HILSON MORAN

Energy Strategy

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PROJECT:

Highgate Centre and AA Self Storage
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03	26/9/2016	FINAL ISSUE WITH SEPTEMBER 2016 UPDATE

Contents

1. Executive Summary

Hilson Moran was appointed by Fortnum Developments (the Applicant) to provide an Energy Strategy for the proposed development at 19 – 37 Highgate Road and the neighbouring A&A Self Storage unit. Proposals for the Site comprise a mixed development with residential units, offices and relocation of the self-storage provision to below ground.

This Energy Strategy identifies the energy efficiency measures that have been assessed and incorporated throughout RIBA Stage 2 design to ensure compliance with, and where feasible, exceedance of relevant national, regional and local policy, including carbon dioxide (CO_2) emissions reduction targets. The proposed design measures were considered using current industry Best Practice and applying the London Plan Energy Assessment guidance, resulting in an overall regulated CO_2 saving of 15.35%. Taken on their own the dwellings achieve a 38% improvement over Part L 2013.

Energy and CO_2 emissions data used in this assessment is obtained from as-designed Part L:2013 assessments output (Appendices C and D). Fabric and system efficiency figures used in the assessments need to be verified for viability during future design stages.

The methodology of this Energy Strategy robustly follows the London Plan's Energy Hierarchy, as follows:

- Be Lean: A wide range of passive and energy efficiency measures are incorporated in the design, including very good levels of thermal insulation, building air tightness, daylight infiltration reducing reliance on artificial lighting, efficient artificial lighting and controls, as well as high efficiency building services that exceed Part L:2013 requirements and reduce the overall CO_2 emissions of the scheme.
- Be Clean: All low carbon technologies have been assessed for viability in the proposed scheme. Gas-fired CHP is proposed for the development, with the potential to connect to neighbourhood heating schemes in the future.
- Be Green: A detailed assessment of renewable energy opportunities and viability has been undertaken, which has determined that Air Source Heat Pumps (in heating mode), are a viable technology for integration into the scheme.

Measures that reduce the predicted CO_2 emissions from the proposed development have been considered and thoroughly assessed by the project team (Table 1.1). Limiting factors include the urban context of the site, view constraints and a limited site footprint and roof area. Notwithstanding, all possible viable measures have been integrated into the proposed design and specification to result in a significant improvement beyond the Part L 2013 target emission rate.

Energy Strategy opportunities summary	Viable for the scheme?
Energy efficient passive design measures incorporated	Yes
Energy efficient plant measures incorporated	Yes
Exceed Part L:2013 Building Regulation requirements	Yes
Combined Heat & Power (CHP)	Yes
Tri-generation (CCHP)	Not viable
Is connection to any future district heating scheme viable	Yes
Ground source heat pumps (GSHP)	Not viable
Air source heat pumps (ASHP)[1]	Yes
Urban wind power	Not viable
Photovoltaics	Electrical Output from CHP anticipated to serve electrical demand from the commercial and residential common areas. PV is not considered viable as it could compete with the CHP for electrical demand.
Solar thermal heating systems	CHP has been prioritised and sized to serve the hot water demand for the commercial office, Self Storage facility and the residential dwellings.
Biofuel heating	Not viable
Provide robust unregulated load management and reduction	Yes

***Table 1.1** Energy Strategy measures proposed for the development*

[1] *EU Directive 2009/28/EC defines 'aerothermal energy' as energy stored in the form of heat in the ambient air and it also defines 'energy from renewable sources' as energy from renewable non-fossil sources, namely wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases.*

The following is the breakdown of the energy strategy performance resulting from energy hierarchy measures adopted by the proposed development:

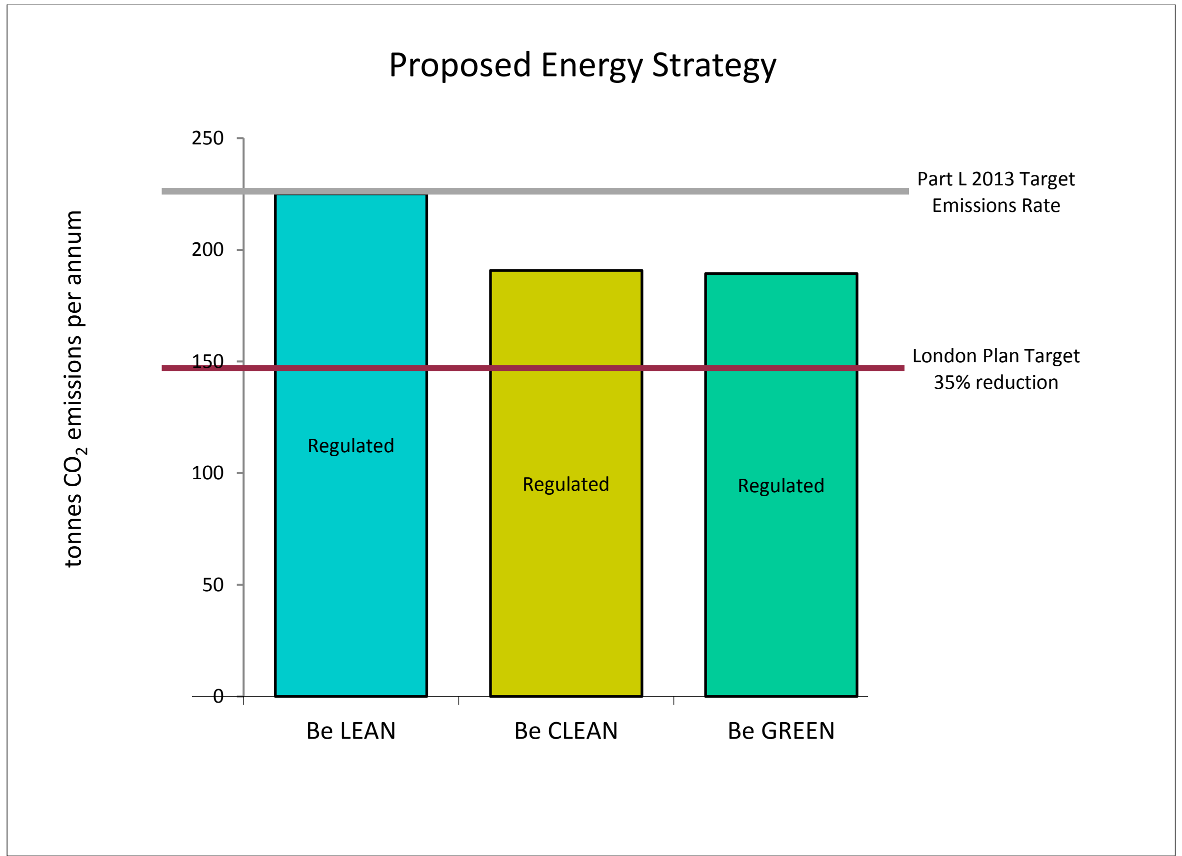


Figure 1.1 *Energy Strategy performance for the energy hierarchy measures for the development*

Energy hierarchy stage	Unregulated CO_2 emissions	Regulated CO_2 emissions	Regulated CO_2 emissions reduction	
	Tonnes CO_2/annum	Tonnes CO_2/annum	Tonnes CO_2/annum	% development regulated emissions
Baseline: Building Regulations 2013 Part L Compliant Development	211.75	216.74*	-	-
After energy demand reduction **(Be Lean)**	211.75	215.85	0.89	0.41%
After district energy **(Be Clean)**	211.75	184.88	30.97	14.35%
After renewable energy **(Be Green)**	211.75	183.46	1.42	0.77%
Total cumulative savings			**33.28**	**15.35%**
Total Target Savings (GLA/Camden Council)			75.86	35.00%
Annual Shortfall (GLA/Camden Council)			42.58	-19.65%

**The residential Target Emissions Rate (TER) for the 'Be Lean' tier of the hierarchy is different from that of the 'Be Clean' and 'Be Green' tiers. This is due to the National Calculation Method and the different heating sources applied at the 'Be Lean' tier. The overall site-wide results above are relative to the final ('Be Green') TER for comparative consistency, but individual 'Be Lean' TERs for the residential and non-residential component are presented in section 5.2 of this report.*

	Annual Shortfall	Cumulative Shortfall (30 years)
	Tonnes CO_2	Tonnes CO_2
Shortfall (GLA/Camden Council)	42.58	1,277.3

Table 1.2 *Energy Strategy performance for the proposed energy hierarchy measures*

2. Introduction

2.1. Background

Hilson Moran have been appointed by Fortnum Developments Ltd to provide an Energy Strategy for the proposed redevelopment of the site at 19 – 37 Highgate Road and the neighbouring A&A self storage unit. Proposals for the Site comprise a mixed development with residential units, offices and relocation of the self-storage provision to below ground.

Figure 2.1 Greenwood Place Development area

The project is targeting a BREEAM NC 2014 'Excellent' rating for the Offices, BREEAM NC 2014 'Very Good' for the Self Storage facility and a Code for Sustainable Homes 2014 'Level 4' for the dwellings. For this reason, a minimum target of 19% reduction of CO_2 emissions with respect to Part L1A 2013 is required for the residential component and a minimum EPR_{NC} of 0.375 from the non-residential component (Offices). There are no minimum standards of performance under the Ene 01 credit (Reduction of energy use and carbon emissions) stipulated for a BREEAM NC 2014 rating of 'Very Good'.

The London Plan's and Camden Council's CO_2 reduction targets for new building applications in 2013-2016 are 35% with respect to Part L: 2013.

2.2. Scope

This Energy Strategy will focus on relevant policies of the London Plan, including Policy 5.2 'Minimising carbon dioxide emissions', Policy 5.3 'Sustainable design and construction', Policy 5.5 and 5.6 'Decentralised energy networks' and 'Decentralised Energy' and Policy 5.7 'Renewable Energy' and will provide a robust design route with which to ensure compliance. The London Borough of Camden's Policies DP22 (Camden Development Policies 2010-2025), Policy CS13 (Camden Core Strategy CS13) and recommendations from the Camden Planning Guidance (CPG3) are also addressed.

This document identifies drivers relating to an energy efficient design over and above minimum compliance of the whole development with current Building Regulations and other appropriate national and regional policies.

2.3. Purpose

The purpose of this document is to report on the process and design route of the Energy Strategy for the proposed development and to present energy efficiency and CO_2 emissions reduction targets, opportunities and predictions.

2.4. Structure

The introductory section is followed by a review of national and local policies on CO_2 reduction and sustainability.

In line with industry best practice and Policy 5.2 of the London Plan, the energy hierarchy design strategy has been applied to the development and was used to structure this report.

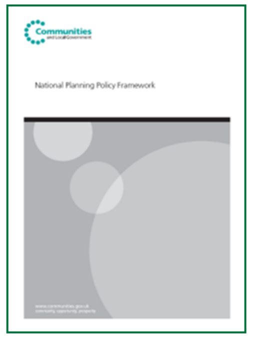
The Part L1A and Part L2A:2013 report and results are included in Appendices B and C.

