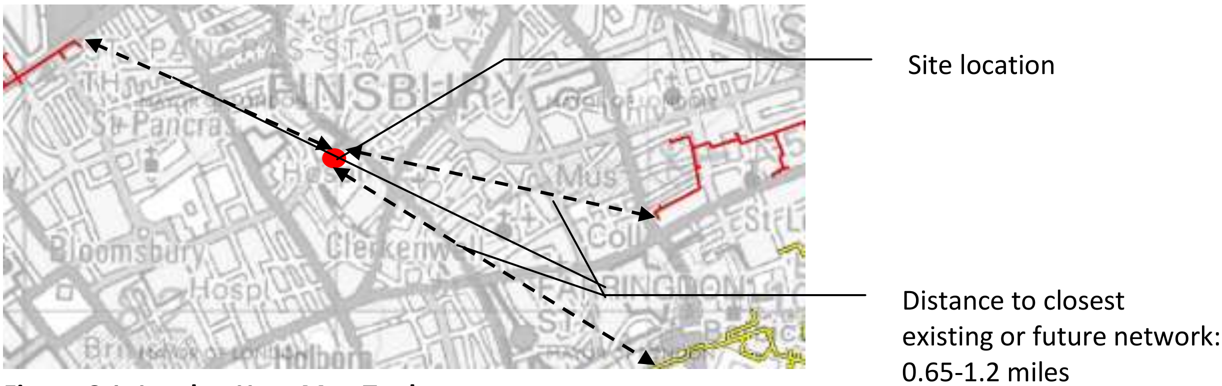

Figure 6.1: London Heat Map Tool

6.5 Based on the information given by the London Heat Map and the maps contained in Section 5 of Camden's guidance document CPG 3 there are no existing or proposed heat networks, within 0.65 miles of the proposed development location. As this distance, it is not considered feasible to connect the scheme to a decentralised heat network due to distribution heat losses and installation cost.

Combined Heat and Power System

6.6 The potential integration of conventional CHP plant has been evaluated for the development proposal at 51 Calthorpe Street, in compliance with appropriate planning policies, including the London Plan Policy 5.6 'Decentralised Energy in Development Proposals' and London Borough of Camden CPG 3 - Sustainability.

6.7 Decentralised CHP recovers the waste heat from the power generation prime mover that would otherwise be lost, via the engine water jacket, exhaust gases and oil cooler (dependent on model). Combined Heat and Power (CHP) is the simultaneous generation of both electricity and heat in the same process. The CHP process can be applied to both renewable and fossil fuels. Sizing a CHP system is a complex undertaking and viability is largely dependent upon a development's heat demand and usage profile. Typically a CHP system would be sized to the base heat load (the heat load present all year round) in order to maximise the running time, and therefore the efficiency of the system.

6.8 A CHP installation would typically be the lead heat generator in a sequenced boiler system to ensure maximum run time and efficiency. For a residential application the base heat load is likely to be the domestic hot water demand. To meet a domestic residential hot water demand, a CHP system would likely need a proportionally large thermal store to account for the typical hot water usage profile, which will be subject to daily peaks in demand, primarily in the morning and early evening, as is common with residential applications. Such a system would need a suitably sized plant room area and a site wide insulated distribution pipe network to supply heated water to all dwellings. A central energy centre should be sufficient to house the expected thermal store and distribution infrastructure. The thermal store would also likely be required for any future connection to a district heat network.

6.9 The energy demand assessment for the 51 Calthorpe Street development has been reviewed with regard to the potential feasibility of CHP meeting a proportion of this heat demand, along with a proportion of the site's electricity demand, with an overall reduction in carbon dioxide emissions. A CHP unit is considered very well suited to the scheme due to its high consistent base heating load throughout the year (hot water load).

6.10 To maximise the run time and efficiency of the system, the CHP system will be sized to meet a proportion of the base heat load and will include a thermal storage system. The detailed service design carried out at the detailed design stage will determine the most efficient ratio of energy supplied by the CHP system in relation to the conventional boiler load; however, for the purpose of the calculations supporting this report an assumption has been made that CHP will supply approximately 45% of the heating demand. This would allow near continual running throughout the day to build up a store of hot water with additional gas boilers meeting the remaining load and any peaks in demand.

Communal Heating

6.11 The development will utilise a central communal heating system, distributing a heating flow to the residential units. The heat source would utilise sequenced high efficiency gas boilers. The use of sequenced gas boilers would allow the heating system to more efficiently match the heat load at any one time as only those boilers required would operate.

6.12 The use of a communal heating system would be a pre-requisite for the incorporation of a CHP system and for the possible connection of the building's heating system to a decentralised energy network at a later date.

