156 West End Lane

a2dominion

ENERGY STATEMENT

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A2Dominion Developments Limited

156 West End Lane, Camden

Energy Statement

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Disclaimer

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Executive Summary

This Energy Statement describes the details of the energy strategy proposed by A2Dominion Developments Limited (A2Dominion) for the proposed redevelopment of 156 West End Lane, Camden, in response to the London Plan and Camden Borough Council energy policies.

The energy statement describes the design and technology options appraised, and the preferred energy strategy option in line with the London Plan (2015) and Camden Council policies. The proposed energy solution for the development follows and responds to the Be Lean, Be Clean, Be Green principles (London Plan Policy 5.2A) and includes various energy efficiency measures as well as low-carbon and renewable energy technologies as summarised in the table below.

Energy Principles	Energy Strategy Response
Be Lean: Use less energy. Minimise energy demand through efficient design and the incorporation of passive measures	**Passive design** • Optimised orientation to enable controlled solar gain and improved direct and indirect natural lighting. • Incorporation of balconies into the design to reduce risks of overheating in summer. **Building Fabric** • Use of optimal building fabric standards. **Energy Efficiency** • 100% energy efficient lighting and appropriate controls • Variable speed heating system with high delta T and low return temperatures • High efficiency motors and variable speed pumps for heating and extraction systems • High efficiency heating system • Appropriate controls for heating system • Temperature and time zoning • Appropriate insulation of heating distribution system • Provision of energy efficient white goods
Be Clean: Supply energy efficiently. Reduce energy consumption through use of low-carbon technology	**Energy efficient energy supply** • On-site CHP system connected to on-site heat network to supply domestic hot water and space heating to the entire development • Energy efficient VRF systems to supply cooling to private residential and the non-residential units
Be Green: Use renewable energy systems	**Renewable energy** • PV system to supply renewable electricity for the non-residential units.

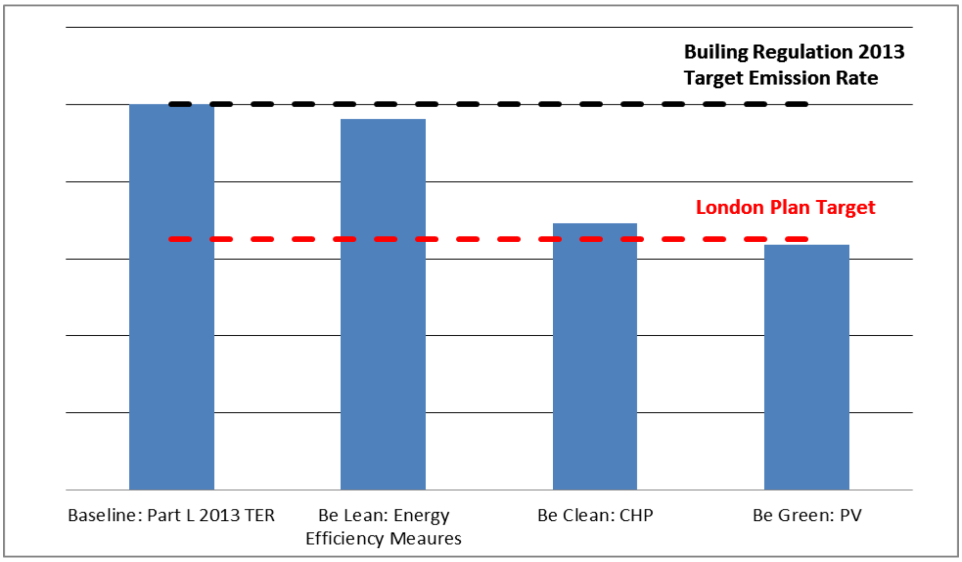
The development will significantly reduce CO_2 emissions by incorporating a range of passive design and energy efficiency measures throughout the site, including improved building fabric standards beyond the requirements of Building Regulations and energy efficient mechanical and electrical plant. The implementation of all passive design and energy efficiency measures can reduce the CO_2 emissions by circa 3.9% as well as the future energy costs for the residents.

Once energy demand has been reduced, the strategy proposes implementation of a gas-fired Combined Heat and Power (CHP) engine and efficient gas-fired boilers connected to a site-wide district heating network (DHN), which will supply heating and hot water for the entire development. It is anticipated that the use of the CHP engine and DHN would help to reduce the regulated CO_2 emissions by approximately 26.9%.

In addition, it is proposed to provide a dedicated Photovoltaics (PV) system for the non-residential units in order to achieve the required CO_2 reductions for the development. The renewable electricity can reduce the regulated CO_2 emissions of the site by circa 5.6%. The regulated energy CO_2 savings expressed in terms of actual and percentage reduction after each stage of the energy hierarchy are presented in the table below.

	Regulated Energy CO_2 savings	
	Tonnes per annum	**%**
Savings from energy demand reduction	8.3	3.9%
Savings from CHP	57.8	26.9%
Savings from renewables	12.0	5.6%
Total cumulative savings	**78.2**	**36.4%**
Total Target Savings	**75.2**	**35%**
Annual Surplus	**3.0**	**1.4%**

The table shows that the proposed strategy can achieve regulated CO_2 savings of 78.2 tCO_2 which is equivalent to circa 36.4% reduction when compared to the baseline. The table also shows the annual CO_2 savings surplus which is expected to be 3.0 tCO_2.



A summary of the overall reduction in CO_2 emissions after each stage of the energy hierarchy is presented in the following table.

	CO_2 emissions (tonnes per year)		
	Regulated	**Unregulated**	**Total**
Residential CO_2 Emissions Baseline	214.9	223.8	438.7
After energy demand reduction	206.6	199.6	406.2
After use of CHP technology	148.7	199.6	348.4
After use of PV technology	136.7	199.6	336.3

This table shows that the overall CO2 emissions from both regulated and unregulated energy can be reduced by circa 102.4 tCO2 per annum which is equivalent to circa 23.3% reduction.

In summary, the proposed energy solution for the development:

1. Informs the built form and orientation of the buildings to respond to daylight and overheating issues.
2. Includes optimal fabric standards, energy efficient design of building services and energy efficient appliances.
3. Complies with Part L 2013 Building Regulations and meets TFEE requirements.
4. Includes an efficient on-site heating network with a CHP system designed to meet the hot water and space heating demands of the development.
5. Includes PV renewable technology.
6. Meets the 35% regulated energy CO_2 emissions reduction requirement.
7. Achieves BREEAM ‘Very Good’ energy requirements.

1. Introduction

1.1 Background

Silver has been instructed by A2Dominion Developments Limited (A2Dominion) to prepare an Energy Statement focusing on the proposed energy strategy for the proposed redevelopment of 156 West End Lane, Camden. The Energy Statement is prepared to support the full planning application in response to the local, regional and national legislation.

To support the planning application this document identifies and describes the energy efficiency design and low carbon and renewable technology options that were explored for this proposal and describes the preferred option for achieving the carbon emissions and renewable energy targets. The document is produced to demonstrate how the development can fulfil the relevant national, the London Plan and the Camden's Local Plan policies.

In order to achieve the energy and sustainability objectives defined by national, regional and local policies, research has been undertaken to identify and present the most appropriate commercially viable technology to achieve the carbon and renewable reductions targets. The energy options have been considered in this report at a strategic level only.

1.2 Description of the Development

The proposals are for demolition of all existing buildings and redevelopment of the site to provide 164 mixed-tenure homes (Use Class C3), new floorspace for town centre uses (Use Classes A1, A2, A3, D1 or D2), new employment floorspace (including four dedicated units for start-up businesses) (Use Class B1), a community meeting room and new and improved public open spaces, together with associated new landscaping, on-site access, servicing and disabled car parking.

The residential element proposes 164 mixed tenure units, with 50% of the residential floor area allocated for affordable housing, with a mix of 60% affordable rent and 40% shared ownership. The affordable rented element includes a high proportion of family units.

2. Planning Requirements

This section summarises the relevant energy policy context for the proposed development. The national, regional and local policies and regulations related to energy and sustainability are summarised below.

2.1 National Planning Policy Framework

The National Planning Policy Framework (NPPF) document sets out the Government's planning policies for England and was published on 27th March 2012.

The NPPF is designed to consolidate circulars and guidance documents into a single document, making the planning system more user-friendly and transparent. The primary objective of the NPPF is sustainable development, therefore focussing on the 3 pillars of sustainability. The NPPF is split into three sections; planning for prosperity (Economic), planning for people (Social) and planning for places (Environmental), each of which outline guidance to tackle issues such as housing, transport infrastructure, business and economic development, climate change, etc.

In regard to climate change, the NPPF supports reduction in greenhouse gas emissions and the delivery of renewable and low carbon energy. Climate change is covered in section 10 'Meeting the challenge of climate change, flooding and coastal change'. In summary the NPPF advises the following:

To support the move to a low carbon future, local planning authorities should:

- plan for new developments in locations and ways which reduce greenhouse gas emissions;
- actively support energy efficiency improvements to existing buildings; and
- adopting nationally described standards when setting any local requirement for a building's sustainability.

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, massing and landscaping to minimise energy consumption.

2.2 The London Plan (2015)

As a major development in London, the planning application will be governed by the London Plan (2015).

The London Plan requires all developments to actively tackle climate change through their design as an integral part of sustainable development. Chapter 5 (London's Response to Climate Change) of the London Plan contains the following crosscutting policies supporting London as an exemplar city in adapting to climate change.