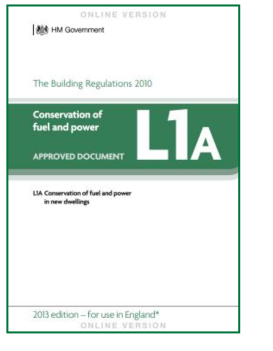
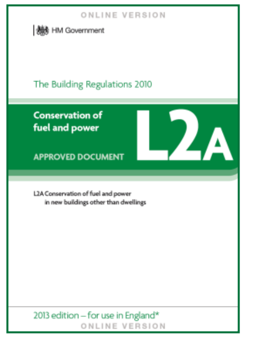
Low and zero carbon technologies are reviewed in detail for feasibility within the scheme, in relation to the 'Be Clean' and 'Be Green' elements of the London Plan Energy Hierarchy.

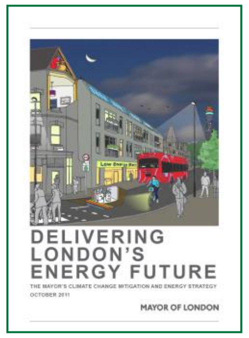
A summary of the Energy Strategy for the scheme is provided at the end of this document.

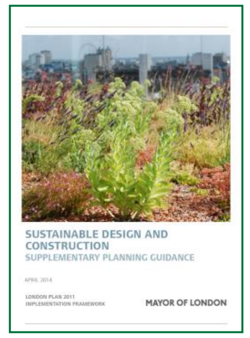
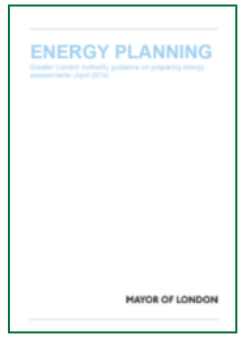
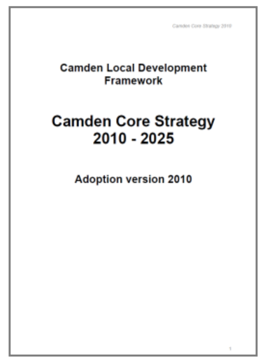
3. Policy and Good Practice Review

The following key energy, CO_2 emissions reduction and sustainability policies and documents have been reviewed in detail within the context of the scheme, in order to identify and target compliance with relevant requirements and to inform the viable sustainability design features and opportunities across all measures of the development:

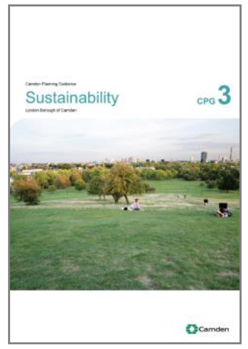
Policy/standards	Description	Key policy & target summary	Document
National Planning Policy Framework (CLG, 2012):	Sets out the Government's Planning Policies for England and how these are expected to be applied, informing Local Councils and communities with regards to local plans and requirements. The document provides a revised and condensed approach to national planning and sustainability that includes economic, social and environmental roles.	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. Responding to climate change, conserving and enhancing the natural environment form important sections of this document. The main relevant policies are: **Policy - 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); **Policy - 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. **Policy - 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. **Policy - 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. **Policy - 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	

Policy/standards	Description	Key policy & target summary	Document
		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. **Policy - 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.	
Building Regulations Approved Document Part L1A: 2013 'Conservation of fuel and power'; (DCLG, 2013)	Sets out elemental minimum energy and CO_2 emissions performance standards for all elements of the built environment along with assessment methodologies necessary to confirm compliance within new build dwellings.	The Part L1A 2013 specification sets a provision for a 6% reduction in CO_2 emissions from Part L1A 2010. The document set out new limiting U-Values for improved fabric performance and introduced design submissions as well as built submissions. **Regulation 24 and 25:** Set out the minimum energy performance requirements against a target CO_2 emission rate that shall not be exceeded. The notional building used to determine carbon dioxide and fabric efficiency targets is the same size and shape as the actual dwelling, constructed to concurrent specification. **Regulation 26A:** Requires new dwellings to achieve or better a fabric efficiency target in addition to the carbon dioxide target.	
Building Regulations Approved Document Part L2A: 2013 'Conservation of fuel and power'; (DCLG, 2013)	Sets out elemental minimum energy and CO_2 emissions performance standards for all elements of the built environment along with assessment methodologies necessary to confirm compliance. Sets out amendments to the current Part L documents, with regards to the requirements of the provision of an Energy Strategy document, to include the viability assessment of all Low and Zero Carbon technologies. The 2013 edition of the Building Regulations Approved Document Part L came into effect on **6th April 2014** for use in England.	The Part L 2013 specifications have been strengthened to deliver a further 9% carbon dioxide savings across the new non-domestic building mix relative to Part L 2010. **Regulation 25A**: 'Must analyse and take into account the technical, environmental and economic feasibility of using high efficiency alternative systems (such as the following systems) in the construction, if available: a) Decentralised energy supply systems based on energy from renewable sources b) Co-generation c) District or block heating or cooling, particularly where it is based entirely or partially on energy from renewable sources d) Heat pumps Energy from renewable sources means energy from renewable non-fossil sources, namely wind,	

Policy/standards	Description	Key policy & target summary	Document
		solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases, and Heat pump means a machine, a device or installation that transfers heat from natural surroundings such as air, water, ground to buildings or industrial applications by reversing the natural flow of heat such that it flows from a lower to a higher temperature. (For reversible heat pumps, it may also move heat from the building to the natural surroundings).	
The London Plan (Mayor of London, 2015; Further Alterations to the London Plan, Mayor of London, March 2015)	Provides a spatial development strategy, setting an integrated economic, environmental, transport and social framework for the development of London. A key section includes 'London's response to climate change', with Policy 5.2 'Minimising carbon dioxide emissions', directing developments to adopt the Energy Hierarchy: 'Be Lean' (use less energy), 'Be Clean' (supply energy efficiently) and 'Be Green' (use renewable energy), along with achieving relevant CO_2 emissions reduction targets. Policy 5.3 'Sustainable Design and Construction' targets the highest standards of sustainable design and construction. On 11 October 2013, the Mayor published Revised Early Minor Alterations to the London Plan (REMA). From this date, the REMA are operative as formal alterations to the London Plan (the Mayor's spatial development strategy) and form part of the development plan for Greater London.	**Policy 5.2**: Minimum 35% improvement over Part L:2013 CO_2 emissions (October 2013-2016); minimising CO_2 emissions in accordance with the Energy Hierarchy: 1: Be Lean (use less energy) 2: Be Clean (supply energy efficiently) 3: Be Green (use renewable energy). **Policy 5.3:** Highest Standards of sustainable design. **Policy 5.6:** Decentralised Energy in development proposals. **Policy 5.7: Renewable Energy -** The Mayor seeks to increase the proportion of energy generated from renewable sources. **Policy 5.9: Overheating and cooling -** reduce the impact of the urban heat island effect and to avoid overheating and excessive heat generation.	
Delivering London's Energy Future – The Mayor's Climate Change Mitigation and Energy Strategy (Mayor of London, 2011):	The strategy to reduce London's CO_2 emissions, maximise low carbon economic opportunities, ensure a reliable energy supply is secured and to meet or possibly exceed national climate change and energy objectives.	**Policy 1 & 2**: Contributing to the low carbon economy and associated skills. **Policy 3, 4 and 5**: Enabling, delivering and commercialising decentralised energy. **Policy 9**: Minimising CO_2 emissions from London's new buildings. Detailed policies are set within the London Plan.	

Policy/standards	Description	Key policy & target summary	Document
Sustainable Design and Construction SPG (Mayor of London, 2014).	Providing sound sustainability principles, encompassing an integrated holistic approach as well as a high level of detail and best practice guidance.	**Section 2.4**: Buildings should seek to minimise CO_2 emissions though passive and active means, in line with London Plan CO_2 reduction targets. Buildings should also seek to connect or contribute to district heating or cooling networks where possible. **Section 2.5**: Buildings should seek to incorporate renewable energy technologies to minimise overall CO_2 emissions, where feasible. Buildings that cannot meet the London Plan CO_2 reduction targets through on site means alone should provide cash in lieu contributions to meet the shortfall through off site means. **Section 3.2**: Buildings to adapt to and mitigate for the effects of the urban heat island and the expected increases in hot dry summers and mild wet winters.	
Energy Planning (Mayor of London, 2015)	Provides detail on how to prepare energy assessments to accompany planning applications as set out in the London Plan. The purpose of an energy assessment is to demonstrate that climate change mitigation measures comply with London Plan energy policies, including the energy hierarchy.	From 6 April 2014 the 2013 changes to Part L of the Building Regulations came into effect. Part L 2013 delivers an overall reduction in CO_2 emissions for new residential and new non-domestic buildings, with the targets for individual buildings being differentiated according to building type. This reduction in CO_2 emissions affects the percentage reduction necessary above the new Part L 2013 regulations to meet the Mayor's targets in the London Plan. From 6 April 2014 the Mayor applied a 35% CO_2 reduction target beyond Part L 2013 of the Building Regulations - this is deemed to be broadly equivalent to the 40% target beyond Part L 2010 of the Building Regulations, as specified in Policy 5.2 of the London Plan for 2013-2016. The 35% target is a flat percentage reduction across both residential and non-domestic buildings. All applications received from the 6 July 2014 will be assessed against the 35% reduction target beyond Part L 2013 of the Building Regulations. In April 2015 the GLA updated the Energy Planning guidance document, which now contains additional text around CHP and overheating and a number of changes to technical requirements.	
Camden Core Strategy 2010-2025	Camden's Core Strategy sets out the key elements of the Council's planning vision and strategy for the borough.	**Policy CS13 – Tackling climate change through promoting higher environmental standards** *'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:* *a) ensuring patterns of land use that minimise the need to travel by car and help support local energy networks;* *b) promoting the efficient use of land and buildings;* *c) minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing, in order, all of the elements of the following energy hierarchy:* *- 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;*	

Policy/standards	Description	Key policy & target summary	Document
		- generating renewable energy on-site; and *d) 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.'* **Energy Hierarchy** **Ensuring developments use less energy** *'The Council will encourage all developments to meet the highest feasible environmental standards taking into account the mix of uses, the possibility of re-using buildings and materials and the size and location of the development.'* **Making use of energy from efficient sources** *'Once a development has been designed to minimise its energy consumption in line with the approach above, the development should assess its remaining energy needs and the availability of any local energy networks or its potential to generate its own energy from low carbon technology.'* **Generating renewable energy on-site** *'Buildings can also generate energy, for example, by using photovoltaic panels to produce electricity, or solar thermal panels, which produce hot water. Once a building and its services have been designed to make sure energy consumption will be as low as possible and the used of energy efficient sources has been considered, the Council will expect developments to achieve a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation (which can include sources of site-related decentralised renewable energy) unless it can be demonstrated that such provision is not feasible.'*	

Policy/standards	Description	Key policy & target summary	Document
Camden Planning Guidance (CPG 3)	The Camden Planning Guidance was developed to support the policies in the Local Development Framework. The guidance provides information on ways to achieve carbon reductions and more sustainable developments.	**Section 3- Energy Efficiency: New Buildings** All new developments are to be designed to minimise carbon dioxide emissions by being as energy efficient as is feasible and viable. The document cites the best practice standards stipulated by London Plan Policy 5.2 i.e. a 35% CO_2 reduction target beyond Part L 2013 of the Building Regulations. **Section 5- Decentralised energy networks and combined heat and power** Once a development has been designed to be as energy efficient as possible (Energy hierarchy - Stage 1), developments will be required to consider the following steps, in the order listed, to ensure energy from an efficient source is used, where possible: • Investigating the potential for connecting into an existing or planned decentralised energy scheme and using heat • Installing a Combined (Cooling) Heat and Power Plant (CHP or CCHP), including exporting heat, where appropriate • Providing a contribution for the expansion of decentralised energy networks • Strategic sites are to allow sufficient accessible space for plant equipment to support a decentralised energy network • Designing the development to enable its connection to a decentralised energy network in the future	
Code For Sustainable Homes (DCLG, 2010 including Code Addendum 2014)	The Code for Sustainable Homes (the Code) is an environmental assessment method for rating and certifying the performance of new homes. It is a national standard for use in the design and construction of new homes with a view to encouraging continuous improvement in sustainable home building. The Code covers a range of categories such as energy and CO_2 emissions, water, materials, surface water run-off, waste, health and well being, management and ecology.	Mandatory standards are set by the Code level targeted. The standards are detailed in the Code for Sustainable Homes Technical Guide. A Code Level 4 rated dwelling requires a minimum of 68 points including a minimum 19% improvement of CO_2 emissions reduction over Part L1A 2013.	