6.13 The design and layout of the building's plant room will be such that it will facilitate the possible future connection of the development to an energy network. Space will be allowed for the possible inclusion of heat exchange equipment and the building's heating circuit will be designed to incorporate connection points suitable for future connection to a decentralised energy network.

Clean Case CO_2 Emissions and Energy Requirements

6.14 The effect on CO_2 emissions and energy requirements of incorporating a CHP system and the energy efficiency measures noted above would be as follows:

Residential Energy demand Proposed development Be Clean	Total energy delivered (kWh/year/m^2)	Total energy delivered (kWh/year)	Total CO_2 emissions (kgCO2/year)
Space and water heating	95.1	133,517	28,840
Pumps and Fans	0.7	913	474
Lighting	4.3	6,050	3,140
Electrical appliances	29.1	40,814	21,182
Cooking	6.8	9,607	3,530
Lift and communal lighting	5.4	7,585	3,937
Electricity produced by CHP	14.6	20,552	10,666
Gas	98.5	138,320	29,877
Electricity	28.2	39,614	20,560
Total	126.8	177,934	50,437

Table 6.1: 'Clean Case' Development CO_2 Emissions and Energy Requirements

6.15 The scheme achieves an improvement over Part L1A of 20.56% owing to energy efficiency features and the use of CHP for its base load heating demand.

6.16 The CO_2 emission reductions achieved by the scheme through the 'Be Clean' measures only are:

- 16.55% for the regulated loads;
- 7.89% for the total scheme.

6.17 The CO_2 emission reductions achieved by the scheme through the 'Be Lean' & 'Be Clean' measures are:

- 20.56% for the regulated residential loads;
- 10.06% for the total scheme.

6.18 The CO_2 emissions for the 'Clean', 'Lean' and Part L - Base case are shown on the graph below:

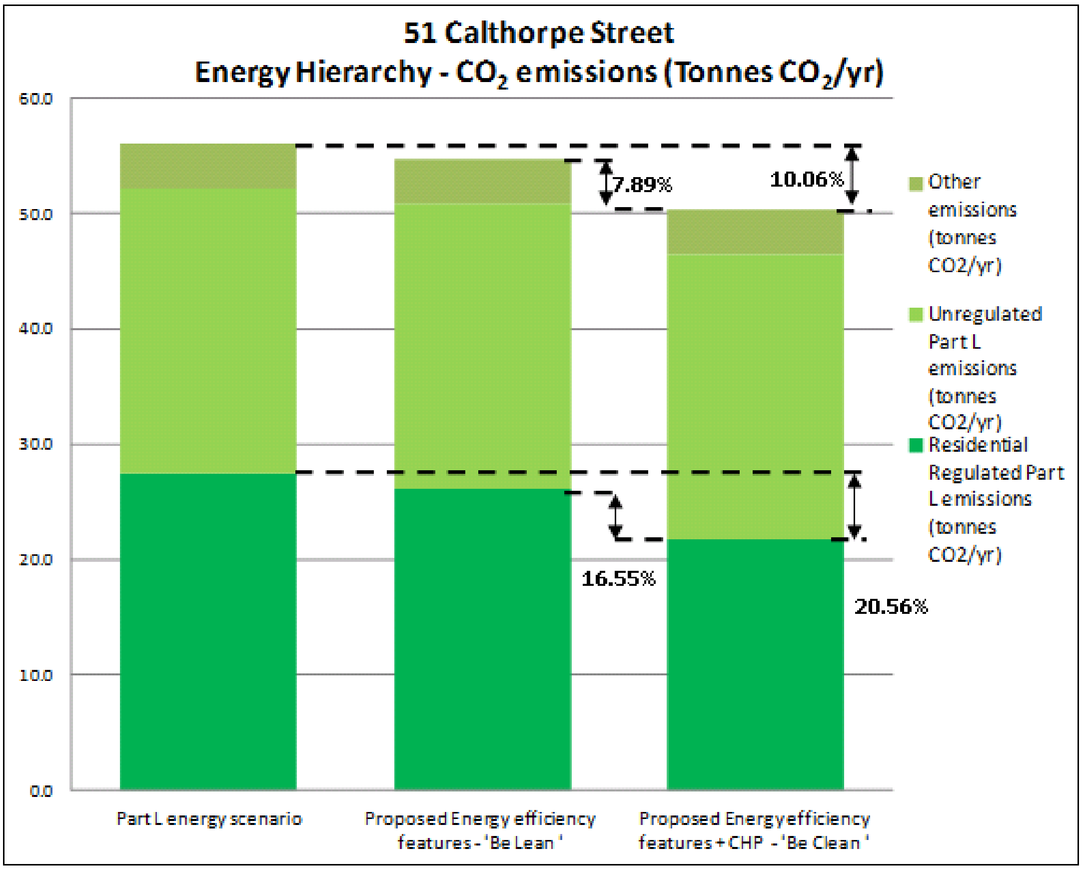

Figure 6.2: Energy Hierarchy – Base Case, 'Be Lean' Case and 'Be Clean' Case – 51 Calthorpe Street

7.0 'BE GREEN': USE RENEWABLE ENERGY

7.1 The final step in the energy hierarchy requires the clean generation of energy by renewable energy technologies be examined. Camden Core Strategy Policy CS13 requires the incorporation of on site renewable energy generation to provide a percentage reduction in the carbon emissions from the proposed development. The London Borough of Camden require all developments to achieve a 'reduction in carbon dioxide emissions of 20% from on-site renewable energy generation unless it can be demonstrated that such provision is not feasible'.