1. Policy 5.1 - Climate change mitigation

2. Policy 5.2 - Minimising carbon dioxide emissions
3. Policy 5.3 - Sustainable design and construction
4. Policy 5.5 - Decentralised energy networks
5. Policy 5.6 - Decentralised energy in development proposals
6. Policy 5.7 - Renewable energy
7. Policy 5.8 - Innovative energy technologies
8. Policy 5.9 - Overheating and cooling

The London Plan requires that developments include energy assessments with the planning applications explaining the strategy for carbon emissions reduction based on the energy hierarchy.

The London Plan requires that major development proposals include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined below are to be met within the framework of the energy hierarchy.

Policy 5.2 of the London Plan requires carbon dioxide emissions to be minimised in accordance with the following energy hierarchy:

1. Be lean: use less energy
2. Be clean: supply energy efficiently
3. Be green: use renewable energy

Policy 5.2 also requires that major developments meet the following targets for carbon dioxide emission reduction in buildings. The targets are expressed in the tables below as minimum improvements over Target Emission Rate (TER) outlined in the national Building Regulations.

Residential Buildings

Year	Improvement on 2010 Building Regulations
2013 - 2016	40% CO_2 emissions reduction
2016 - 2031	Zero Carbon

Non-Residential Buildings

Year	Improvement on 2010 Building Regulations
2013 - 2016	40 % CO_2 emissions reduction
2016 - 2019	As per the Building Regulation requirements
2019 - 2031	Zero Carbon

Policy 5.6 requires major developments to select energy systems in accordance with the following hierarchy:

1. Connection to existing heating or cooling networks.

2. Connection to site wide CHP network.
3. Development of communal heating and cooling networks.

Policy 5.7 requires major developments to provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation where feasible.

In April 2014 the Greater London Authority (GLA) published a revised Sustainable Design and Construction SPG and Energy Planning Guidance, which provide guidance on how the energy targets need to be assessed and met over Part L 2013 that came into force on the 6th of April 2014.

As outlined in the Sustainable Design and Construction SPG, from 6th April 2014 a 35% carbon reduction target beyond Part L 2013 of the Building Regulations needs to be met which deemed to be broadly equivalent to the 40% target beyond Part L 2010, as set out in London Plan Policy 5.2 for 2013-2016.

If the carbon reduction targets cannot be achieved on-site, any shortfall will be provided off-site or through a cash in lieu contribution to the relevant borough. Boroughs can use the guidance in the SPG, including the suggested nationally recognised price (£60 per tonne), to form the basis of their carbon off-setting fund or develop a locally specific fund. Contributions will be secured by a S106 agreement.

2.3 Local Policy - Camden Local Plan

The site is located in the London Borough of Camden and therefore the development should comply with local planning policies set out within Camden's adopted Development Plan. The Development Plan comprises, but is not limited to, the Camden Core Strategy (2010), Development Policies (2010) and Camden Planning Guidance documents.

2.3.1 Core Strategy

The energy related requirements of the Core Strategy Policy CS13 - Tackling climate change through promoting higher environmental standards are as follows:

Reducing the effects of and adapting to climate change

The Council will require all development 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:

- 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 following energy hierarchy:
  - ensuring developments use less energy,
  - making use of energy from efficient sources, such as the King's Cross, Gower Street, Bloomsbury and proposed Euston Road decentralised energy networks;
  - generating renewable energy on-site; and
- ensuring 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.

Local energy generation

The Council will promote local energy generation and networks by:

- working with our partners and developers to implement local energy networks in the parts of Camden most likely to support them, i.e. in the vicinity of:
  - housing estates with community heating or the potential for community heating and other uses with large heating loads;
  - the Growth Areas of King's Cross, Euston; Tottenham Court Road; West Hampstead Interchange and Holborn;
  - schools to be redeveloped as part of Building Schools for the Future programme;
  - existing or approved combined heat and power/local energy networks.
- protecting existing local energy networks where possible (e.g. at Gower Street and Bloomsbury) and safeguarding potential network routes (e.g. Euston Road).

2.3.2 Development Policies (2010)

Development Policies (2010) Policy DP22 - Promoting sustainable design and construction

The Council will require developments to incorporate sustainable design and construction measures. Schemes must:

- demonstrate how sustainable development principles have been incorporated into the design and proposed implementation; and
- incorporate green or brown roofs and green walls wherever suitable.

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

- expecting new build housing to meet Code for Sustainable Homes Level 3 by 2010 and Code Level 4 by 2013 and encouraging Code Level 6 (zero carbon) by 2016;
- expecting non-domestic developments of 500sqm of floorspace or above to achieve "very good" in BREEAM assessments and "excellent" from 2016 and encouraging zero carbon from 2019.

The Council will require developments to be resilient to climate change by ensuring schemes include appropriate climate change adaptation measures, such as:

- summer shading and planting;
- limiting run-off;
- reducing water consumption;
- reducing air pollution; and
- not locating vulnerable uses in basements in flood-prone areas.

2.3.3 Camden Planning Guidance 3 - Sustainability

Camden Council prepared Camden Planning Guidance 3 to support the energy and sustainability policies in the Local Development Framework (LDF). This guidance forms a Supplementary Planning Document (SPD) which is an additional “material consideration” in planning decisions.

The Camden Planning Guidance provides information regarding a range of topics as well as sustainability (such as design, housing, amenity and planning obligations). 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

Among other sustainable development issues the guidance covers the following aspects:

- Energy efficiency – in new and existing buildings
- Decentralised energy and combined heat and power (CHP)
- Renewable energy

2.4 Sustainability Requirements

2.4.1 Code for Sustainable Homes

Camden’s Development Plan Policy DP22 requires all new residential developments to be rated against Code for Sustainable Homes. However, the Deregulation Act 2015, which received Royal Assent on the 26th March 2015, has withdrawn the Code for Sustainable Homes.

The Council has confirmed that it will not require compliance against the Code for Sustainable Homes in-line with the Deregulation Act.

2.4.2 BREEAM

BREEAM (Building Research Establishment’s Environmental Assessment Method) is a standard assessment method established by the Building Research Establishment (BRE) and used to assess the environmental impact of non-domestic buildings.

The first BREEAM version for assessing new office buildings was launched in 1990 and was followed by versions for other buildings including superstores, industrial units and existing offices. The latest major update in 2011 resulted in the launch of BREEAM New Construction. The current version of BREEAM New Construction was published in May 2014 and should be used to assess and certify all new non-residential buildings in the UK.

Overall BREEAM covers a range of issues and credits which are awarded where a building achieves a benchmark performance. BREEAM is a voluntary standard although central government and some planning authorities require compliance.

The Development Policies Document requires all non-residential development to achieve BREEAM "Very Good" rating. The Deregulation Act 2015 does not have an impact on the BREEAM requirements.

2.5 Part L Building Regulations

2.5.1 Part L1A 2013

Approved Document Part L1A 2013 incorporates a number of changes and additions compared to Part L1A 2010. Part L1A 2013 requires new homes to reduce their carbon emissions by a further 6% across the build mix, compared to Part L1A 2010. In addition to achieving an overall carbon emission target, (i.e. TER or Target Emission Rate), there is a further requirement to achieve or better fabric energy efficiency targets (TFEE: "Target Fabric Energy Efficiency"). This means the thermal performance of the building fabric now has its own standards which cannot be compensated by services strategy or renewable features.

Approved Document Part L1A 2013 also includes the notional dwelling specification. The document states that if the actual dwelling is constructed entirely to the notional dwelling specification, it will meet the carbon dioxide and fabric energy efficiency targets and the limiting values for individual fabric elements and building services. The summary of the notional dwelling specification is provided in Table 2.1.

Table 2.1 Notional dwelling specification

Element or System	Values
Opening areas (windows and doors)	Same as actual dwelling up to a maximum proportion of 25% of total floor area
External walls U-value	0.18 W/(m^2K)
Party walls U-value	0.0 W/(m^2K)
Floor U-value	0.13 W/(m^2K)
Roof U-value	0.13 W/(m^2K)
Windows U-value (whole window U-value)	1.4 W/(m^2K)
Windows g-value	0.63
Opaque doors U-value	1.0 W/(m^2k)
Semi glazed doors u-value	1.2 W/(m^2k)
Airtightness	5.0 m^3/(hm^2) at 50 Pa
Linear thermal transmittance	Standard Psi values as per SAP 2012 Appendix R expect use of ψ=0.05 W/(m^2K) if default value of ψ=0.15 W/(m^2K) is used in the actual dwelling
Ventilation type	Natural with intermittent extract fans

Element or System	Values
Air-conditioning	None
Heating system	Main gas, combi or regular boiler and radiators. Room sealed, fan flue, efficiency - 89.5%
Heading controls	Time and temperature zone control, weather compensation, modulating boiler with interlock
Primary pipework	Fully insulated
Hot water cylinder	If combi boiler no cylinder otherwise 150 litres (declared loss factor = 0.85 x (0.2 + 0.051 $V^{2/3}$) kWh/day, where V is the volume of the cylinder in litres
Secondary space heating	None
Low-energy lighting	100%
Thermal mass parameter (TMP)	Medium – 250

Developers are free to vary the specification, provided the same overall level of carbon emissions and fabric energy efficiency performance are achieved or bettered.