Policy/standards	Description	Key policy & target summary	Document
BREEAM New Construction (BRE, 2014):	The Building Research Establishment Environmental Assessment Method (BREEAM) is a widely used environmental assessment methodology for non-domestic buildings, covering a broad range of sustainability categories. This includes Management, Health and Wellbeing, Energy, Transport, Water, Materials, Waste, Land Use & Ecology and Pollution. The methodology is used to quantify and reduce the environmental impacts of the built environment by rewarding designs that take positive steps to minimise their environmental effects. Undertaking a BREEAM assessment and integrating the associated design requirements into the scheme helps to set Best Practice sustainability standards across a broad range of building design, construction and operational targets, summarised by a single rating, from 'Pass' to 'Outstanding' (BREEAM).	Minimum BREEAM rating requirements are determined by the Local Authority's Planning policy. Minimum credit requirements are set by the BREEAM rating target, which are detailed in the BREEAM manual. A BREEAM 'Excellent' rating requires a minimum EPR_{NC} rating of 0.375 or higher. There are no minimum standards of performance under the Ene 01 credit (Reduction of energy use and carbon emissions) stipulated for a BREEAM NC 2014 rating of 'Very Good'.	

4. Technical Appraisal and Performance

With reference to the policy requirements, guidance and industry best practice detailed in section 3, a comprehensive energy and carbon dioxide (CO_2) emissions assessment has been carried out for the development. The environmental performance of the scheme has been comprehensively analysed and evaluated in order to achieve a higher level of energy and CO_2 emissions performance than that required by the 2013 Building Regulations and associated polices, as well as achieving an optimum balance between environmental, social and economic sustainability criteria. This analysis has included:

- Part L1A 2013 CO_2 assessment for the development.
- Part L2A 2013 CO_2 assessment for the development.
- An energy demand assessment of the proposed scheme & CO_2 emissions calculations.
- Low and zero carbon energy system evaluation and assessment.

Fuel and energy emissions factors used within the above analysis are in accordance with Part L:2013:

Fuel	Part L:2013 $kgCO_2/kWh$
Natural Gas	0.216
Biofuel – wood pellets	0.039
Grid supplied electricity	0.519
Grid displaced electricity	0.519

Table 4.1 *Fuel and energy emissions factors (Part L 2013)*

4.1. Energy Hierarchy

In line with industry best practice and Policy 5.2 of the London Plan, the following energy hierarchy design approach has been applied to the development, in order to identify all viable opportunities that can be incorporated into the design of the development.

- 'Be Lean': Use less energy by maximising passive and energy efficiency design measures. This included optimising building orientation, passive solar heating, insulation, optimising HVAC plant and efficiency along with all other fixed building services. The energy management of unregulated (plug-in) loads are also addressed via recommendations.
- 'Be Clean': Supply energy efficiently, using viable low carbon technologies. This includes feasibility assessments of combined heat and power (CHP) and allied systems. Additionally, the viability of connection to any district heating system are assessed, or 'future-proofing' the design to enable a future connection, should district heating be available and viable during the life of the development.
- 'Be Green': Use renewable energy, where viable, in order to meet a proportion of the remaining energy demand. This includes a review of all zero carbon (renewable) technologies, in order to assess the technical and financial viability. Air House Heat Pumps (in heating mode) have been proposed as a viable renewable technology for the development.

The overarching aim of all of these energy hierarchy measures is the reduction of CO_2 emissions related to the development's built environment, as represented below:

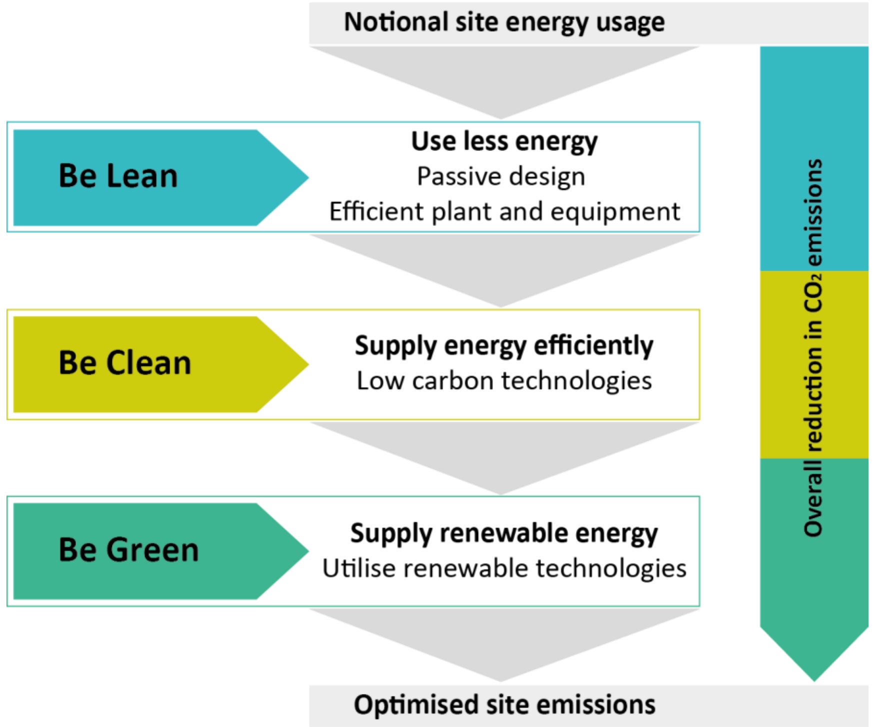


Figure 4.1 *Energy hierarchy approach adopted for the development*

5. 'Be Lean' (Use Less Energy)

5.1. Regulated Loads

Within the first stage of the energy hierarchy, it was proposed to incorporate high levels of passive and energy efficient design measures in order to reduce the development's energy consumption and associated CO_2 emissions.

The proposed design subsequently incorporates a number of passive design and energy efficient measures, in order to reduce the energy demand and associated CO_2 emissions of the development. This design approach has identified the following viable design measures and an overall design route that will be incorporated into the development. An example of some of the 'Be Lean' measures are highlighted in Figures 5.1 and 5.2 and detailed thereafter:

- Optimised U-values for both opaque and transparent elements;
- Low thermal bridging applying Approved Construction Details;
- Optimised levels of air tightness;
- A medium level of internal thermal mass surfaces;
- Natural ventilation through openable windows for the residential elements of the scheme;
- High light transmittance glazing in façade;
- Solar control glazing within the façade, balancing passive solar control versus overheating for the residential elements and controlling thermal comfort on the commercial floors;
- External shading created by balconies;
- Energy efficient lighting systems;
- Photocell control dimming in perimeter office spaces;
- Heat recovery integrated into ventilation systems in the Office, Self-Storage and Cafe; where applicable;
- High efficiency heating and cooling plant for the commercial office spaces.

5.1.1. Passive Efficiency Measures

Whilst the orientation of the development is fixed due to the size and shape of the plot, the facade has been optimised to minimise heat loss from the residential element of the development and in order to provide a balance of thermal control for the non-residential element at the lower floors.

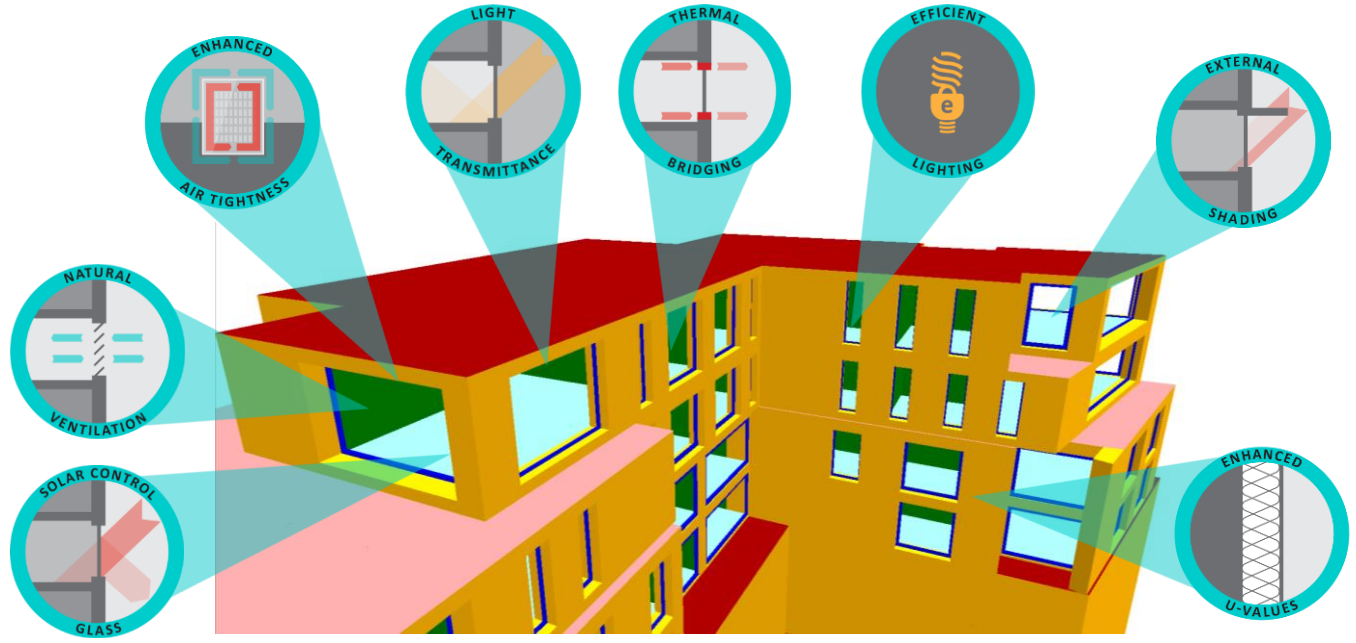


Figure 5.1 *Indication of some of the 'Be Lean' measures incorporated in the residential component of the proposed development, shown on the dynamic thermal model*