7.2 A feasibility study has been undertaken to establish the most economically viable renewable technology which provides the highest overall reduction in carbon dioxide emissions for the proposed development to meet Camden's policy requirements. The following renewable technologies are identified in Camden planning guidance document CPG 3:

- Solar water heating;
- Heat pumps;
- Bio-fuels;
- Wind turbines;
- Photovoltaic panels.

Renewable Technology Feasibility Study

Solar Thermal Hot Water Panels: Suitability – **NOT VIABLE**

7.3 Solar thermal systems supplement the water heating load. Solar thermal systems would not integrate well with a CHP system as they would reduce the water heating demand, which would in turn reduce the CHP run time and efficiency of the CHP system. Integration with a central energy centre would also be problematic, resulting in a large energy demand to circulate a relatively small volume of solar heated water from the collectors to the energy centre. For these reason solar thermal hot water panels have not been considered further

Heat Pumps: Suitability – **NOT VIABLE**

7.4 Heat Pumps, utilising low grade, ground source or recovered heat can potentially provide high efficiency, low carbon heating.

7.5 Ground Source Heat Pumps (GSHP) utilising the ground as a thermal resource, can provide heating and cooling, and have been reviewed in the context of this development, with the following outcomes:

- There is no space around the buildings for a horizontal system.

- It is not considered economically or practically feasible to integrate pile/loop under the development.
- Insufficient heating load exists to be able to operate typical GSHP for long enough periods to contribute significant emissions reduction.

7.6 Consequently GSHP are not considered viable for this scheme.

7.7 An Air Source Heat Pump (ASHP) could be used for the heat supply of the development. However, this system will lead to very limited savings due to use of carbon intensive electricity and the low COP of this system.

7.8 The viability of a heat pump system depends on the heat load and usage profile of the building to be served. Heat pumps can generally offer efficient space heating but are less efficient for domestic hot water heating. As a result, the latter typically requires either immersion heaters or a separate dedicated hot water heating system. Given the high standard of build fabric, the hot water heating load will be dominant for this residential scheme while space heating load will be relatively low.

7.9 The use of heat pumps would also be difficult to integrate with a central energy centre and future connection to the decentralised heat network.

Bio-fuels, Suitability – **NOT VIABLE**

7.10 Bio-fuels have the potential to contribute to the reduction of CO_2 emissions of various developments by using this fuel within a boiler or CHP plant. Biofuels are considered to have low or zero CO_2 intensities as theoretically the CO_2 released when these fuels are combusted is no greater than the CO_2 that has been absorbed from the atmosphere when the plants grew. The only CO_2 emissions attributed to bio-fuels are those associated with the collection, processing and distribution of the bio-fuels, and are available as liquid or solid fuels. Liquid fuels are generally named bio-diesel and are available in various blends up to 100% (B100). Bio-diesels can be produced from virgin crops or by recycling cooking oils. Solid bio-fuel or bio-mass is typically wood chips or wood pellets.

7.11 However, there are a number of issues which must be considered with this type of fuel in urban locations:

- Potential air quality impacts with combusting bio-fuels in urban areas, in particular elevated NOx emissions and particulates and must be addressed.
- Transporting this type of fuel increases lorry movements into and out of London, affecting congestion and transport emissions. The relatively rapid degradation of biodiesel would require appropriately sized on-site storage tanks with regular fuel deliveries.

- Importantly, the actual bio-diesel CO_2 intensity cannot be guaranteed due to variations in fuel stock supplier, demand, the energy input processing the fuel and CO_2 emissions due to growing, harvesting and processing the base fuel.
- Biofuel availability is currently uncertain due to unknown future supply and demand. Whilst an increase in demand for larger developments may stimulate the supply chain, availability could change with variation in demand. Transport is likely to have the most significant impact on the biofuel industry over emerging building demand.
- Socio-economic issues from growing and harvesting feedstock, with potential impacts on food production, particularly for biodiesel that is imported. Solid biofuels have a lesser impact in this area.
- On-site fuel storage requirements requiring additional space, along with regular access to the on-site fuel storage area.
- Increased plant maintenance is generally required, adding to costs and plant down-time.
- Biomass CHP using solid fuels is not considered viable for this scheme as this technology is not sufficiently commercially developed. Additionally, commercially available plant sizes are generally of a larger output and less likely to suit smaller loads.