2.5.2 Part L2A 2013

Approved Document Part L2A 2013 incorporates a number of changes and additions compared to Part L2A 2010. Part L2A 2013 requires new non-domestic buildings to reduce their carbon emissions by a further 9% across the build mix, compared to Part L2A 2010.

Part L2A 2010 was based on comparing the actual building against a notional building. This approach remains the same for Part L2A 2013. However, the notional building has been modified to have more energy efficient building fabric and air permeability. Similarly to Part L 2010, the notional building standards will change depending on the type of the non-domestic building.

Contrary to Part L2A 2010, in Part L2A 2013 not only the efficacy of the light fittings is controlled, but also the level of the lighting provided. In addition, lighting in new and existing buildings should meet the minimum standard.

There are also various other changes on minimum standards for HVAC system.

2.6 Summary of Policy Requirements

The following section provides a summary of local and national planning policy requirements which should be met to achieve compliance.

- Comply with Part L 2013 Building Regulations.
- Achieve a minimum of 35% reduction in carbon emissions (against current 2013 Building Regulations) by following Lean, Clean and Green principles.

- Expect to select energy systems in accordance with the following hierarchy:
    1. Connection to existing heating or cooling networks;
    2. Connection to site wide CHP network;
    3. Development of communal heating and cooling networks.
- Provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.
- Meet BREEAM “Very Good” energy requirement for non-residential units.

3. Approach to the Energy Strategy Development

3.1 Energy Strategy Development Principles

In accordance with the London Plan and the Camden planning requirements, the proposed energy strategy for the development should focus on three key principles:

1. **Be Lean:** Use less energy. Minimise energy demand through efficient design and the incorporation of passive measures;
2. **Be Clean:** Supply energy efficiently. Reduce energy consumption through use of low-carbon technology; and
3. **Be Green:** Use renewable energy systems.

The first principle stresses the primacy of seeking to reduce energy consumption. Within the built environment this comprises of energy efficiency measures in both design and construction of new buildings.

The second principle addresses the efficiency of energy supply. This will require ‘decarbonising’ and improving efficiency in the generation and distribution of energy.

The third principle comprises the use of ‘green’ energy systems. These are renewable sources of energy with low or zero carbon emissions and include, amongst others, solar generated heat and power, wind energy and biomass.

The suggested approach to energy and carbon has been proposed in line with the overall approach to climate change, reflecting requirements of the London Plan, Local Policies, Building Regulations Part L and BREEAM Very Good.

The proposed low carbon and renewable energy supply solutions match energy profiles of the development, ensuring effective use of these technologies. The solutions also take into consideration viability and flexibility of the scheme from a technical and economic point of view by identifying an optimal combination of energy efficiency measures, decentralised energy and renewable energy.

Applying these principles, A2Dominion is aiming to achieve the following objectives:

- Comply with the relevant regulatory requirements;
- Improve viability of the scheme by developing a technically robust and cost effective energy strategy; and
- Improve feasibility, operation and management of the energy systems by promoting holistic design methods and solutions.

The proposed energy strategy aims to achieve the required 35% CO_2 reductions on-site.

3.2 CO_2 Emissions Reduction Assessment Methodology

The CO_2 emissions reduction methodology requires separate energy assessments for the residential and non-residential floor space. The results from these assessments will be combined to provide the overall CO_2 emissions reduction for the entire development.

3.2.1 Residential

The Standard Assessment Procedure (SAP) 2012 methodology has been used to assess to evaluate an initial CO_2 performance of the residential development. To assess energy performance of the entire residential development, an energy and carbon assessment model has been produced to predict the regulated energy consumption and CO_2 performance of the residential development.

The BREEAM methodology has been used to estimate the unregulated CO_2 emissions of the residential development.

3.2.2 Non-residential

An initial assessment of CO_2 performance of the non-residential units is carried out using the standard National Calculation Methodology (NCM).

The assessment of the energy performance of the development considers regulated energy usage for different building services such as cooling, heating, lighting and ventilation. An estimate is also provided of unregulated electricity use (equipment) associated with computers, small power, security systems, etc.

4. Energy Assessment

4.1 Baseline CO_2 Emissions

In order to assess CO_2 performance of the proposed energy strategy, a CO_2 emissions baseline needs to be established. This section sets out the approach taken to calculating baseline CO2 emissions for the residential and the non-residential parts of the development.

Baseline emissions have been calculated for both regulated CO_2 emissions covered by Part L Building Regulations 2013 as well as the unregulated CO_2 emissions not covered by Part L Building Regulations 2013. However, the unregulated CO_2 emissions should be excluded when compliance with the planning policy are calculated.

4.1.1 Residential Baseline

Baseline emissions have been calculated for both regulated (space heating, hot water, fans and pumps and fixed lighting) CO_2 emissions covered by Part L Building Regulations 2013 as well as the unregulated (cooking and appliances) CO_2 emissions not covered by Part L. The regulated CO_2 emissions baseline is based on the Part L 2013 Target Emission Rate (TER).

The unregulated CO_2 emissions have been calculated separately using BREDEM methodology. The regulated, unregulated and total baseline CO_2 emissions for the residential units of the development are summarised in Table 4.1.

Table 4.1 Residential baseline CO_2 emissions

	CO_2 emissions (tonnes/year)		
	Regulated	**Unregulated**	**Total**
Residential CO_2 Emissions Baseline	167.9	201.7	369.6

4.1.2 Non-residential Baseline

The baseline CO_2 emissions are based on the calculation of the energy consumption of a 'notional' building under the standard National Calculation Methodology (NCM). The regulated, unregulated and total baseline CO2 emissions for the non-residential floor space are summarised in Table 4.2.

Table 4.2 Non-residential baseline CO_2 emissions

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Non-residential CO_2 Emissions Baseline	47.0	22.2	69.2

4.1.3 Total Baseline

For the entire development (residential and non-residential), the CO_2 emissions baseline is determined by adding the CO_2 emissions baselines for the residential and the non-residential parts of the development. The regulated, unregulated and total baseline CO_2 emissions for the entire development are summarised in Table 4.3.

Table 4.3 Total baseline CO_2 emissions

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Total CO_2 Emissions Baseline	214.9	223.8	438.7

4.2 Energy Demand Reduction

The key focus for the proposed energy strategy is to reduce the energy demands of the development as much as practically and cost effectively possible by implementing various energy demand reduction measures.

Reducing the energy demand is the most effective way to reduce the CO_2 emissions associated with energy use. Energy efficiency measures can be adopted to reduce energy demand without making a significant impact on the design, appearance or character of the building. Reducing energy demand also helps to reduce fuel demand and hence reduces the future energy costs for the residents.

A range of measures to reduce CO_2 emissions and increase resilience to climate change will be incorporated into the design of the building. This will include good building fabric standards as well as an energy efficient M&E systems and lighting.

4.2.1 Residential

4.2.1.1 Passive Design

The design of the development follows sustainable design and construction principals and standards aiming to use natural resources efficiently, reduce energy consumption and avoid internal overheating as well as contribution to the urban heat island effect.

Natural ventilation has been considered but due to noise sources around the site, it difficult to implement a natural ventilation strategy. Therefore, at this stage, it is assumed that mechanical ventilation strategy with heat recovery (MVHR) will likely be provided.

The ventilation strategy needs to be constantly reviewed as the design develops to ensure compliance with all the relevant regulations and standards.

It is proposed to have openable windows albeit that they will not be essential to provide fresh air supply but will offer further choice to residents and occupiers. The openable windows can be used for purge ventilation to reduce risk of overheating.

The glazing will be selected aiming to maximise daylight and minimise overheating. In addition, the glazing specification will be selected to provide a balance of solar control and access of direct and indirect natural lighting.

4.2.1.2 Building Fabric

In order to achieve the Part L 2013 Target Fabric Energy Efficiency (TFEE) targets, good building fabric standards will be used. The use of good fabric standards is one of the most cost-effective measures to reduce CO_2 emissions; it can also help to improve the cost effectiveness of all other energy and CO_2 reduction measures. Good standards of insulation can pay for itself in the reduction in running costs and also reduce the costs of low carbon and renewable energy systems.

In order to achieve this, it is necessary to go beyond the Part L1A 2013 minimum building fabric standards. The minimum building fabric requirements for Part L1A 2013 and the proposed specification for individual building elements for the residential part of the development are presented in Table 4.4.

Table 4.4 Proposed fabric energy efficiency targets for individual building elements

Element	**U-values W/m^{2}K**	
	Part L1A 2013 minimum fabric requirements	**Proposed specification for the development**
External walls	0.30	0.18
Roof	0.20	0.15
First floor	0.25	0.15
Windows [1]	2.00	1.30
Airtightness	10 (m^3/(hm^2) at 50 Pa)	4 (m^3/(hm^2) at 50 Pa
y - value	0.15	0.04 [2]

[1] Glazing performance will need to be reviewed alongside acoustic performance as the design is developed.

[2] Target value. It is proposed to use 'Accredited Construction Details' or the equivalent standard on all junctions.

Implementing these (or similar) building fabric standards will help to deliver substantial reductions in CO_2 emissions compared with the current building performance and regulations and meet the TFEE. The proposed specification should be viewed as guidance and may change subject to detailed design.