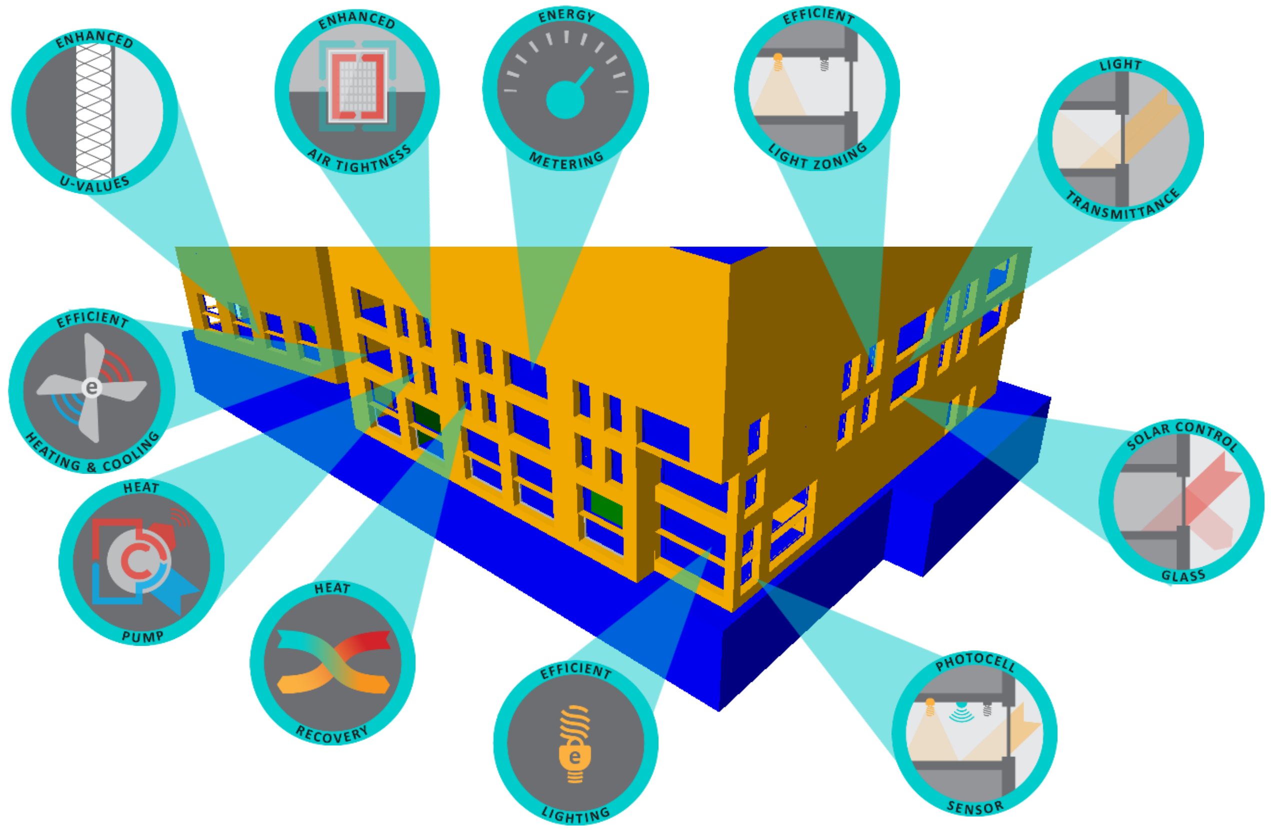


Figure 5.2 *Indication of some of the 'Be Lean' measures incorporated in the commercial component of the proposed development, shown on the dynamic thermal model*

Dynamic thermal modelling simulations were used to analyse internal temperatures of the commercial element of the proposed building and determine the optimum glass solar energy transmittance (g-value) to limit solar gain, while maintaining high levels of natural light transmittance. The glass specified will help to contain the thermal energy within these spaces, allow a controlled and beneficial level of solar gain, as well as prevent overheating and excessive artificial cooling demands.

The specification of the glazing exceeds Part L:2013 building requirements, enables the apartments to achieve overheating criteria and enables the office spaces at the lower levels of the proposed building to meet CIBSE Guide A overheating recommendations. The proposed light transmission of glass is maximised in order to increase the availability of natural light and reduce the use of artificial lighting.

	Dwellings		Non-residential	
Glass Performance	**Part L1A:2013 limiting factors**	**Proposed performance**	**Part L2A:2013 limiting factors**	**Proposed performance**
Centre pane U-value, (W/m^2K)	2.00	1.3	2.20	1.27
Frame U-value, (W/m^2K)				3.00
Light transmission	-	>0.50*	-	0.80
Solar transmittance, (g-value)	-	0.42	-	0.42

**To be further informed by internal daylight calculations at the detailed design stage*

***Table 5.1** Proposed glazed façade performance properties*

The fabric's thermal and air permeability performance level exceeds the Part L:2013 minimum standards, in order to reduce heat loss from the residential element of the propose building and optimise thermal control in the commercial spaces. For the dwellings, U-values were reduced to a feasible level and thermal bridging is specified through the application of Approved Construction Details. The fabric air-permeability is limited to $3.0m^3/(h.m^2)$ for the offices and dwellings whilst the air permeability of the Self Storage facility and Cafe is limited to $5.0m^3/(h.m^2)$ .The following outlines the U-values of the external envelope.

	Dwellings		Non-residential	
Opaque Fabric Performance	**Part L1A:2013 limiting factors**	**Proposed performance**	**Part L2A:2013 limiting factors**	**Proposed performance**
External wall	0.30	0.15	0.35	0.15
Roof	0.20	0.13	0.25	0.13
Floor	0.20	0.20	0.25	0.20
Party wall	0.00*	0.00	-	-

**Solid wall or fully filled cavity with effective sealing at all exposed edges*
***Table 5.2** Proposed building envelope thermal properties*

5.1.2. Active Efficiency Measures

High efficiency plant and equipment has been specified in order to limit the energy consumed to provide the required and best practice indoor environment performance and control. Performance efficiency values were tested and improved in the SAP and dynamic thermal model to benchmark the resulting predicted carbon dioxide reduction. The equipment efficiency measures include:

- High efficiency artificial lighting with the following light power densities and controls:

Use	Power density (W/m^2)	Power density (lumens/circuit Watt)	Illuminance (lux)	Auto presence detection	Daylight control
Dwellings: Internal	100% efficient lighting			*None*	*None*
Dwellings: Circulation	8	-	150	Auto on/Dimmed	None
Cafe	-	60	150	*None*	*None*
Cafe: Kitchen	-	60	500	*None*	*None*
Cafe: WC	-	60	200	Auto on/Auto off	*None*
Cafe: Circulation	-	60	100	Auto on/Auto off	*None*
Offices: Perimeter	8	-	400	Auto on/Auto off	Photocell Control Dimming
Offices: Internal	8	-	400	Auto on/Auto off	*None*
Offices: Circulation	8	-	150	Auto on/Dimmed	*None*
Offices: Kitchenette	10	-	150	Auto on/Auto off	*None*
Offices: WC	7	-	200	Auto on/Auto off	*None*
Offices: Bikestore	7	-	150	Manual On/Auto Off	*None*
Offices: Reception	10	Display Lighting 22[2]	200	Auto on/Dimmed	*None*
Self Storage: Store	7	-	300	Manual On/Auto Off	*None*
Self Storage: Reception	10	Display Lighting 22[3]	200	Auto on/Dimmed	None
Self Storage: Plant	10	-	150	*None*	*None*
Self Storage: Circulation	8	-	150	Auto on/Dimmed	*None*
Self Storage: WC	7	-	200	Auto on/Auto off	*None*

***Table 5.3** Proposed lighting performance*

[2] NCM Activity Zone determines if the zone has display lighting.

- The efficiency performance of mechanical plant has been carefully assessed and selected to exceed Part L:2013 minimum compliance requirements, as detailed below. For the areas to be fitted out by tenants, the offices and retail areas as ground and first floor, compliant backstop values were assumed for terminal efficiencies in the Part L2A assessment:

Use	System	Heating Source	Cooling Source	Heat Recovery efficiency	Ventilation Plant SFP (W/(l/s))		
					SP	EX	TR
Dwellings	Mechanical ventilation with Heat Recovery	CHP Heat Efficiency: 61.8% (0.8 heat fraction) Additional Boiler Efficiency: 89% (0.2 heat fraction)	-	-	0.76 (1 add. wet room) 0.88 (2 add. wet rooms) 1.07 (3 add. wet rooms)		
Dwellings (Circulation)	Natural Ventilation	CHP with backup boiler CHP Total System Efficiency @ 50% - 93.67% @75% - 92.75% @100% - 92.12% Backup Boiler-95%	-	-	-	-	-
Offices	VRF with Mechanical Ventilation and Heat Recovery	540%	7.4	50%	0.8	1.1	-
Offices (Reception)	VRF with Mechanical Ventilation and Heat Recovery	540%	7.4	50%	0.8	1.1	-
Offices (WC)	Extract Only	Direct Electric 100%	-	-	-	0.5	-
Offices (Circulation)	Natural Ventilation	Direct Electric 100%	-	-	-	0.5	-
Offices (Bike Store)	Occupied and Unheated	-	-	-	-	-	-
Offices (Kitchenette)	Mechanical Ventilation	Direct Electric 100%	-	-	0.6	0.5	-
Self Storage (Store)	Mechanical Ventilation with Heat Recovery	Gas Boiler – 95%	-	50%	0.6	0.5	-
Self Storage (Circulation)	Natural Ventilation	Gas Boiler – 95%	-	-	-	-	-
Self Storage (Plant Rooms)	Mechanical Ventilation with Heat Recovery	Gas Boiler – 95%	-	50%	0.6	0.5	-
Self Storage (WC)	Extract Only	Gas Boiler – 95%	-	-	-	0.5	-
Self Storage (Reception)	VRF with Mechanical Ventilation and Heat Recovery	540%	7.4	50%	0.8	1.1	-
Cafe	VRF with Mechanical Ventilation and Heat Recovery	350%	4	50%	0.8	1.1	-
Cafe (WC)	Extract Only	Direct Electric 100%	-	-	-	0.5	-
Cafe (Kitchen)	Mechanical Ventilation	Direct Electric 100%	-	-	0.6	0.5	-
Cafe (Circulation)	Natural Ventilation	Direct Electric 100%	-	-	-	-	-

Table 5.4 *Proposed mechanical system efficiencies*

- A power factor correction (> 0.95) will be included to improve the electric stability and efficiency of the transmission network.
- Smart meters are planned for the development to enable a demand-led response, which makes it possible to save energy by turning off non-essential equipment or running equipment at lower capacities at times of peak demand.
- In addition, a Home/Building User Guide will be handed over to residents and tenants (as required by Code for Sustainable Homes and BREEAM) and will contain recommendations on how to reduce unregulated energy consumption through the procurement of energy efficient equipment.

5.1.3. The Cooling Hierarchy

The design was developed in line with the GLA's recommended 'Cooling Hierarchy' approach which applies a similar principle to the thorough decision-making process of the 'Energy Hierarchy' applied specifically with the aim of reducing CO_2 emissions from cooling:

A. **Minimisation of internal heat generation through energy efficient design**

- Heat gain from lighting is kept to a minimum as a result of an energy-efficient lighting design solution.
- The availability of natural light is maximised to discourage the use of artificial lighting by optimising the light transmittance of the glass elements of the façade.
- Heat gains from tenant equipment can be influenced by low energy recommendations provided in a Building User Guide for tenants.