7.12 Consequently biofuels for combustion within a boiler or CHP plant are not appropriate for the scheme.

Wind Turbines: Suitability – **NOT VIABLE**

7.13 Whilst a wind turbine could be sized to meet the requirements of this development there are numerous factors that would discount its suitability in this setting. Typically wind turbines perform poorly in urban environments as surrounding buildings and features dissipate much of the useful energy of the wind before it can be extracted by the turbine. To be clear of the disturbance created by surrounding buildings, it would be necessary to provide a mounting tower in excess of 25m tall, which would also require a large amount of free space for the erecting and periodic maintenance of the turbine. This is likely to be an issue with this site.

7.14 Environmental concerns such as noise and shadow flicker are also problematic in populated areas. While modern turbines have low levels of noise generation, even at high rotational speeds, the noise generated may still be an issue for local residents, particularly given the close proximity of the turbine. Given the dense urban setting of this development, shadow flicker is likely to be a problem for the residents of the proposed development and the adjacent hotel. A wind turbine would not be a viable option for this development.

Photovoltaic Panels: Suitability – **VIABLE**

7.15 The potential integration of photovoltaic panels has been evaluated for the development within the Energy Strategy, in compliance with appropriate planning policies, including the London Plan Policy 5.7 'Renewable Energy'.

7.16 Photovoltaic cells directly convert sunlight into electrical current using semiconductors. The output of a cell is directly proportional to the intensity of the light received by the active surface of the cell. The location and positioning of PV cells is therefore critical to achieving acceptable performance. Exposure to sunlight causes electricity to flow through the cells. Mono-crystalline PV cells provide higher levels of electricity generating performance over other panel types. PV panels can be incorporated into a range of building designs and positions, provided they are located in a shade-free environment and facing as close to south as possible.

7.17 Photovoltaics are generally technically suitable for residential developments. Their use can be limited due to their high capital cost. However, with the introduction of the Feed in Tariff, the high capital cost could be balanced with the running cost savings and the fixed tariff offered during a set period of time.

7.18 The following issues are considered in relation to the feasible integration of PV:

- High capital cost;
- Low maintenance;
- Simple installation;
- Photovoltaic panels are typically straightforward to integrate into a building's services strategy and would not conflict with a CHP installation;
- Self cleaning if tilted at an angle of 10 degrees or more;
- Electrical baseloads from pumps of the primary hot water distribution system and cold water booster system along with the communal residential space lighting will ensure that most of the generated electricity can be utilised on site. Any unused electricity can be sold back to the grid;
- Performance output and emissions reduction is greater for PV over solar thermal systems for this arrangement, panel area and specific project loads;
- Electricity Feed in Tariffs are available for this type of installation, improving the Return on Investment and payback periods;
- Access issues / Mansafe system;
- Lift overrun / Roof lights / Access hatch/ Green roof areas.

7.19 PV panels are a viable option for this development. The available roof area suitable for locating the PV panels is constrained by the orientation and roof layout of the development. The marked up drawing below indicates suitable roof space for the mounting of PV panels:

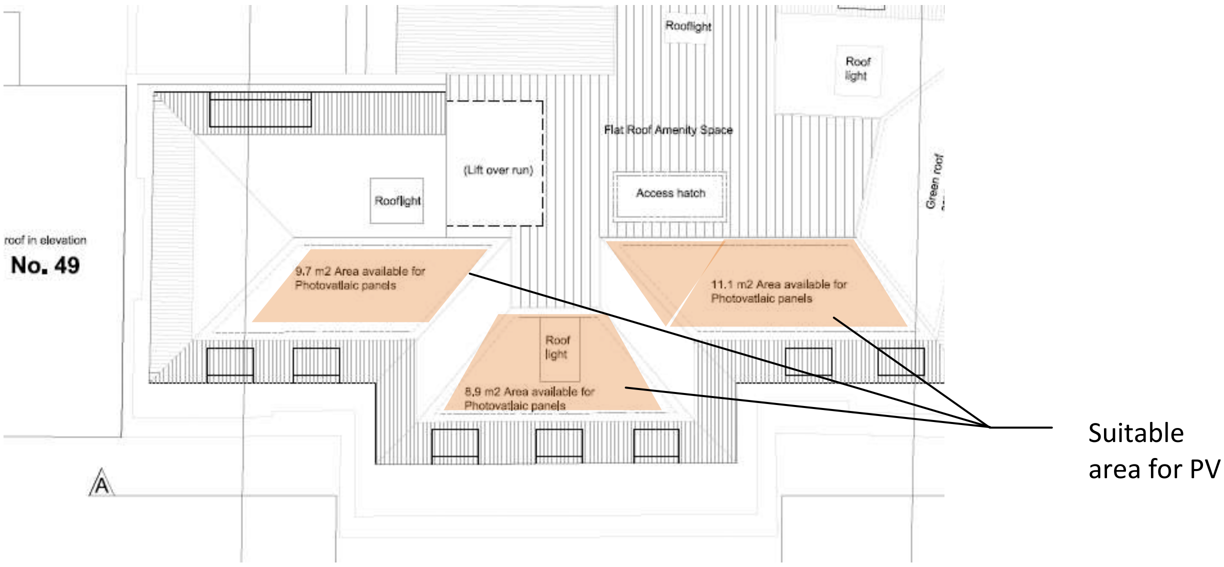

Figure 7.1: Area available for PV – Roof of 51 Calthorpe Street

Recommended Renewable Technology – PV panels

7.20 Photovoltaic panels have been identified as the only feasible technology for incorporation into this development. This system is examined in greater detail in relation to this development in the following section. The system has been evaluated against the following criteria:

- System size;
- CO_2 emissions from renewables;
- Capital and life cycle costs, payback and grants;
- Environmental and visual impact;
- Site suitability;
- Security and availability of fuel supply;
- Installation and maintenance issues.

7.21 The following section details the technology that is considered potentially suitable to meet the requirements of this development.

Photo Voltaic Panels	
PV panels would offer a relatively inexpensive option with low technical risk.	
System Size:	The development would utilise a 2.97 kWp photovoltaic panel array mounted on the south orientated tilted roof. A 2.97kWp PV system would have a total panel area of approximately 22.3 m^2 (The active PV area (75% of total area available for PV) will be maximised owing to the use of bespoke PV panels with triangular and trapezoidal forms). PV is inherently flexible and the system size can be adjusted with relative ease to accommodate changes in building design.

CO_2 Emissions from renewables:	A 2.97 kWp PV system would reduce CO_2 emissions as follows:

Description of calculation step	Value	Units
Approximate PV Installed Capacity	**2.970**	kWp
Maximum annual irradiation at the specific location	1160.0	kWh/m^2/year
Module conversion efficiency	14.1%	%
Positioning factor based on system's tilt and orientation	100.0%	%
Inverter efficiency	95.0%	%
Angular reflectance effect	96.2%	
Temperature losses factor	93.1%	
Additional system losses	90.0%	%
Resulting annual kWh system Electrical output from 1m^2 of panel	125	kWh/year
CO_2 factor for electricity	0.519	kgCO_2/kWh
CO_2 factor for displaced electricity	0.519	kgCO_2/kWh
Annual CO_2 saving from 1m^2 panel	65	kgCO_2/year
Panel area of proposed PV array	**22.3**	m^2
Delivered electricity requirement substituted by electricity generated by PV	**2,789.9**	kWh/year
Reduction in CO_2 emissions due to application of photovoltaic array	**1,447.9**	kgCO_2/year

Regulated CO_2 emissions reduction:

'Be Clean' scheme: 21.8 tonnes CO_2/yr
' Be Green' scheme: 20.3 tonnes CO_2/yr
((21.8 – 20.3)/21.8) x 100 = **5.28%**

Total CO_2 emissions reduction

'Be Clean' scheme: 50.5 tonnes CO_2/yr
' Be Green' scheme: 49.0 tonnes CO_2/yr
((50.5 – 49.0)/50.5) x 100 = **2.58%**

The CO_2 emission reductions achieved by the Photovoltaic system specified for the scheme are of 5.28% for the regulated residential loads and of 2.58% for the total development.

The total site wide CO_2 emissions will be those after the incorporation of all 'LEAN', 'CLEAN' and 'GREEN' measures.

Regulated CO_2 emissions reduction:

Part L compliant scheme: 27.4 tonnes CO_2/yr
' Be Green' scheme: 20.3 tonnes CO_2/yr
((27.4 – 20.3)/ 27.4) x 100 = **25.84%**