4.2.1.3 Energy Efficient Systems

Energy demand can be significantly reduced by using energy efficient M&E systems. Some of the proposed key measures for the non-residential development are listed below:

- 100% energy efficient lighting and appropriate controls
- Variable flow rate heating system with high delta T and low return temperatures
- High efficiency motors and variable speed pumps for heating
- High efficiency heating system (e.g. condensing boilers with seasonal efficiency > 92% and NOx emissions less than 40 mg/kWh)
- Energy efficient ventilation system with heat recovery
- Appropriate controls for heating
- Appropriate temperature and time zoning
- Enhanced insulation of heating pipework and valves

- Energy efficient cooling systems for private dwellings with seasonal energy efficiency ratio (SEER) of 5 or higher
- Appropriate smart energy metering and monitoring

Implementing these or similar energy efficiency measures will help to deliver substantial reductions in CO_2 emissions compared with the baseline.

The overarching principle for final selection of the building fabric standards and energy efficient systems is to achieve compliance with Part L1A 2013 requirements through energy demand reduction measures alone.

Mechanical Ventilation with Heat Recovery

An important component of the design is to provide an appropriate ventilation system for the dwellings. At this stage an MVHR system is proposed for each dwelling of the residential development.

MVHR systems are balanced whole home ventilation systems which are intended to work continuously year round. MVHR systems recycle the heat from exhaust air by passing it to incoming air. This is a passive process that relies on heat exchangers with large surface areas and it requires no additional energy input. There are also other benefits using MVHR systems including filtration of incoming air, improvement of hourly air changes in air tight dwellings and replacement of window trickle vents in dwellings where windows must remain closed for acoustic or pollutant reasons. In addition, MVHR systems warm up the cold incoming outside air in winter helping to avoid cold draughts.

There is a risk that in summer months MVHR systems will keep returning heat into the building. This would compound rather than reduce overheating risk. Therefore, it will be required to specify MVHR systems which include measures to overcome this issue. These measures can include purge ventilation, controls and summer by-pass. The MVHR system should be specified to have purge ventilation or boost. When systems are in boost mode they cannot recover heat efficiently due to the volume of air flow through them and can help to quickly remove heat from overheated rooms. In addition, the MVHR systems should be selected to meet Specific Fan Power of 0.5 W/l/s or less. This can be achieved by using systems with high efficiency fan motors and radiused bends and turning vanes in ductwork.

Metering Systems and Energy Display Devices

Use of intelligent controls and a high degree of sub metering / monitoring will be used to optimise the efficiency of energy systems through analysis of empiric data. Smart metering systems including smart in-home displays are proposed for dwellings to assist occupiers in reducing energy consumption and to control the cost energy.

Energy Efficient Appliances

The unregulated energy demand and the associated CO_2 emissions can be reduced by providing energy efficient white goods. It is assumed that energy efficient white goods will be provided in dwellings.

It is estimated that provision of the energy efficient appliances can reduce the total unregulated CO_2 emissions associated with the residential development by circa 24.2 tCO_2 per annum, which equates to approximately 12.0%.

4.2.2 Non-residential

4.2.2.1 Passive Design

The design of the non-residential unit proposes to incorporate a number of passive design measures to reduce CO_2 emissions and improve indoor climate. The unit has been designed to optimise the amount of direct sunlight which will help to minimise the use of energy-intensive artificial lighting.

The passive solar design will incorporate measures which enable controlled solar gain and improved direct and indirect natural lighting. Internal glare control measures such as occupant controlled devises and internal blinds should be considered and introduced as required by the non-residential tenants. These devises can also be used to limit overheating of the non-residential floor space.

The glazing will be selected aiming to maximise daylight and minimise overheating. In addition, the glazing specification will be selected to provide a balance of solar control and access of direct and indirect natural lighting.

It is assumed at this stage that the non-residential units will not have openable widows. Therefore, energy efficient mechanical ventilation will need to be provided in line with Part F Building Regulations. It is suggested to consider and implement mechanical ventilation strategy with heat recovery (MVHR) to reduce heating requirement of the non-residential units.

The ventilation strategy needs to be constantly under review when fit-out design develops to ensure compliance with all the relevant regulations and standards.

4.2.2.2 Building Fabric

Part L of the 2013 Building Regulations for non-residential buildings highlights the need to ensure energy efficiency in design.

The introduction of BREEAM has moved this agenda further forward and has focused on ensuring buildings are well insulated and airtight which will help to reduce the space heating and cooling demand and associated primary energy.

The use of good fabric standards for non-residential floor space is one of the most cost-effective measures to reduce CO_2 emissions and can also help to improve the cost effectiveness of all other energy and CO_2 reduction measures.

Correct selection of good fabric standards can pay for itself in the reductions in running costs and also reduce the costs of low carbon and renewable energy systems. The use of good building fabric standards will help to deliver substantial reductions in CO_2 emissions and to achieve the BREEAM energy requirements.

The minimum building fabric requirements for Part L2A 2013 and the proposed specification for individual building elements for the non-residential floor space are presented in Table 4.5.

Table 4.5 Proposed fabric energy efficiency targets for individual building elements

Element	U-values W/m²K	
	Part L2A 2013 minimum fabric requirements	Proposed specification for the development
External walls	0.35	0.18
Ground floor	0.25	0.15
Windows [1]	2.2	1.30
Airtightness	10 ($m^3/(hm^2)$ at 50 Pa)	4 ($m^3/(hm^2)$ at 50 Pa)
ψ - value	0.15	0.04 [2]

[1] Glazing performance will need to be reviewed alongside acoustic performance as the design is developed.
[2] Target value. It is proposed to use 'Accredited Construction Details' or the equivalent standard on all junctions.

Implementing these (or similar) building fabric standards will help to deliver substantial reductions in CO_2 emissions compared with the current building performance and regulations. The proposed specification should be viewed as guidance and may change subject to detailed design.

4.2.2.3 Energy Efficient Systems

Energy demand can be significantly reduced by using energy efficient M&E systems. The recommended indicative energy efficiency measures for the proposed non-residential units are provided below and have been used to carry out the energy and carbon modelling. As the non-residential units will be provided as shell and core, it will be the responsibility of the future tenants to review the proposed energy efficiency measures and incorporate them into the final design as required to meet the regulatory requirements. The proposed strategy sets out attainable measures to achieve compliance by the future tenants. The future tenants may vary the proposed energy efficiency measures/specification for specific requirements and needs.

For the purposes of final BREEAM shell and core energy modelling, green fit-out agreement will be required to enable the design team to substitute the minimum energy efficiency standards or backstop levels required by the relevant national building regulations with more realistic and appropriate energy efficiency measures.

The overarching principle for final selection of the building fabric standards and energy efficient systems is to achieve compliance with the BREEAM energy requirements and Part L2A 2013 requirements (if possible) through energy demand reduction measures alone.

Heating

The following design specifications are proposed to achieve energy efficient heating system:

- Optimised plant start/stop times;
- Variable flow rate heating system with high delta T and low return temperatures;
- High efficiency motors and variable speed pumps for heating;
- High efficiency heating system (e.g. condensing boilers with seasonal efficiency > 92% and NOx emissions less than 40 mg/kWh);
- Appropriate controls for heating;
- Appropriate temperature and time zoning;

- Enhanced insulation of heating pipework and valves;
- Appropriate smart energy metering and monitoring.

Lighting

High efficiency internal and external lighting should be used throughout the development in conjunction with a lighting control system incorporating daylight and presence detection as appropriate. This will ensure that lights are switched off when not required. Energy efficient lighting with appropriate controls should be considered and provided to the non-residential areas as required.

Ventilation

It is proposed to use individual MVHR systems for non-residential units. The MVHR systems should be selected with a heat recovery to meet Specific Fan Powers of 1.4 W/l/s or less. This can be achieved by using systems with high efficiency fan motors and radiused bends and turning vanes in ductwork.

MVHR systems and ducts will need to be specified to meet highest standards of air leakage and to ensure heat recovery complies with the Enhanced Capital Allowance (ECA) criteria for efficiency and low pressure drops.

A more detailed ventilation strategy will be developed during the detailed design with the aim to specify the most appropriate ventilation system and achieve pleasant indoor climate in non-residential areas.

The overall ventilation strategy approach needs to be constantly reviewed as the design progresses to ensure cost effectiveness and compliance with all the relevant regulations and standards.

Cooling

Cooling will need to be provided for the non-residential units. The cooling systems will need to be specified to the following minimum energy efficiency standards:

- Energy efficient cooling systems with seasonal energy efficiency ratio (SEER) of 5 or higher;
- High efficiency motors, variable speed pumps and energy efficient compressors for circulation of refrigerant in the cooling system;
- Enhanced insulation of distribution pipework and valves; and
- Appropriate controls, temperature and time zoning.

The specifics of the cooling system will be defined during the detailed design stage.

Energy Metering and Monitoring

Sub metering of major energy consuming systems together with an accessible energy monitoring and management system or separate accessible energy sub-meters with pulsed or other open protocol will be provided. The energy metering and monitoring strategy will be fully compliant with the BREEAM energy monitoring requirements.

4.2.3 Summary of CO_2 Savings after Energy Demand Reduction

4.2.3.1 Residential CO_2 Savings from Energy Demand Reduction Measures

The regulated energy and carbon baselines were calculated by extrapolating the Dwelling Emission Rates (DER) of the typical dwellings across the entire residential development. The total energy demand and the CO_2 emissions for the residential development were calculated using the energy and carbon assessment model. DERs do not include the unregulated energy use for appliances and cooking and these CO_2 emissions have been calculated separately using the BREDEM methodology.