B. **Reduction of the amount of heat entering the building in summer**

- Living areas are shaded by balconies that are inset from the external plane of the façade.
- All representative dwellings comply with the Part L1A Overheating criteria as the g-value is limited to 0.42 and the air change rate is ≥2.0 ach[3].
- All representative dwellings were assessed using the CIBSE TM 52 'The Limits of Thermal Comfort: Avoiding Overheating in European Buildings' (See separate report titled *'Residential Overheating Risk-Greenwood Place')*. The results confirmed that the majority of dwellings do not present an overheating risk when using the current Design Summer Year weather file. However, isolated exceedances could be observed in the top floor apartments assessed. To mitigate against these exceedances, passive design measures have been recommended to inform further design development at the detailed design stage. Additionally, comfort cooling is being provided for the penthouse apartments on the 8th and 6th floors of Buildings 1 and 2, respectively. The dwellings were also assessed using three TM 49 Design Summer Years for London.
- All commercial spaces comply with the Part L2A recommendation to limit solar gains with the lone exception of the Self Storage reception area on the ground floor.
- A detailed thermal comfort analysis was additionally carried out for all office spaces within the building which determined that the g-value should not exceed 0.42.

C. **Management of the heat within the building through exposed thermal mass and high ceilings**

- A medium level of internal thermal mass surfaces was assumed for the residential element of the proposed development. This will be integrated at detailed design stage.

D. **Passive ventilation**

- Residential windows are openable, providing natural ventilation to the dwellings.

E. **Mechanical cooling**

- The commercial office spaces and self storage facility (reception and office areas only) shall be cooled by VRF units to provide required fresh air rates and temperature control for commercial tenants'.
- The cafe located on the ground floor of Building 2 shall also be cooled by VRF units.
- No cooling has been provided in dwellings with the exception of the penthouse apartments.

F. **Active cooling**

- Cooling to the relevant areas in the offices and Self Storage facility is delivered by highly efficient VRF Units (SEER of 7.4)
- Cooling to the cafe is delivered by VRF units whose energy efficiency (SEER of 4) exceeds the minimum values stipulated by the Non-Domestic Building Services Compliance Guide.

The cooling requirement/ demand of the different elements of the proposed development are reported in the following table:

	Actual	Notional
Residential element (kWh/m²)	0.63	0
Non-residential element (kWh/m²)	14.61	14.17

Table 5.5 *Cooling requirement/ demand of the different elements of the proposed*

The estimated overall emissions performance of the above 'Be Lean' measures, in relation to Part L:2013 target emissions is **0.41%** for the whole building (Figure 5.3). In order to calculate these values, a Part L assessment was carried out that removed other 'Be Clean' and 'Be Green' measures that are described later in this report and that sourced heat from a gas-fired boiler (89.5% efficiency for the domestic and 91% for the non-domestic).

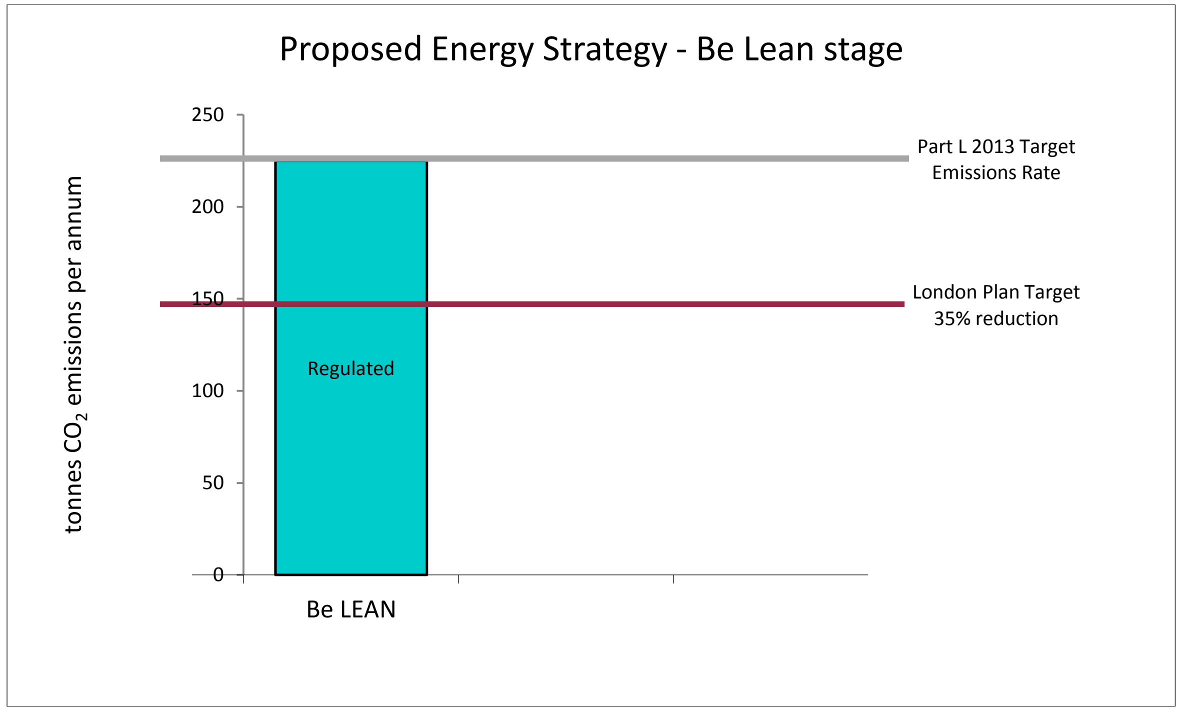


Figure 5.3 *Part L2A:2013 performance due to application of 'Be Lean' measures only*

5.2. Part L: 2013 Compliance (under 'Be Lean' measures only)

The building has been assessed for Part L:2013 compliance using SAP for the residential element and dynamic thermal modelling accredited software for the non-residential element. The 'Be Lean' tier design consider all passive design and energy efficient measures in order to reduce the energy demand and associated CO_2 emissions of the development and applies them where viable.

Table 5.6 below summarises the results from the application of the 'Be Lean' measures only, without the application of any viable 'Be Clean' and 'Be Green' measures at this stage. The scheme's performance under further stages of the energy hierarchy in relation to Part L:2013 are given in the 'Be Clean' and 'Be Green' sections of this report.

[3] The Building Regulation Part L1A recognise that the overheating test does not cover all factor influencing overheating and additional design assessments would be required to mitigate this risk.

Use	Target Emission Rate ($kgCO_2/m^2$.annum)	Dwelling/ Building Emission Rate ($kgCO_2/m^2$.annum)	Part L:2013 improvement (%) 'Be Lean' only
Residential element 'Be Lean' Results against 'Be Lean' TER of Residential	15.83	17.08	7.31%
Non-residential element 'Be Lean' Results against 'Be Lean' TER of Residential	19.20	19.00	-1.05%*
Overall 'Be Lean' results against final ('Be Green') TER			0.41%**

Table 5.6 *Building emissions performance under 'Be Lean' measures only*

**All viable energy hierarchy measures will continue to be assessed as the design develops.*

***The residential Target Emissions Rate (TER) for the 'Be Lean' tier of the hierarchy is different from that of the 'Be Clean' and 'Be Green' tiers. This is due to the National Calculation Method and the different heating sources applied at the 'Be Lean' tier. The overall site-wide results above are relative to the final ('Be Green') TER for comparative consistency, but individual 'Be Lean' TERs for the residential and non-residential component have also been presented in the table above.*

5.3. Energy Signature of the Scheme (under 'Be Lean measures only)

The total CO_2 footprint for the proposed development has been estimated at approximately **447** tonnes per annum for the building, using the development's Part L:2013 loads plus operational 'in use' loads, before the addition of low and zero carbon technologies.