	Total CO_2 emissions reduction Part L compliant scheme: 56.1 tonnes CO_2/yr ' Be Green' scheme: 49.0 tonnes CO_2/yr ((56.1 – 49.0)/ 56.1) x 100 = **12.64%** The combined improvement over the base case, incorporating the Lean, Clean and Green measures would be 25.84**%** for the regulated residential loads and **12.64%** for the total emissions of the development.
Capital and Life Cycle Cost, Payback and Grants.	The cost of a 2.97kWp PV system would be approximately £11,150 although a bulk purchase may reduce this estimate. PV systems do not require any notable additional power input to operate, resulting in negligible running costs. Feed in Tariffs, introduced in April 2010, offer a guaranteed price per kWh significantly above the market rate for energy generated. The tariff levels are subject to periodic review but at the time of writing the rate for a 0-4kWp system would be 11.63 pence per kWh. The feed in tariff is allocated based upon the registered meter location. For a 2.97 kWp array this would give a tariff rate of: **2,789.9 x 0.1163 = £324.5/year for 25 years** A Feed in Tariff of this level would give a payback period of approximately 35years.
Environmental and Visual Impact:	The PV system will be located on the tilted south-orientated roof of the building. Its visual impact will be low and it will have no noise impact.
Site Suitability:	Suitable unshaded roof areas for the PVs have been selected (Please refer to Figure 7.1). Their tilt and orientation will ensure the renewable energy generation for the scheme is maximised.
Security and Availability of Fuel Supply	PV panels generate electricity from solar radiation, an inexhaustible resource. All UK sites are suitable.
Maintenance and installation Issues:	PV systems have no moving parts and minimal maintenance requirements. Maintenance is generally restricted to periodic visual inspection and cleaning. PV panels only require electric cabling to connect multiple panels making them relatively simple and quick to install.

Table 7.1 'Be Green' – Renewable Technology selected for the scheme – Photovoltaics

7.22 The proposed PV array for the scheme ('Be Green') in combination with the 'Be Lean' and 'Be Clean' measures will lead to an improvement over the base case of **25.84%** for the regulated residential loads and **12.64%** for the total emissions of the development (Please refer to Figure 7.2 below).

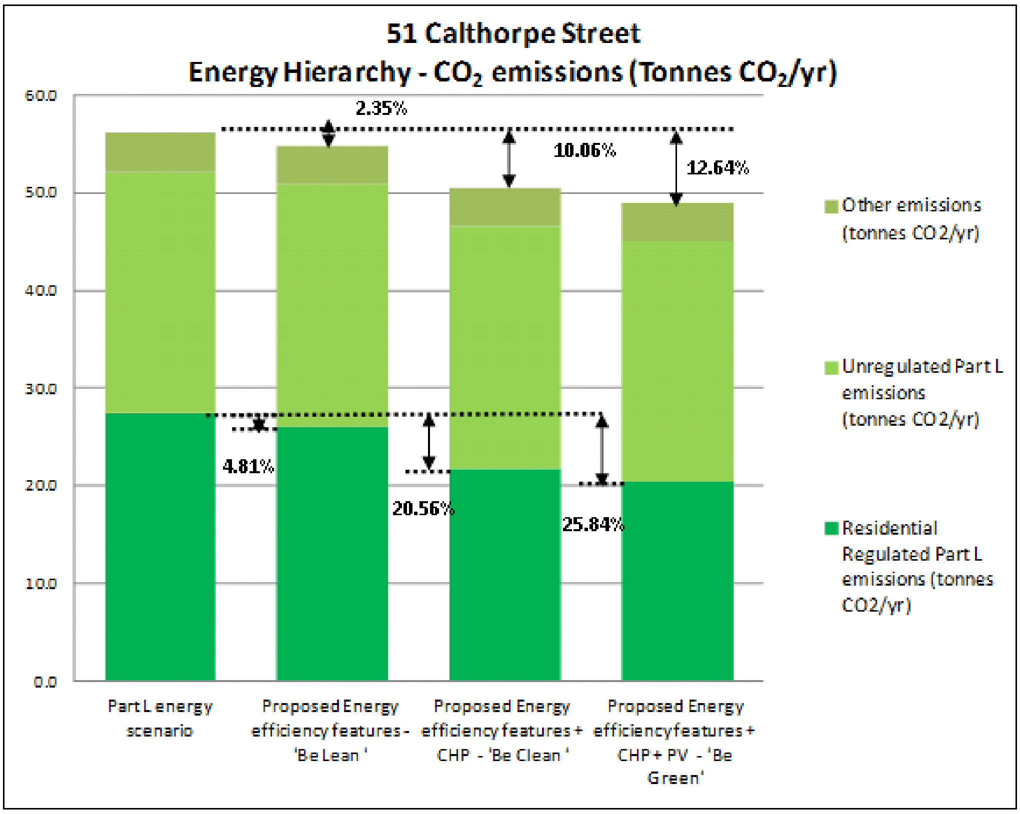

Figure 7.2 London Plan -Energy Hierarchy - CO_2 emissions reductions

8.0 BREEAM – ENERGY CREDITS

8.1 The proposed units have been modelled following the government's guidance published in SAP document. SAP Worksheets, obtained from the Plan Assessor software were used to determine the dwellings' Energy Efficiency Rating and to ascertain the number of energy credits achievable for the scheme under the BREEAM Domestic Refurbishment Scheme.