The energy assessment shows that by implementing the energy efficient design, by incorporating enhanced building fabric standards and by using energy efficient systems, the regulated CO_2 emissions can be reduced by circa 5 tCO_2 per annum, which equates to circa 3% reduction in total CO_2 emissions over the baseline. The regulated, unregulated and total emissions after energy demand reduction are summarised in Table 4.6.

Table 4.6 Residential CO_2 emissions after energy demand reduction

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Residential CO_2 Emissions Baseline	167.9	201.7	369.6
After energy demand reduction	162.9	177.5	340.3

4.2.3.2 Non-residential CO_2 Savings from Energy Demand Reduction Measures

The Building Emission Rate (BER) has been used to determine anticipated CO_2 emissions of an 'actual' building under the standard National Calculation Methodology (NCM). The total energy demand and the CO_2 emissions for the non-residential units were calculated using the energy and carbon assessment model.

The energy assessment shows that by implementing the energy efficient design, by incorporating enhanced building fabric standards and by using energy efficient systems, the regulated CO_2 emissions can be reduced by circa 3.3 tCO_2 per annum, which equates to circa 7% reduction in regulated emissions over the baseline.

Table 4.7 Anticipated CO_2 emissions after non-residential demand reduction

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Non-residential CO_2 Emissions Baseline	47.0	22.2	69.2
After energy demand reduction	43.7	22.2	65.9

4.2.3.3 Total Anticipated CO_2 Savings from Energy Demand Reduction Measures

The CO_2 assessment shows that by implementing the energy efficient design, the CO_2 can be reduced by circa 8.3 tCO_2 per annum for the entire development, which equates to circa 3.9% reduction in regulated CO_2 emissions over the baseline.

The summary of regulated, unregulated and total CO_2 emissions and anticipated savings are presented in Table 4.8.

Table 4.8 Summary of CO_2 emissions after energy demand reduction

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Total CO_2 Emissions Baseline	214.9	223.8	438.7
After energy demand reduction	206.6	199.6	406.2

4.3 Energy Efficient Supply

London Plan Policy 5.6 and Camden Planning Guidance 3 require all major development proposals to evaluate and where appropriate select decentralised energy options 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.

4.3.1 Residential Energy Demand

The residential space heating, hot water and cooling demands have been estimated based on SAP methodology.

The estimated residential hot water demand is expected to present a consistent load throughout the year, although there will be peaks and troughs in daily use. These peaks and troughs can be managed through use of a thermal store to transform the hot water load into a consistent base load which can potentially be delivered by a CHP technology connected to a district heating network.

During the summer months the space heating may not be needed or its requirement will be relatively low. The space heating demand during colder months of the year, which will be minimised through energy efficiency measures, can also be delivered by the CHP technology. The remaining space heating demand can effectively be supplied by gas boilers which work well with the CHP technology.

It is proposed that all private residential units will include mechanical comfort cooling. The estimated residential cooling load is expected to be relatively low and only during the summer months. This relatively low load can be supplied effectively by Variable Refrigerant Flow (VRF) systems or conventional air or water cooled chillers. The VRF systems are generally more efficient than conventional cooling systems.

Therefore, where appropriate, the VRF systems should be used over the conventional cooling systems. It is considered that use of absorption chillers is unsuitable in this instance due to the relatively small anticipated cooling load and low efficiencies.

4.3.2 Non-residential Energy Demand

The non-residential space heating, hot water and cooling demands have been estimated based on NCM methodology.

It is more difficult to assess non-residential heat demand because the non-residential units will be provided as shell and core and tenants of the units are currently unknown.

However, it is anticipated that the space heating and hot water demand of the non-residential units will to be relatively low. The non-residential space heating and hot water demand alone will not justify use of the CHP technology but if combined with the residential heat demand, it can make use of the CHP technology justifiable as it will help to diversify the heat demand.

The estimated non-residential cooling load is expected to be all year round, but predominantly during the summer months. This relatively small load can be supplied effectively by either VRF systems or conventional air or water cooled chillers. It is considered that use of absorption chillers is unsuitable in this instance due to the relatively small anticipated cooling load and low efficiencies.

The VRF systems are generally more efficient than conventional cooling systems. Therefore, where appropriate, the VRF systems should be used over the conventional cooling systems.

4.3.3 Energy Supply Options Assessment

Policy 5.5 and Policy 5.6 of the London Plan as well as Camden Core Strategy Policy CS13 encourage development of decentralised energy networks. Policy 5.6 requires all major development proposals to evaluate, and where appropriate, 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.

4.3.3.1 Connection to Existing Heating or Cooling Networks

In response to the London Plan Policy 5.6 hierarchy, an investigation using the London Heat Map was carried out to identify existing and planned district heating networks in the vicinity of the site. The London Heat Map indicates that there are no existing or planned district heating networks around the site.

However, the snapshot of the London Heat Map provided in Figure 4.1 indicates that the site is located within the district heating opportunity area which is shown in violet colour on the map.

Figure 4.1 District heating opportunity areas in the vicinity of the site

This means that district heating or community heating schemes may potentially be developed within the opportunity area and there may be a possibility to connect the development to the district heating or community heating schemes in the future if site-wide heating network for the site is provided.

4.3.3.2 Site-wide Heating Network

As there could be a possibility in the future to connect the development to a wider heat network, investigation into on-site decentralised energy is required for the site.

The development has reasonably high density which can make site-wide heating network justifiable. The provision of an on-site district heating system will provide an opportunity for the proposed development to be 'future proofed' to make the best use of efficient energy generation with current and future technologies. In particular, such a system will enable the necessary infrastructure to be brought forward to link with other potential decentralised energy generation schemes which may be developed in the area after completion of the proposed development.

Site-wide CCHP/CHP system is favoured by Policy 5.5 and Policy 5.6. A CHP technology requires a relatively consistent heat demand throughout the year and the estimated total hot water demand (residential and non-residential) is expected to be high enough to justify the use of this technology. It will also help to deliver significant CO_2 savings which can help to achieve the CO_2 reduction targets.

Therefore, it is proposed to develop a site-wide heating network with CHP to supply hot water and space heating to both residential and non-residential parts of the development.

The CCHP system was considered but due to an anticipated relatively small non-residential cooling demand and low efficiencies of absorption chillers as well as space and practical constraints, this system is considered to be unsuitable to supply cooling for the development.

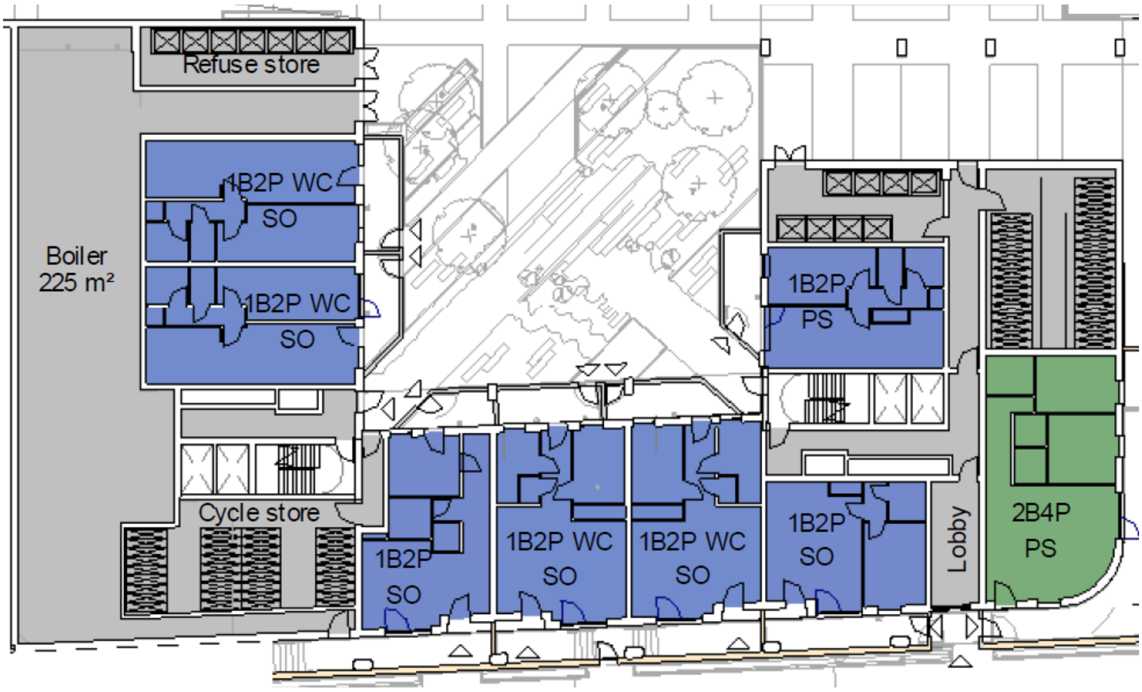
Heating Network Design

The proposed design of the development's on-site heating system will incorporate:

1. gas-fired CHP engine;
2. thermal store(s) for hot water storage; and
3. gas-fired boilers as back-up/top-up.

These systems together with all the associated ancillary equipment will be located in the basement in the energy centre with a total floor area of circa 225 m^2. This size of energy centre will be sufficient for the size development and the proposed design. The gas intake and the controls will be located in different basement plantrooms. Figure 4.2 provide a simple schematic of the proposed location of the energy centre and other plantrooms.