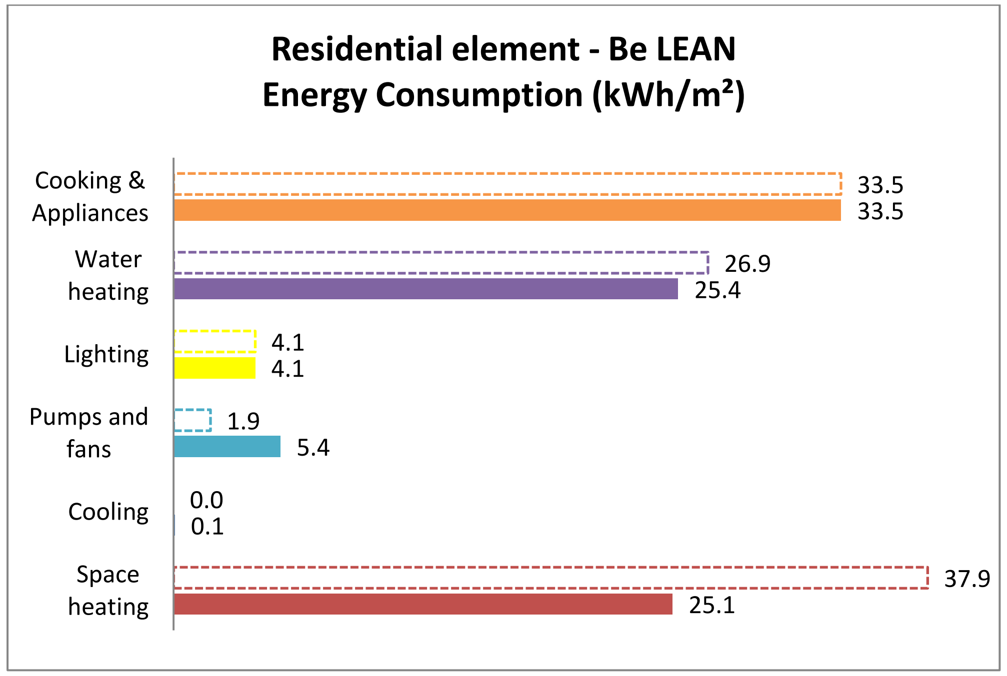


Figure 5.4 *Energy signature for the residential element of Greenwood Place*

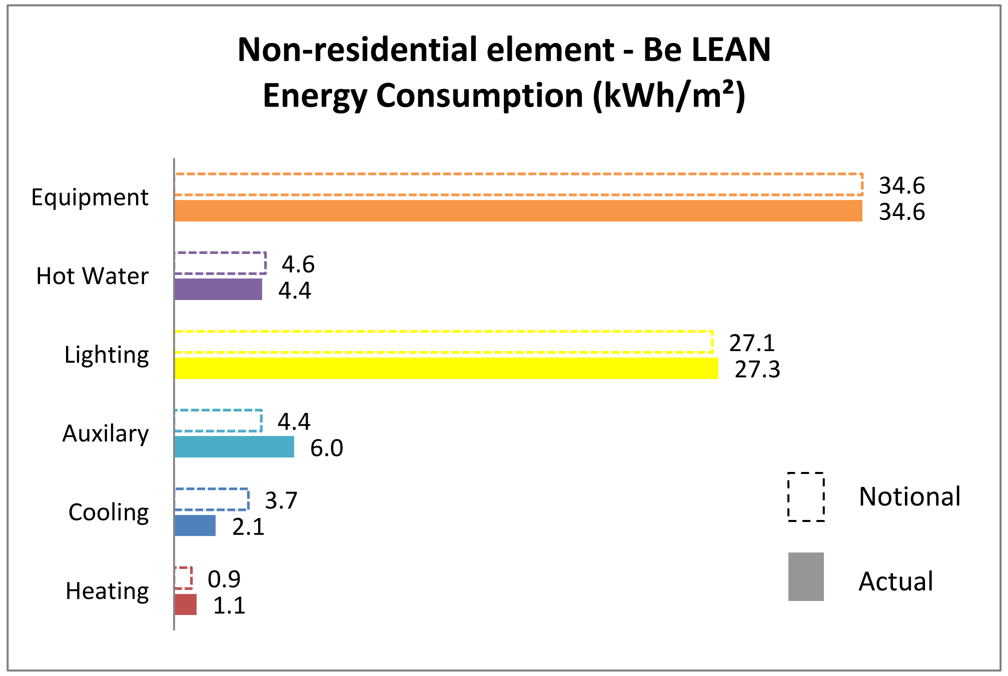


Figure 5.5 *Energy signature for the non-residential element of Greenwood Place*

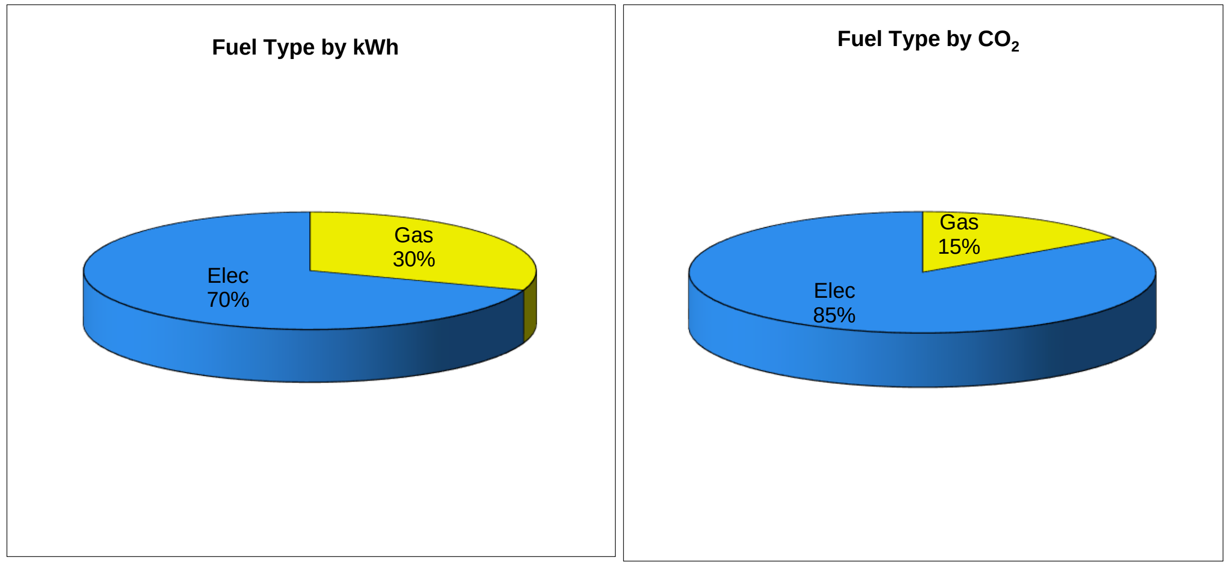


Figure 5.6 *Estimated fuel consumption assessed in kWh and $kgCO_2$ for the proposed development*

5.4. Unregulated and Operational Load Reduction Strategy

Unregulated loads (plug-in and specialist process equipment) can contribute to a significant fraction of the overall CO_2 emissions of any development. The following measures and opportunities will be explored and included in a residents/tenant user guide where appropriate:

Unregulated load reduction opportunities	Details	Viable for the scheme?
Energy efficient lifts	Variable voltage drives	**Yes**
	LED lights in lift cars	**Yes**
	Standby / hibernation mode availability	**Yes**
	Regenerative lift motors to be considered.	**Yes**
White goods	Fridges / freezers will be selected to be either A, A+ or A++ rated.	**Yes**
	Washing machines / dish washers will be A rated	**Yes**
External lighting	Energy efficient lamps (Efficacy > 50 lamp lumens / circuit watt)	**Yes**
	Daylight / time clock controls to avoid lights being left on when not required	**Yes**
Computing & I.T. loads	Selecting efficient Energy Star I.T. products	**Yes**
	Application of industry Best Practice with regards to server loads & server room temperatures	**Yes**

Table 5.7 *Unregulated loads viability assessment*

A home/ building user guide can inform incoming occupants how to control their building efficiently and how to optimise its systems. Further guidance will be provided on building energy management to include unregulated loads that are outside the scope of procurement.

Good energy management can be approached in a range of ways, as follows:

1) Adopting the 'Soft Landings framework' – ensuring the occupants and design team are engaged throughout the project programme, from project brief, through construction, commissioning, handover and importantly into occupancy and beyond. Performance monitoring is an important aspect of this latter phase.
2) Provide an energy management guidance document, stating best practice principles for the control of regulated and unregulated loads.
3) Develop a more detailed building specific energy policy and energy management strategy, where all elements of the building, plant, equipment and operation are reviewed for energy efficiency. An energy management strategy can be developed by a suitably qualified professional in order to incorporate energy efficient design measures of the building, as well as optimise energy efficiency from loads directly under the occupant's control. A phased approach to this energy management strategy can assist budgets and future programming of activities, represented as follows:
   a. Develop an energy awareness campaign, so that all occupants, visitors and contractors are aware of the energy policy and receive regular communication with regards to energy consumption optimisation.
   b. Develop a purchasing policy that ensures plant, equipment, spares and consumables have their energy efficiency merits considered along with other drivers, where an decrease in energy consumption over the life of the equipment will often outweigh any apparent additional capital cost.
   c. The above approach and suitable energy management best practice will be encouraged and developed by the applicant and developer, where appropriate to the final operation, management and occupancy of the building.
   d. Any subsequent energy and emissions savings from the management of unregulated loads will be in addition to those stated within this Energy Strategy.

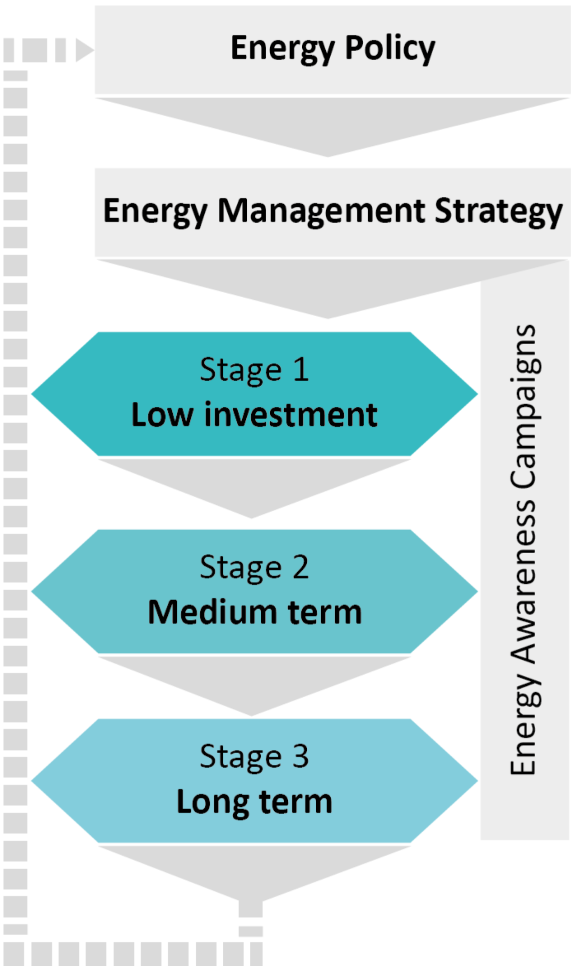


Figure 5.7 *Best practice Energy Management Strategy, with a phased approach to opportunities*

6. 'Be Clean' (Supply Energy Efficiently)

In keeping with relevant policy, building accreditation requirements and sustainability best practice, all 'Be Clean' low carbon technologies have been reviewed for viability within the development, in order to target the further reduction of regulated loads and/or associated CO_2 emissions. Viable opportunities will continue to be assessed for performance and feasibility as the design progresses.

The following table sets out a summary of the complete list of 'Be Clean' technologies which have been considered for viability. Technologies are covered in detail within the subsequent pages of this section, with regards to the technology's operation, potential integration within the development, overall CO_2 emissions benefit if applicable, along with a recommendation for their inclusion within the design, where viable.

Energy Hierarchy	Design approach /technology	Viable?	Notes	Tonnes CO_2/annum reduction	% regulated CO_2 reduction	% CO_2 reduction
Be Clean	Combined Heat and Power (CHP)	Yes	A 40kWt gas-fired CHP (with backup boilers) was integrated at the preliminary design stage. Sizing and required thermal storage are to be designed at the detailed design stage.	30.97	14.35%	**14.35%**
	Combined Cooling Heat and Power (CCHP)	No	The cooling demand of the proposed development is considered too low and intermittent to make CCHP a viable option (Appendix A).	-	-	
	District Heating	Yes	The proposed development has the potential to connect to future district heating networks.	*to be determined*	*to be determined*	

The consideration of whether on-site CHP is an appropriate energy solution for a development will depend on the type and size of the development and whether a heat network is planned in the area. The following diagram illustrates the GLA's recommended approach to determine the feasibility of on-site CHP.