8.2 The weighting of the energy section is very high; 43%, with more than 25% of the overall score made up by the scheme's achievement in the following three BREEAM Energy credits:

- Ene 01 – Improvement in Energy Efficiency Rating (EER) – Post-refurbishment;
- Ene 02 – Energy Efficiency Rating (EER) – Post-refurbishment;
- Ene 03 – Primary Energy Demand.

8.3 The expected score of the scheme for these three credits achieved by the proposed energy strategy is detailed in Tables 8.1 &8.2 below:

Energy Efficiency Rating (EER) SAP Rating	Energy Efficiency Rating (EER) Existing	Energy Efficiency Rating (EER) Proposed	Improvement in Energy Efficiency Rating (EER)	Primary Energy Demand ($kWh/m^2/year$)
Flat 2 - Basement Flat	84	84	0	105.6
Flat 7 - Mid-floor	56	84	12	114.9
Flat 9 - Mid-floor	47	84	11	107.5
Flat 13 - Mid-floor	48	84	14	109.4
Flat 17 - Top-floor	87	87	0	82.2
Average value (area weighted)	61.9	84.4	22.5	107.7

BREEAM Ene 01 credits: Improvement in Energy Efficiency Rating Maximum achievable: 6	2.5
BREEAM Ene 02 credits: Energy Efficiency Rating Post Refurbishment Maximum achievable: 4 Minimum for an Excellent rating : 2.5	3.5
BREEAM Ene 03 credits: Primary Energy Demand Maximum achievable: 7	7

Tables 8.1 & 8.2 Summary Tables – Ene 01, Ene 02 & Ene 03

8.4 The optimised energy strategy detailed in Section 4-7 of this report has allowed the scheme to achieve 76.47% of the available BREEAM credits under the first 3 issues of the BREEAM energy section, which relate directly to energy performance of the proposed refurbishment scheme.

9.0 CONCLUSION AND RECOMMENDATIONS

9.1 This Energy Efficiency Plan outlines how the proposed re-development of 51 Calthorpe Street, Camden will meet the energy requirements as specified by the London Plan and the London Borough of Camden's relevant policies.

9.2 This Energy Efficiency Plan has been prepared following the principles of the London Plan Energy Hierarchy: 'Be Lean', 'Be Clean' and 'Be Green'. The overriding objective in the formulation of the Energy Efficiency Plan has been to maximise the viable reductions in total carbon dioxide emissions from the development within the framework of the energy hierarchy.

9.3 In addition to the Energy Hierarchy the Energy Efficiency Plan takes into consideration decentralised energy in development proposals and supply of renewable energy detailed within Camden planning guidance document CPG 3 - Sustainability.

9.4 'Be Lean': Energy efficiency measures will be applied to the development. The development will meet and exceed all of the building fabric performance standards suggested within Camden guidance document CPG 3 and exceed the minimum requirements of Part L1A and L1B for fabric efficiency standards.

9.5 'Be Clean': The opportunity for the proposed development to link into an existing or planned decentralised energy network has been explored using the London Heat Map tool. In the absence of an existing heat network within a reasonable distance of the proposed development site, the report assessed the feasibility of incorporating a CHP communal heating system within the development. The installation of the CHP system in combination with the 'Be Lean' measures will reduce the regulated carbon dioxide emissions in comparison to the 2013 Building Regulations compliant case by **20.56%.**

9.6 'Be Green': A feasibility study has been undertaken to establish the most suitable renewable technology for integration at the proposed development. Solar photovoltaic panels are the recommended renewable technology within the constraints of the site and provide the most cost effective carbon dioxide emission saving for the proposed development. A 22.3 m² - 2.97 kWp photovoltaic system mounted on the south orientated tilted roof of the scheme, combined with the 'Be Lean' energy conservation measures and 'Be Clean' CHP system will provide a **25.84%** reduction in the CO_2 emissions over the Building Regulations compliant case.

9.7 The carbon savings achieved after each stage of the Energy Hierarchy have been presented in the tables and figures shown below which are in line with the GLA guidance on preparing energy assessments:

Carbon Dioxide Emissions after each stage of the Energy Hierarchy Residential Scheme	Carbon Dioxide Emissions (Tonnes CO_2 per annum)	
	Residential Regulated	Residential Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	27.4	28.6
Be Lean - After energy demand reduction	26.1	28.6
Be Clean - After CHP	21.8	28.6
Be Green -After PV (indicative results for 204.4 m^2 of PV for residential)	20.3	28.6

Table 9.1 Carbon Dioxide Emissions after each stage of the Energy Hierarchy

Regulated carbon dioxide savings from each stage of the Energy Hierarchy – Residential Scheme	Regulated Carbon Dioxide Savings	
	Tonnes CO_2 per annum	%
Savings from energy demand reduction	1.3	4.81%
Savings from CHP	4.3	15.75%
Savings from Renewable Energy	1.4	5.28%
Total cumulative savings	7.1	25.84%