Figure 4.2 Location of Energy Centre



Capped pipework connections will be provided to enable physical connection of the on-site heat network to the near-site energy generation facilities and networks should they become available and feasible in the future.

This arrangement will enable connection of the development to near-site energy generation facilities and networks by providing capped connections, should these options become available in the future. This will also allow installation of emerging low carbon/renewable energy technologies such as biofuel CHP and fuel cells in the future should they become technically and economically feasible.

It is expected that the space heating to all dwellings will be provided via radiator heating systems. The space heating to the non-residential units will be either provided via radiator, underfloor or air heating systems.

The design of the proposed site-wide heating system will be developed during the detailed design stage. However, the overarching design principle is to design the system in accordance with standards and design recommendations provided within emerging Heat Networks Code of Practice, the London Heat Network Manual, CIBSE AM12 Combined Heat and Power for Buildings and other relevant publications.

The design of the site-wide heating system needs to ensure that heat distribution pipework runs are minimised, particularly lateral pipework in the corridors, and the heating infrastructure including distribution pipework and Hydraulic Interface Units (HIUs) are insulated to the highest possible standards to minimise heat losses.

Choice of Fuel for CHP

Most CHP systems in the UK run on natural gas or diesel but there are other fuels which are technically feasible, such as biomass and biogas.

Specially designed CHP engines can run on biogas, however, it would not be possible to produce biogas on site (e.g. via anaerobic digestion) due to space and technical (food stock etc.) constraints. In addition, there are a limited number of biogas suppliers, therefore there are concerns regarding the fuel supply security and fuel cost. Taking into consideration the above, this option has been ruled out.

Small biomass CHP systems are in development. However, this technology is still unproven, representing high technical risks at this time.

Liquid biofuels can be used to run biodiesel CHP engines however there are similar concerns with biogas regarding security of supply and over the sustainability of liquid biofuel production. In addition, delivery of liquid biofuels will be an issue for the site.

Taking into account the aforementioned issues, biofuel CHP is neither reliable nor cost effective and has been disregarded for the application. It is therefore proposed to use proven and reliable gas-fired CHP units.

CHP System Sizing and Selection

Based on the assessment of the space heating and hot water demand profiles, it is proposed to size the CHP system to supply up to 80% of the total heat demand of the development. It is assumed that the CHP system will supply all annual domestic water demand of the development. Some of the space heating demand will also be supplied by the CHP. The remaining space heating load will be covered by energy efficient gas boilers, installed in parallel to the CHP unit in the energy centre.

Based on the available information, a preliminary CHP sizing has been carried out which indicates that the CHP engine should be 80 kWth (40 kWel) as a minimum to supply the targeted demand.

To facilitate achievement of the heat supply contribution from the CHP system, a sufficiently sized thermal store should be provided. The size of the thermal store must be such that the operation of the CHP is maximised and a full assessment must be undertaken at detail design stage.

Sizing and selection of the CHP system should be carried out during detailed design stage. The underlining principle for sizing and selecting the CHP system will be to maximise CO_2 reduction and reduce life cycle costs as well as achieve all other requirements such as NOx emissions and noise levels.

In April 2014, the GLA published specific NOx requirements related to the CHP engines which are provided in the Sustainable Design and Construction SPG. The CHP engine will be selected to comply with these requirements.

In addition, the p CHP system will be selected to facilitate minimum 5000 operating hours per year and should improve the financial viability of the heating system operation whilst maintaining the technical ability of the system to meet variations in hot water and space heating demand.

Heating System Operation and Management

The detailed design of the heating system is to be completed during the detailed design stage but the intention is that the CHP engine will act as a primary heat source followed by the thermal store and top-up gas boilers. Heat will be provided from the CHP engine to meet demand from the building and / or to charge the thermal storage vessel. If the heat demand of the building cannot be met by the CHP, the thermal store will discharge heat into the heating system. If the thermal store contains insufficient heat to meet the required heat demand which exceeds that provided by the CHP, the gas-fired boilers will operate.

The inclusion of a thermal store allows the CHP to run when there is low demand to build up a reserve of heat energy in the stored hot water. This energy can be released to provide heat at periods of peak demand. Releasing stored heat energy in this way means that the use of the top-up gas boilers is reduced and the proportion of heat supplied from the CHP increased. There are other benefits from the thermal store in that the CHP system will run at optimum output for the majority of the time. An optimum run time also reduces the size and life cycle cost of CHP required to meet a given energy load and increases CO_2 savings.

The proposed CHP system design and operation strategy should facilitate maximum possible operating hours per year to improve the financial viability of the heating system operation whilst maintaining the technical ability of the system to meet variations in hot water and space heating demand.

The gas boiler system will be sized to provide full hot water demand backup in the event of failure or maintenance of the CHP units.

When there is a sufficient electricity demand in the landlord areas, the electrical output of the CHP system will be fully utilised on site with no export to the grid. If the electricity demand is lower than the electricity supplied by the CHP unit, the surplus will be exported to the grid.

To minimise the electricity export and improve viability of the system operation, a possibility to supply electricity from the CHP directly to the non-residential areas should be investigated during detailed design.

It is not possible to provide specific details regarding the electricity export arrangements due to the lack of available technical information at this stage. In addition, the utility companies do not generally engage with potential electricity exporters at early project stages or provide site specific information related to electricity export arrangements.

Even if it is possible to supply the CHP electricity to the non-residential units, it is envisaged that some of the CHP electricity will need to be exported to the grid. Therefore, an import and export electricity meter will be installed on site and the G59 requirements met to enable the electricity to be exported.

Currently, it is not possible to confirm an operator of the site-wide energy system; again it is too early in the process. However, at this stage, it is expected that it will not be less viable to operate the site-wide energy system with CHP than without CHP. In addition, site-wide energy system operators will more likely favour an energy centre with CHP as it would provide an additional financial incentive regarding the potential electricity sale and export.

As required, the electricity export contractual arrangements should be discussed and agreed with a DNO during later stages of the project. The electricity demand of the landlord areas will also be determined during later stages of the project when more details about the M&E design of the development is available.

Management of the Heating Network

It is expected that A2Dominion will own and operate the heating system with a commitment to deliver heat to all residential and non-residential customers. The CHP system will be monitored and the evidence of continued compliance with emissions limits will be provided annually in the form of an annual maintenance report.

4.3.4 Summary of Anticipated CO_2 Reductions from CHP system

4.3.4.1 Anticipated CO_2 Savings from CHP System - Residential

The energy assessment shows that by use of the proposed site-wide heating network with CHP, it is possible to achieve a reduction of CO_2 emissions of approximately 56.5 tCO_2 per annum for the residential part of the development. This is equivalent to a reduction in the regulated CO_2 emissions from the energy efficient building of circa 34.7%. The regulated, unregulated and total regulated emissions savings through use of CHP technology is summarised in Table 4.9.

Table 4.9 Residential CO_2 emissions after use of CHP technology

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Residential CO_2 Emissions Baseline	167.9	201.7	369.6
After energy demand reduction	162.8	177.5	340.3
After use of CHP technology	106.3	177.5	283.8

Table 4.9 shows that the building fabric and energy efficiency measures combined with the use of the district heating network can achieve 36.7% CO_2 reduction over the residential baseline. This means that the London Plan target of 35% can be met without contribution from additional low carbon or renewable energy technologies. Therefore, use of additional low carbon or renewable energy technologies is not required for the residential development.

4.3.4.2 Anticipated CO_2 Savings from CHP System – Non-residential

The energy assessment shows that by use of the proposed site-wide heating network with CHP, it is possible to achieve a reduction of CO_2 emissions of approximately 1.3 tCO_2 per annum for the non-residential unit. This is equivalent to a reduction in the regulated CO_2 emissions from the energy efficient building of circa 3%. The anticipated CO_2 savings are low due to low hot water and space heating demands associated with the non-residential units. The regulated, unregulated and total regulated emissions savings through use of CHP technology is summarised in Table 4.10.

Table 4.10 Non-residential CO_2 emissions after use of CHP technology

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Non-residential CO2 Emissions Baseline	47.0	22.2	69.2
After energy demand reduction	43.7	22.2	65.9
After use of CHP technology	42.4	22.2	64.6

4.3.4.3 Anticipated CO_2 Savings from CHP System – Entire Development

The energy assessment shows that by use of the proposed site-wide heating network with CHP, it is possible to achieve a reduction of CO_2 emissions of approximately 57.8 tCO_2 per annum for the entire development. This is equivalent to a reduction in the regulated CO_2 emissions from the energy efficient building of circa 28%. The regulated, unregulated and total regulated emissions savings through use of CHP technology is summarised in Table 4.11.

Table 4.11 Total CO_2 emissions after use of CHP technology

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Total CO_2 Emissions Baseline	214.9	223.8	438.7
After energy demand reduction	206.6	199.6	406.2
After use of CHP technology	148.7	199.6	348.4

4.4 Renewable Energy

requires providing a reduction in expected CO_2 emissions through the use of on-site renewable energy generation, where feasible.