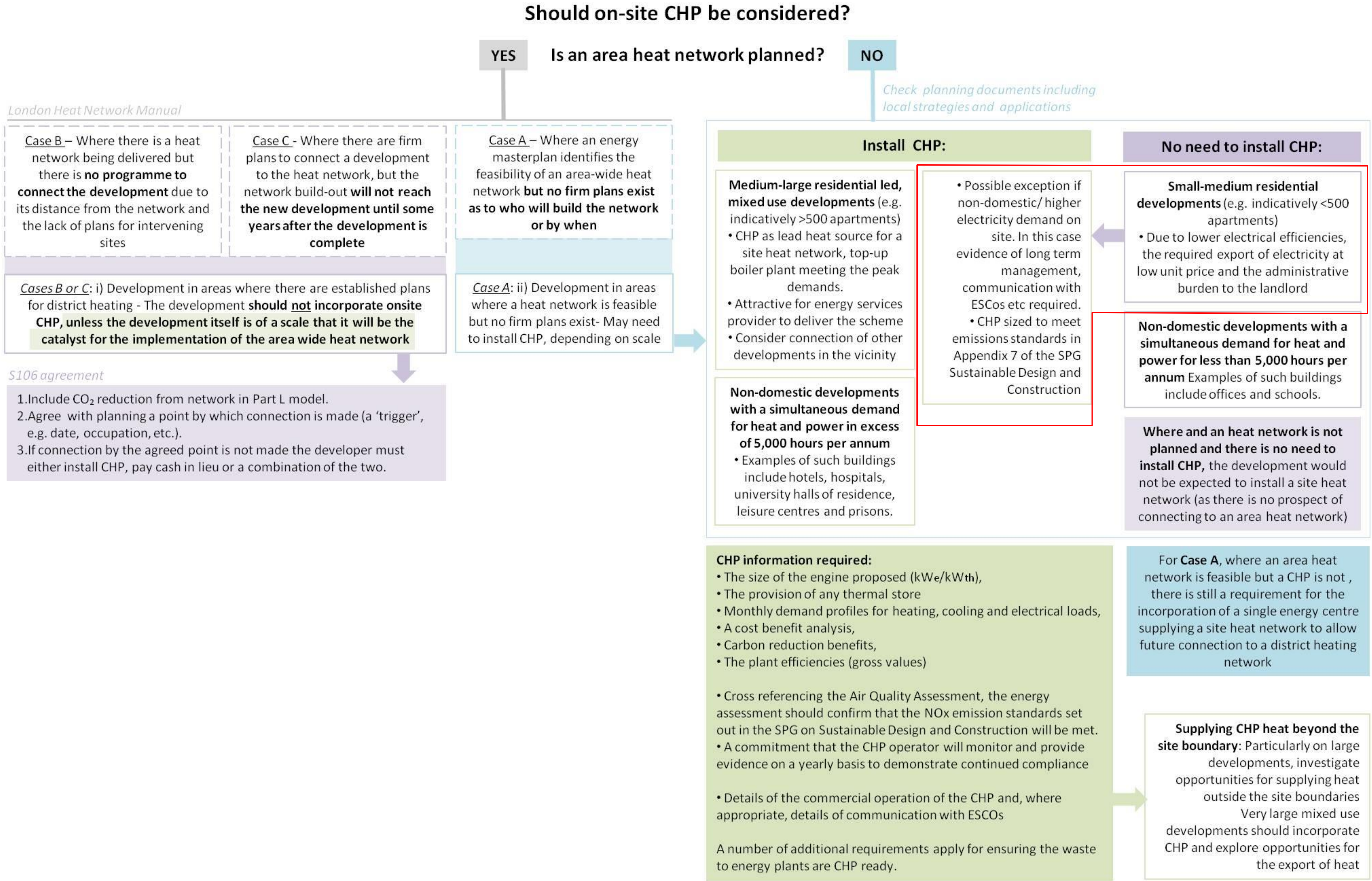


Figure 6.1 *GLA 'Energy Planning' district heating and CHP flowchart (red box marks applicable case for this proposed development)*

Camden Council expect developments to achieve a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation (which can include sources of site-related decentralised renewable energy) unless it can be demonstrated that such provision is not feasible. Hence, the potential for the proposed development to connect to such a system has been reviewed for the scheme.

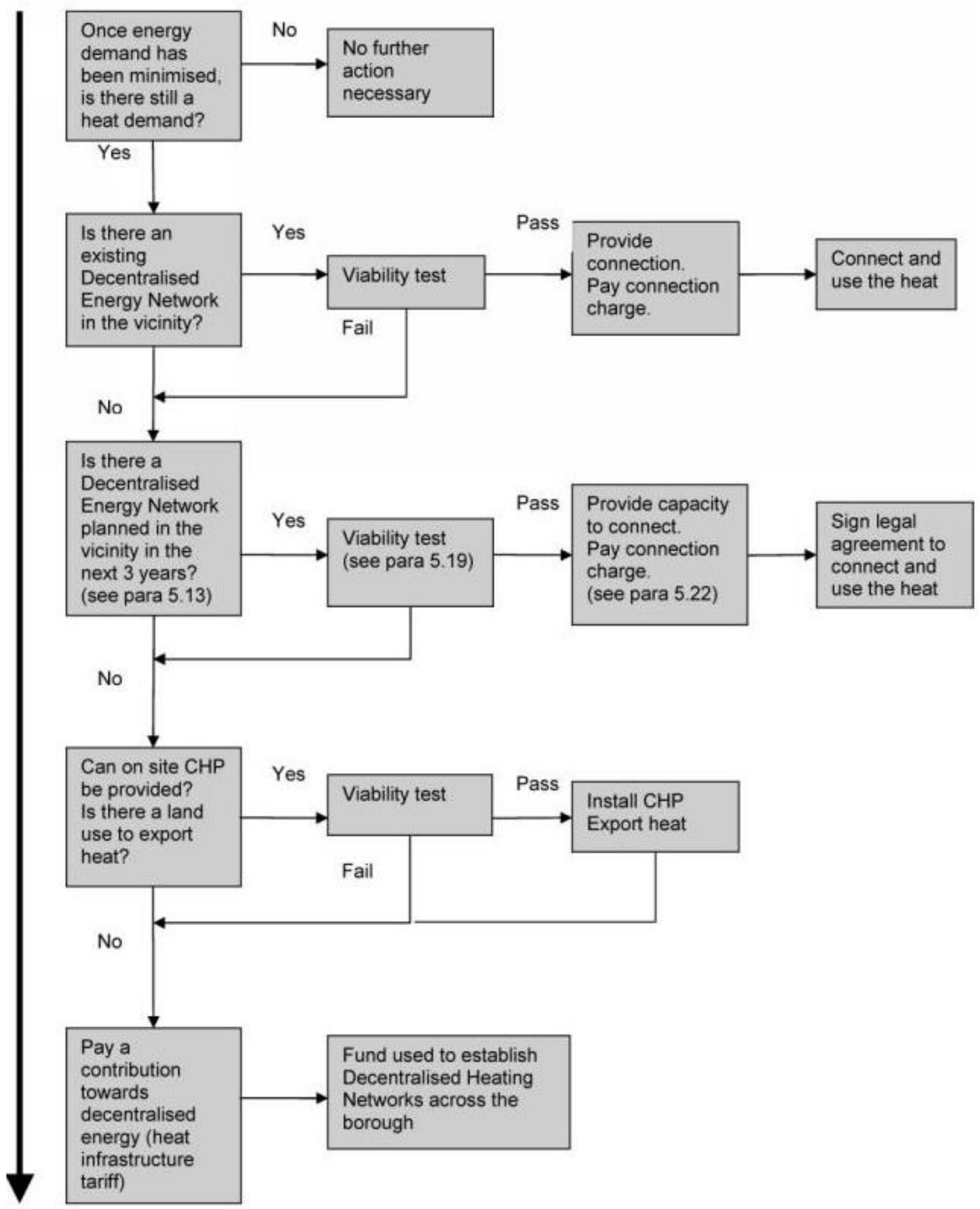


Figure 6.2 *Extract from Camden CPG3 – Decentralised energy flow chart*

6.1. Existing and Planned Decentralised Energy Networks

Decentralised energy networks generate and supply electricity, heating or cooling close to where it is used. The energy can be generated in the same building or a relatively short distance from where it is used and transmitted through pipes (generally as hot or cold water) or along cables. Decentralised energy is more carbon dioxide efficient than traditional energy sources due to the shorter distances the energy has to travel to where it is used. Heat, coolth or power for the decentralised energy network can be generated by various technologies including traditional boilers, combined heat and power and renewable energy technologies.

The decentralised energy flow chart (**Error! Reference source not found.**) has been used to determine whether he development can connect to a decentralised energy network, install a combined heat and power plant or make a contribution towards a decentralised energy network. The extent of the existing and proposed heat networks relative to the site is illustrated in the following map (Figure 6.3). It can be seen that the site is not located in the vicinity of an existing decentralised energy network, or one that is likely to be operational within 3 years of occupation of the development. . The site is also not located within a 'Heat Mapping Decentralised Energy Potential Area' opportunity area.

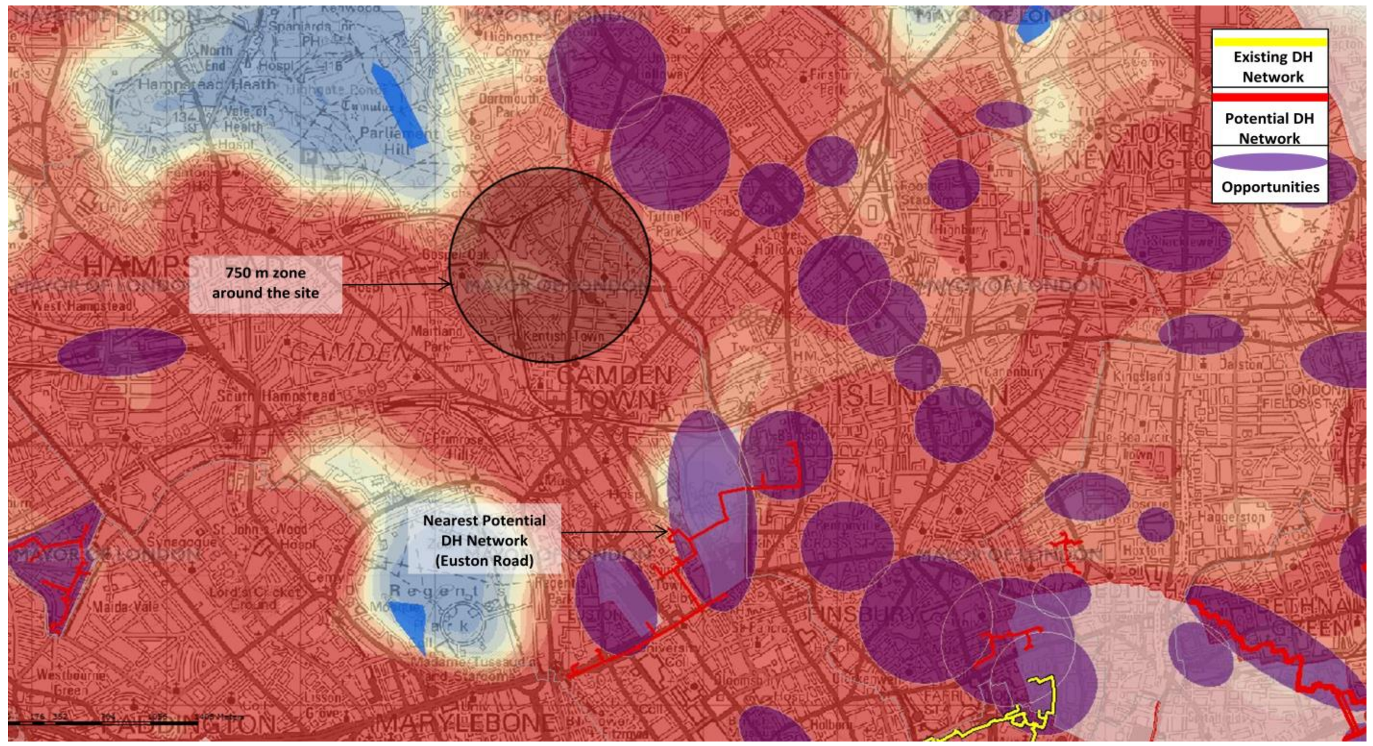


Figure 6.3 *London Heat Map review of the site*

For the aforementioned reasons, the scheme will not connect to existing networks and will secure the opportunity to connect to any future district heating scheme. Actual future connection would be subject to a viability assessment in relation to connection costs when available, analysis of heat loads and profiles, district heating reliability and emissions benefit, should system details and realistic connection opportunity be made available. As a viable and available local and commercial district heating scheme does not currently exist for the area, it is not possible to undertake an accurate cost-benefit assessment at this stage.

To ensure connection is technically feasible, Camden Council expect the heating system to be designed to be compatible with the temperature and pressure of the heat in the decentralised energy network. As a district heating scheme does not currently exist for the area, the system is designed following recommendations set in section 3.8.3 of 'District Heating Manual for London' issued February 2013. An allowance will be made for this connection in relation to indicative pipework routes and heat exchanger positions within the concept design (Figure 6.4), developed further as the design progresses, with any final future connection being subject to a detailed feasibility assessment, as required.