Table 9.2 Regulated carbon dioxide savings from each stage of the Energy Hierarchy

9.8 A highly optimised energy strategy based on passive design, building fabric performance and building services systems and controls, and suitable Low and Zero Carbon systems will allow the scheme to achieve an **improvement over Part L 2013 of approximately of 25.84 %. A 21.03% CO_2 emissions reduction is achieved by the proposed LZC for the scheme:** Combined Heat and Power (CHP) and array of Photovoltaics (PV) modules. The scheme also achieves a reduction in regulated CO_2 emissions compared to the existing building of **73.20%**

9.9 The London Plan energy requirements are not considered achievable for the scheme due to the practical constraints of the site (limited roof area available for PV).

	Regulated (Tonnes CO_2/Yr)	Improve-Ment Over Existing - Regulated Emissions	Improve-Ment Over Part L - Regulated Emissions	Unregulated Part L Emissions (Tonnes CO_2/Yr)	Other Emissions (Tonnes CO_2/Yr)	Total Emissions (Tonnes CO_2/Yr)	Improve-Ment Over Existing - Total Emissions	Improve-Ment Over Part L - Total Emissions
Existing Energy Scenario	75.9			24.7	3.9	104.6		
Part L Energy Scenario	27.4	63.86%		24.7	3.9	56.1	46.36%	
Proposed Energy Efficiency Features - 'Be Lean '	26.1	65.60%	4.81%	24.7	3.9	54.8	47.63%	2.35%
Proposed Energy Efficiency Features + CHP - 'Be Clean '	21.8	71.30%	20.56%	24.7	3.9	50.4	51.76%	10.06%
Proposed Energy Efficiency Features + CHP + PV - 'Be Green'	20.3	73.20%	25.84%	24.7	3.9	49.0	53.14%	12.64%

Table 9.3: London Plan -Energy Hierarchy - CO_2 emissions reductions

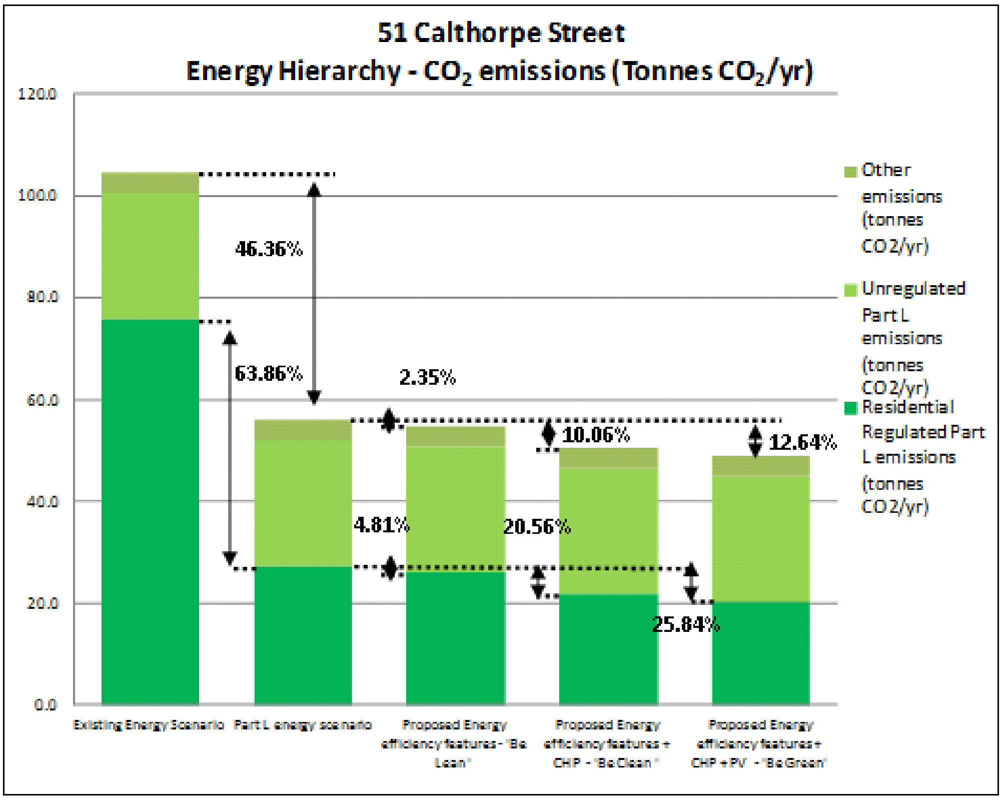

Figure 9.1 London Plan -Energy Hierarchy - CO_2 emissions reductions including existing scenario

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