The likely energy use of the proposed development allows for a feasibility assessment of the renewable energy technology options to determine which are most favourable for this particular development. The following technologies have been assessed for their potential to meet the renewable energy target:

- Biomass boilers
- Ground source heat pumps
- Air source heat pumps
- Wind turbines
- Solar thermal systems
- Photovoltaic (PV) systems

The assessment of these technologies shows that the installation of PV systems is considered to be the most suitable renewable energy technology option for the development. All other renewable energy technology options are considered to be less suitable (or unsuitable) for this development.

A summary of the assessment of the renewable technology options is provided in Appendix A. The preferred PV option is discussed further below.

4.4.1.1 Photovoltaic (PV) Systems

The renewable energy assessment shows that PV systems can be provided to generate renewable power. The technology can work well with all the other proposed technologies (e.g. CHP and gas boilers) and can supply the remaining required CO_2 reduction for the non-residential units.

PV systems are suitable for any type of building but they require significant un-shaded south facing space, as even a small shadow may significantly reduce output. PV systems can be incorporated into the units in various ways: on sloped roofs and flat roofs, or in facades, atria and shading devices.

Currently, there are four types of solar PV cells available: mono-crystalline, poly-crystalline, thin film and hybrid. Mono-crystalline and hybrid cells are the most expensive to produce but are 12-20%, poly-crystalline cells are cheaper but their efficiency is 9-15% and thin film cells are only 5-8% efficient but can be produced as thin flexible sheets.

Generally, PV systems should ideally face south with an incline of 30º, although orientations within 45º of south and other angles can still generate high outputs. The panels should be ideally mounted on the roof of the building to facilitate correct orientation and minimise shading.

The technology is easily scalable, which means that the required amount can be installed to meet the renewable energy requirements and the required CO_2 reduction targets. The only technically limiting factor on the maximum size of PV system is the available south facing un-shaded roof area, as surplus electricity can be fed back into the grid.

A preliminary assessment of the capacity of the PV systems for all the non-residential areas has been carried out. The assessment shows that circa 29.0 kWp of total PV capacity is required for the non-residential units to achieve the London Plan CO_2 reduction target.

It is assumed that 1 kWp of PV will require circa 15 m^2 PV area (including access) if energy efficient PV panels (e.g. mono-crystalline) are used. Therefore, 435 m^2 of unshaded suitable roof area will be required to accommodate the required PV capacity. Assuming that 1 kWp of PV panels can generate circa 800 kWh per annum, the PV plant can produce circa 23,200 kWh/year renewable electricity.

The PV system design and layout will be developed during the detailed design stage. The design will ensure that the visual impact of the PV panels is minimised.

The required PV capacity and the required roof area should be re-assessed and confirmed during detailed design stage.

It is proposed to connect the PV system to the non-residential units. This arrangement will benefit future non-residential tenants as most of the produced PV electricity can be used in the non-residential units reducing their reliance on the grid electricity. In addition, applying this arrangement will help achieve BREEAM “Very Good” rating as the CO_2 savings associated with the dedicated PV systems will be directly related to the non-residential areas.

To maximise the CO_2 savings associated with PV systems, it is proposed to use mono-crystalline PV panels. Optimum design of the PV installation is required to ensure maximum electrical output per kWp installed. There are a number of design considerations to be made to ensure the best use of the system. The key design considerations are:

- Design of PV installation to optimise inclination and orientation;
- Ensure that all parts of the PV panels are un-shaded (as much as possible);
- Ensure correct installation of PV arrays for good ventilation;
- Ensure that the electrical wiring from PV arrays to inverters is kept to minimum to reduce electrical losses;
- Provide sufficient space around PV installations for safe access and maintenance of the modules and other equipment installed on the roof;
- Ensure that inverter performance is monitored to ensure consistent electrical generation in line with the strategy.

4.4.2 Summary of Anticipated CO_2 Savings from Renewable Systems

4.4.2.1 Anticipated CO_2 Savings from Renewable Systems – Non-residential

The energy assessment shows that PV may result in circa 12 tCO_2 reduction of regulated CO_2 emissions per annum which equates to circa 28.4% reduction. The regulated, unregulated and total emissions after use of PV technology is summarised in Table 4.13.

Table 4.13 Non-residential CO_2 emissions after use of PV technologies

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Non-residential CO_2 Emissions Baseline	47.0	22.2	69.2
After energy demand reduction	43.7	22.2	65.9
After use of CHP technology	42.4	22.2	64.6
After use of PV technology	30.4	22.2	52.5

4.4.2.2 Anticipated CO_2 Savings from Renewable Systems – Entire Development

The energy assessment shows that by use of the proposed renewable energy technologies, it is possible to achieve a reduction of CO_2 emissions of approximately 12 tCO_2 per annum for the entire development. This is equivalent to a reduction in the regulated CO_2 emissions from the energy efficient building of circa 8.1%. The regulated, unregulated and total regulated emissions savings through use of the renewable energy technologies is summarised in Table 4.14.

Table 4.14 Total CO_2 emissions after use of renewable technologies

	CO_2 emissions (kg/year)		
	Regulated	**Unregulated**	**Total**
Total CO_2 Emissions Baseline	214.9	223.8	438.7
After energy demand reduction	206.6	199.6	406.2
After use of CHP technology	148.7	199.6	348.4
After use of PV technology	136.7	199.6	336.3

5. Summary and Conclusions

The proposed strategy is to reduce the overall energy demand as far as practically and economically possible, relative to the policy requirements, by implementing energy efficiency measures before applying low carbon and renewable energy technologies.

The strategy follows and responds to the Be Lean, Be Clean and Be Green energy hierarchy principles as summarised and presented in Table 5.1.

Table 5.1 The Energy Strategy: Be Lean, Be Clean and Be Green principles

Energy Principles	Energy Strategy Response
Be Lean: Use less energy. Minimise energy demand through efficient design and the incorporation of passive measures	**Passive design** • Optimised orientation to enable controlled solar gain and improved direct and indirect natural lighting. • Incorporation of balconies into the design to reduce risks of overheating in summer. **Building Fabric** • Use of optimal building fabric standards. **Energy Efficiency** • 100% energy efficient lighting and appropriate controls • Variable speed heating system with high delta T and low return temperatures • High efficiency motors and variable speed pumps for heating and extraction systems • High efficiency heating system (e.g. seasonal efficiency > 92% and NOx emissions less than 40 mg/kWh) • Appropriate controls for heating system • Temperature and time zoning • Appropriate insulation of heating distribution system • Provision of energy efficient oven, hob and washer dryer (applicable to unregulated emissions)
Be Clean: Supply energy efficiently. Reduce energy consumption through use of low-carbon technology	**Energy efficient energy supply** • On-site CHP system connected to on-site heating network to supply domestic hot water and space heating to the development • Energy efficient VRF systems to supply cooling to private residential and the non-residential units
Be Green: Use renewable energy systems	**Renewable energy** • PV system to supply renewable electricity for the non-residential units.

The regulated CO_2 savings expressed in terms of actual and percentage reduction after each stage of the energy hierarchy are presented in Table 5.2.

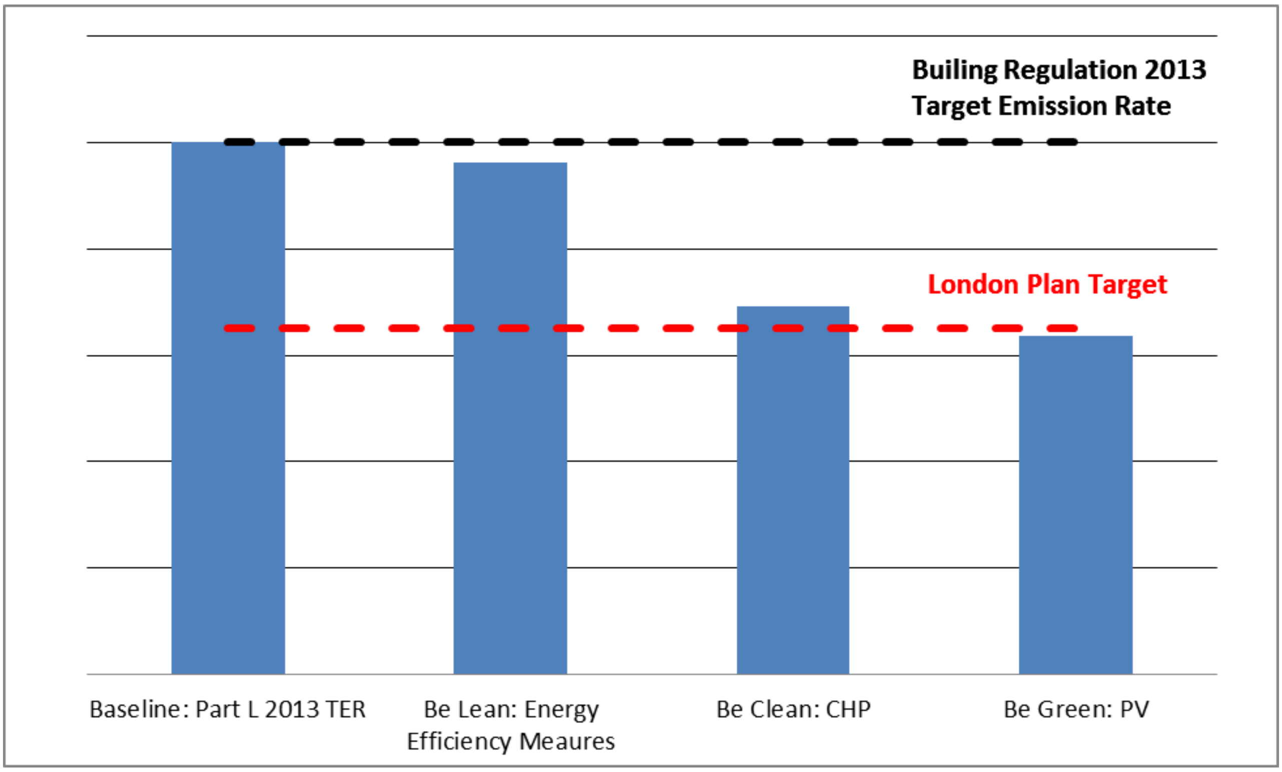
Table 5.2 Summary of CO_2 savings from each stage of the Energy Hierarchy

	Regulated Energy CO_2 savings	
	Tonnes per annum	**%**
Savings from energy demand reduction	8.3	3.9%
Savings from CHP	57.8	26.9%
Savings from renewables	12.0	5.6%
Total cumulative savings	78.2	36.4%
Total Target Savings	75.2	35%
Annual Shortage	3.0	1.4%

Table 5.2 shows that the proposed strategy can achieve regulated CO_2 savings of 78.2 tCO_2 which is equivalent to circa 36.4% reduction when compared to the baseline. The table also shows the annual CO_2 savings surplus which is equal to 3 tCO_2

The overall reduction in regulated carbon emissions associated with the proposed design is graphically illustrated in Figure 5.1.

Figure 5.1 Overall reduction in regulated CO_2 emissions compared to Part L baseline emissions



The summary of the overall reduction in CO_2 emissions after each stage of the energy hierarchy is presented in Table 5.3.

Table 5.3 Summary of CO_2 emissions after each stage of the Energy Hierarchy

	CO_2 emissions (tonnes per year)		
	Regulated	**Unregulated**	**Total**
Residential CO_2 Emissions Baseline	214.9	223.8	438.7
After energy demand reduction	206.6	199.6	406.2
After use of CHP technology	148.7	199.6	348.4
After use of PV technology	136.7	199.6	336.3

Table 5.3 shows that the overall CO_2 emissions from both regulated and unregulated energy can be reduced by 102.4 tCO_2 per annum which is equivalent to circa 23.3%.

In summary, the proposed energy solution for the development:

4. Informs the built form and orientation of the buildings to respond to daylight and overheating issues.
5. Includes optimal fabric standards, energy efficient design of building services and energy efficient appliances
6. Complies with Part L 2013 Building Regulations and meets TFEE requirements.
7. Includes an efficient on-site heating network with a CHP system designed to meet the hot water and space heating demands of the development.
8. Includes PV renewable technology.
9. Meets the 35% regulated energy CO_2 emissions reduction requirement.
10. Achieves BREEAM 'Very Good' energy requirements.

Appendix A – Assessment of Renewable Energy Options

This appendix presents an assessment of the renewable technology options relative to site. This assessment demonstrates that the installation of PV systems is considered to be the most suitable renewable energy technology option for the development. All other renewable energy technology options are considered to be less suitable (or unsuitable).

Biomass Boilers

Biomass boilers are now regarded as a conventional form of technology with a wide range of sizes and types to meet renewable targets. Biomass boilers use biomass as a fuel source, which is an alternative solid fuel to the conventional fossil fuels and has carbon emissions close to zero. Various types of biomass fuel are in use, the most common being wood chips and pellets.

Although pellets are more expensive than chips, they have greater energy content per unit of weight and require a lower storage volume. Pellet boilers also require less maintenance and produce considerably less ash residue.

There are some local/regional as well as national biomass suppliers who can supply biomass for the site. Biomass would need to be delivered to site in large trucks and the arrangements for supply and storage of the biomass fuel would need careful consideration. It would also require a suitable biomass storage space, which given the space constraints on this site is likely to be restrictive.

Biomass boilers could provide heat for a community heating scheme supplying the remaining 20% thermal demand (space heating) after CHP.

The potential reduction in carbon emissions from the installation of biomass boilers can be considerable and this would likely meet the GLA's target for carbon emissions reduction from renewable energy sources. Also, biomass boilers are compatible with CHP units due to similarity in operating temperatures. However, although biomass systems have a number of advantages, in the context of this development, the following issues prevent the installation of biomass boilers:

- Potential negative effect on air quality;
- No space availability for fuel delivery and storage;
- Significantly higher capital costs in comparison with gas boiler system;
- Requirements of additional resources for management of the operation;
- The location of the development may not be suitable for large-scale fuel delivery; and,
- Security of biomass supply.

The conclusion is that biomass boilers can deliver additional CO_2 reductions but the solution is considered to be unsuitable and not cost effective for this development.

Air Source Heat Pumps

The Air Source Heat pumps (ASHP) can be used as both a source of heating and a source for cooling. ASHP use the same principle operation as GSHPs but the use air as a heat source. The downside is that the air temperature and therefore efficiency of the heat pump is reduced in cold weather when the heat is most needed. This means that one either needs to oversize ASHPs to take into account degradation in performance or, alternatively, provide an auxiliary electric heater.

Provision of an auxiliary heater reduces capital cost but adds to running costs and reduces carbon savings.

Outdoor air systems are widely implemented in the form of split systems, with indoor and outdoor units linked by refrigerant pipes running through the wall. Packaged air systems where outdoor air is ducted to an indoor package are also available.

Theoretically, ASHPs could provide heat for a community heating scheme supplying a portion of thermal demand by preheating the district heating water.

However because the ASHPs should be placed on the roofs of the building, it will likely have significant negative aesthetic impact on the development.

Installation of the ASHPs on the roofs would require higher installation costs associated with support and access to the plant and greater need to consider noise impacts.

In addition, they are not very compatible with higher temperature technologies and systems such as CHP systems. Integration of ASHPs in one system with CHP units has significant technical challenges and risks. Therefore, the ASHP system should ideally be installed separately from the CHP system. In either option, the overall heating supply system could become unnecessarily complicated, which would likely increase the costs of the system. Because of the aforementioned issues, this arrangement is unlikely be practical and cost effective and therefore, it is not recommended to provide heating for this development.

However, the VRF technology is using heat pump operational principles and has been proposed to supply cooling for the non-residential units.

Ground Source Heat Pumps

The ground can be used as both a source of heating and a source for cooling. Ground source heating involves heat pumps, drawing heat from underground, whereas ground source cooling can either use heat pumps or make use of low temperature groundwater directly. Ground Source Heat Pumps (GSHP) are a relatively mature technology and utilise the energy in the ground through a refrigeration cycle. Where GSHP are used for both heating and cooling, depending on the season, this can be a very efficient solution. GSHP can be open loop or closed loop.

Closed loop GSHP system comprises a sealed system of buried pipes normally containing brine or water/antifreeze solution. The solution is circulated continuously around a closed system.

Open Loop GSHP system uses groundwater which is taken from an aquifer to supply heating or cooling. The water is then returned to the ground (sometimes via a borehole or sometimes via storm water drainage). Open loop systems require abstraction and discharge licences from the Environment Agency (EA).

There should be sufficient area within the development to accommodate a sufficient number of boreholes to meet the heating demand with a closed-loop system. However, the ground conditions are currently unknown and may not be suitable to use an open-loop system.

GSHP systems which provide heating are most efficient when warming water to 35-40ºC. Theoretically, GSHPs could provide heat for a community heating scheme supplying the remaining 50% thermal demand by preheating the district heating water.

However, as the GSHPs operate at low temperatures, they are not very compatible with higher temperature technologies and systems such as CHP system. Integration of GSHPs in one system with CHP units has significant technical challenges and risks. The overall heating supply system may become unnecessarily complicated, which will likely to significantly increase the costs of the system and maintenance risks. In addition, due to space constraints it is unlikely be possible to accommodate the system within the proposed plantroom area. Because of the aforementioned issues, this arrangement is unlikely be practical and cost effective and therefore, it is not recommended for this development.

Wind turbines

The capacity of wind turbines can range from 500W to more than 2.5MW. Generally speaking, the larger the turbine, the more cost-effective, but also the more complex it is to find suitable space and obtain planning permission.

Installation of large/medium scale wind turbine(s) could meet the renewable energy and carbon reduction targets, however there is no appropriate space for installation of large/medium scale wind turbines within the site. The installation is unlikely to be permitted due to close proximity of the Heathrow airport.

Effective energy generation through small scale roof mounted wind turbines is not feasible due to the following:

- Location of the development in a densely populated area.
- The average wind speed at the site is estimated to be circa 5.6 m/s at 25 m above ground which is based on NOABLE Wind Map (the wind speed was taken from the Rensmart Wind Map). The wind speed is marginal for effective operation of a wind turbine.
- Issues such as noise, telecoms interference proximity to Heathrow airport and visual impact are likely to restrict installation of wind turbines.

Therefore, wind energy is not recommended for this development.

Solar Thermal systems

Solar water heating systems use the energy from the sun to heat water, most commonly for domestic hot water needs. Solar heating systems use a heat collector that is usually mounted on a roof in which a fluid is heated by the sun.

The use of solar thermal panels is inappropriate for this development on the basis that the technology is not compatible with the use of CHP as both technologies compete for the same summertime hot water load.

In addition, the system will produce relatively small CO_2 savings but will have significant negative impact of the cost of the heating system and its practicability. Therefore, solar thermal systems are not recommended for this development.