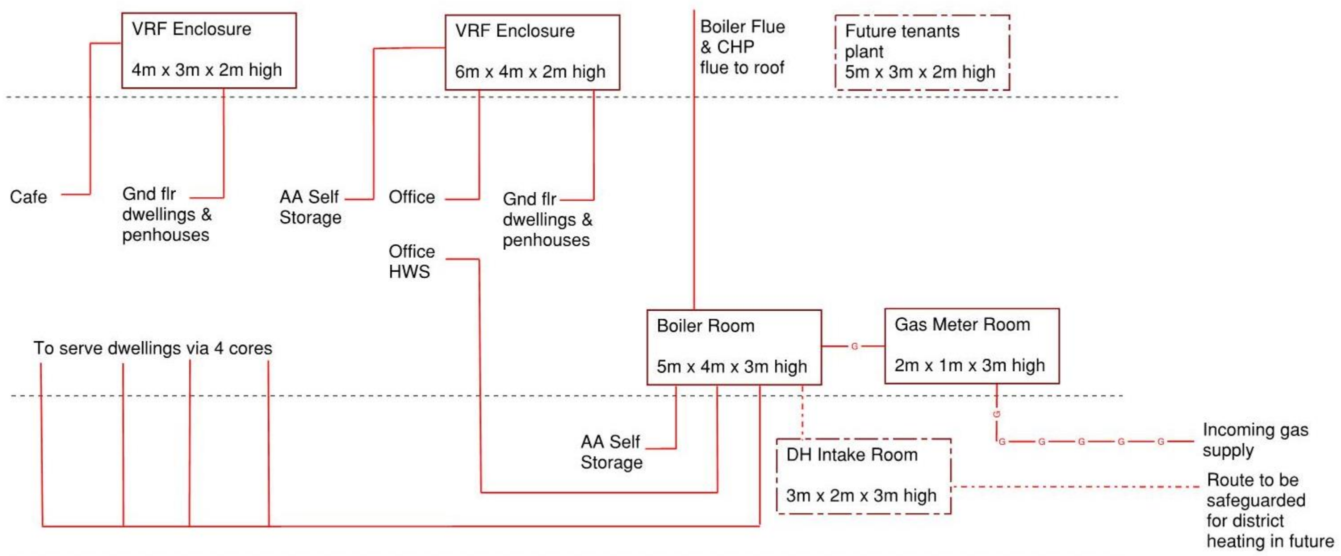


Figure 6.4 *Plant requirements schematics for Greenwood Place – Heating and Cooling*

6.2. CHP

As there is no connection and no agreement to connect the development within 3 years to a decentralised energy network, the potential integration of a CHP system to provide low carbon heat and power on site has been evaluated for the development, in compliance with industry best practice and appropriate planning policies. The methodology adopted follows that outlined by the GLA *'Energy Planning district heating and CHP flowchart'* illustrated in Figure 6.1.

Decentralised CHP recovers the waste heat from a site-based power generation prime mover (e.g. engine) via the engine water jacket, exhaust gases and oil cooler (dependent on model). This can provide low carbon, lower cost heat and electricity, with lower CO_2 emissions than the electricity grid, where the integration and operation of the CHP plant is optimised. Comparison of this technology to traditional power and heat supplies is demonstrated in the following image. Energy losses from distribution are typically reduced from approximately 70% to 27% (Figure 6.5).

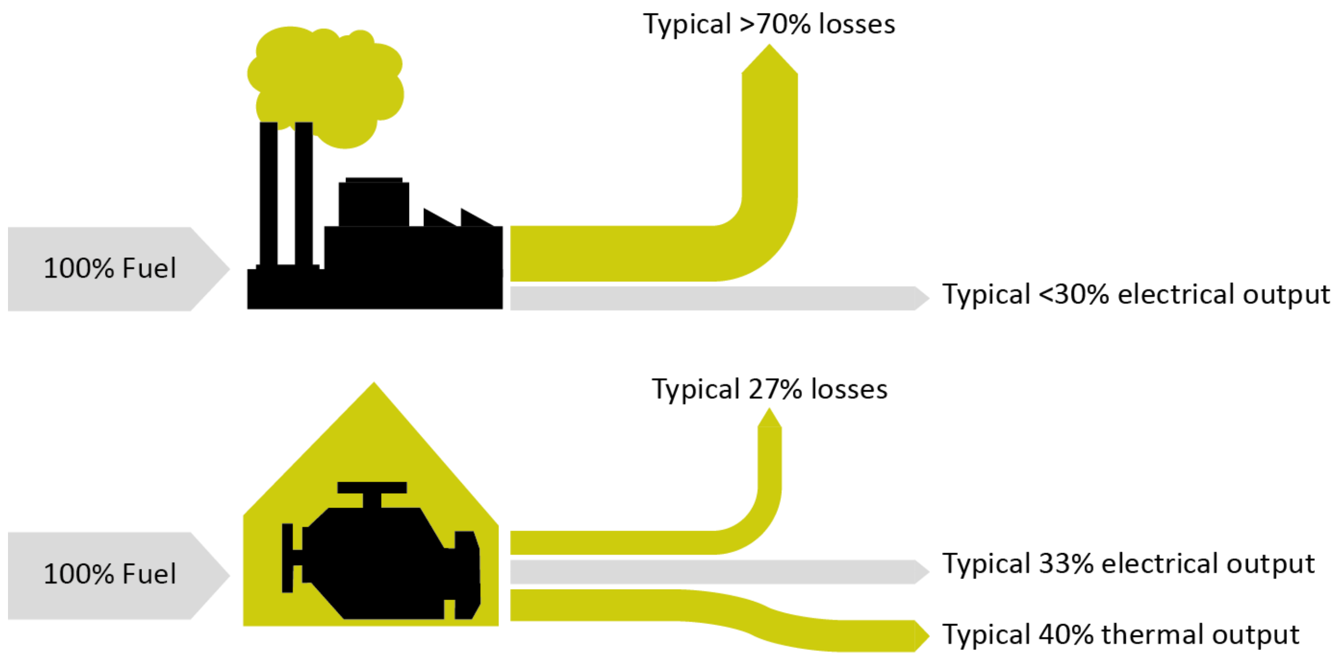


Figure 6.5 *Comparison of typical CHP on-site engine energy losses with those of traditional centralised electricity and heating supply*

Local Planning Issues
Air quality issues must be considered early on and in detail if CHP is considered a viable source of energy for a development. Measures that should be adopted include appropriate plant selection, efficient plant operation potential to prevent start-stop function (which increases emissions), flue location and flue gas treatment. An air quality assessment will be required in most instances and the local authority would be contacted at the earliest opportunity.

Grants and Subsidies
High quality CHP can benefit from enhanced capital allowances, enabling a business to claim 100% first year capital allowance on their spending for qualifying plant and machinery. ESCo contracts are also available, reducing the CAPEX burden whilst still providing emissions benefit to the development.

Applicability for the development

The energy demand of the proposed development has been reviewed with respect to the potential feasibility of a CHP engine meeting a proportion of this heat demand, along with a proportion of the site's electricity demand. Industry Best Practice and CIBSE guidance has identified that the effective integration of CHP requires the plant to operate in excess of 4,000 hours per annum, in order to realise emissions and running cost benefits – the GLA indicates that CHP is not a viable option for developments with a simultaneous demand for heat and power of less than 5,000 hours per annum (See Figure 6.1).

A micro CHP sized on domestic hot water (DHW) demand has been considered applying the following strategy:

- Micro CHP system to provide DHW for the commercial offices, Self Storage facility and dwellings;
- Micro CHP system to provide heating for the residential units only (flats and common areas of the residential element only); and
- Exported electricity to serve Self Storage facility, office space and common areas of the residential element with any surplus electricity to be exported to the grid.

The typical heat demand profile for mixed use developments has been assessed under NCM conditions and is represented indicatively as follows:

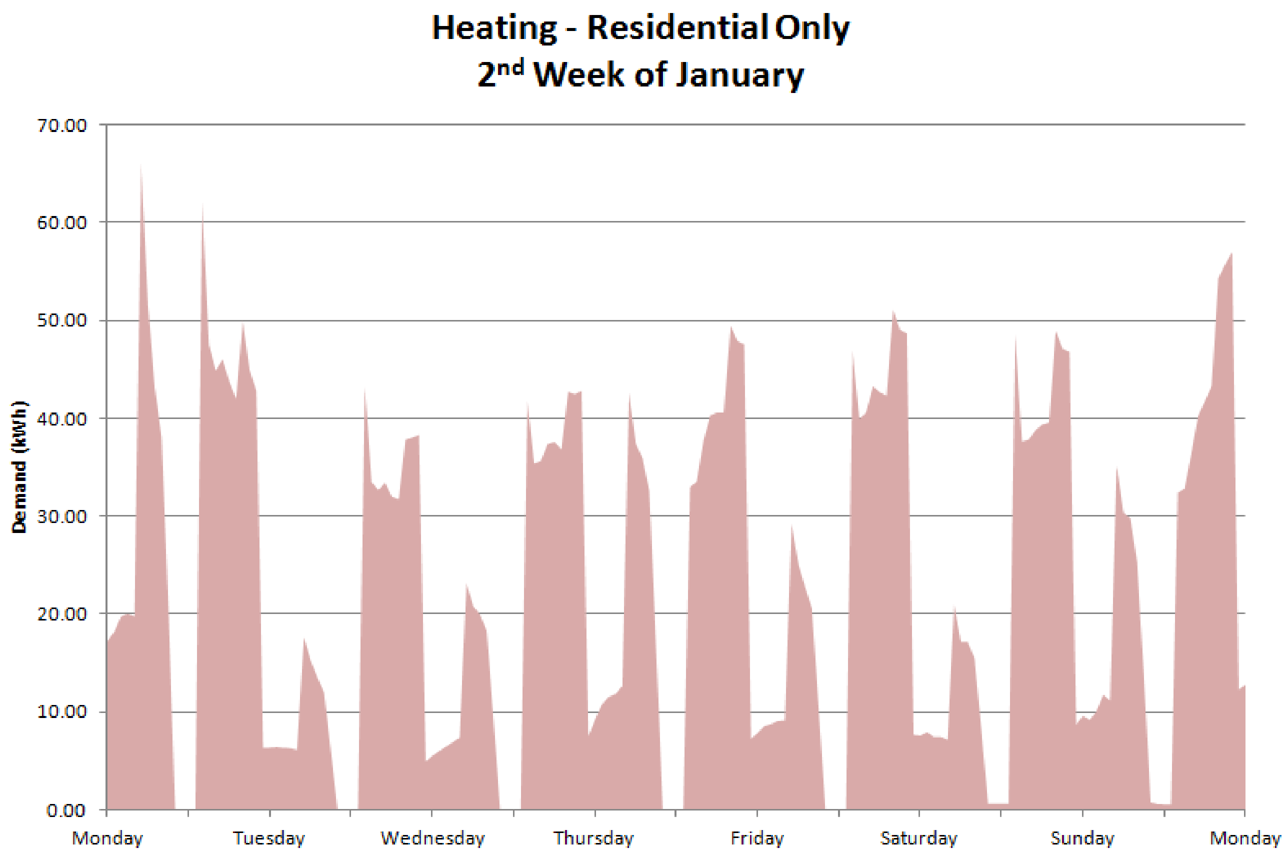


Figure 6.6: *Indicative heating demand of Greenwood Place showing typical 7 days during heating period (based on NCM profiles)*

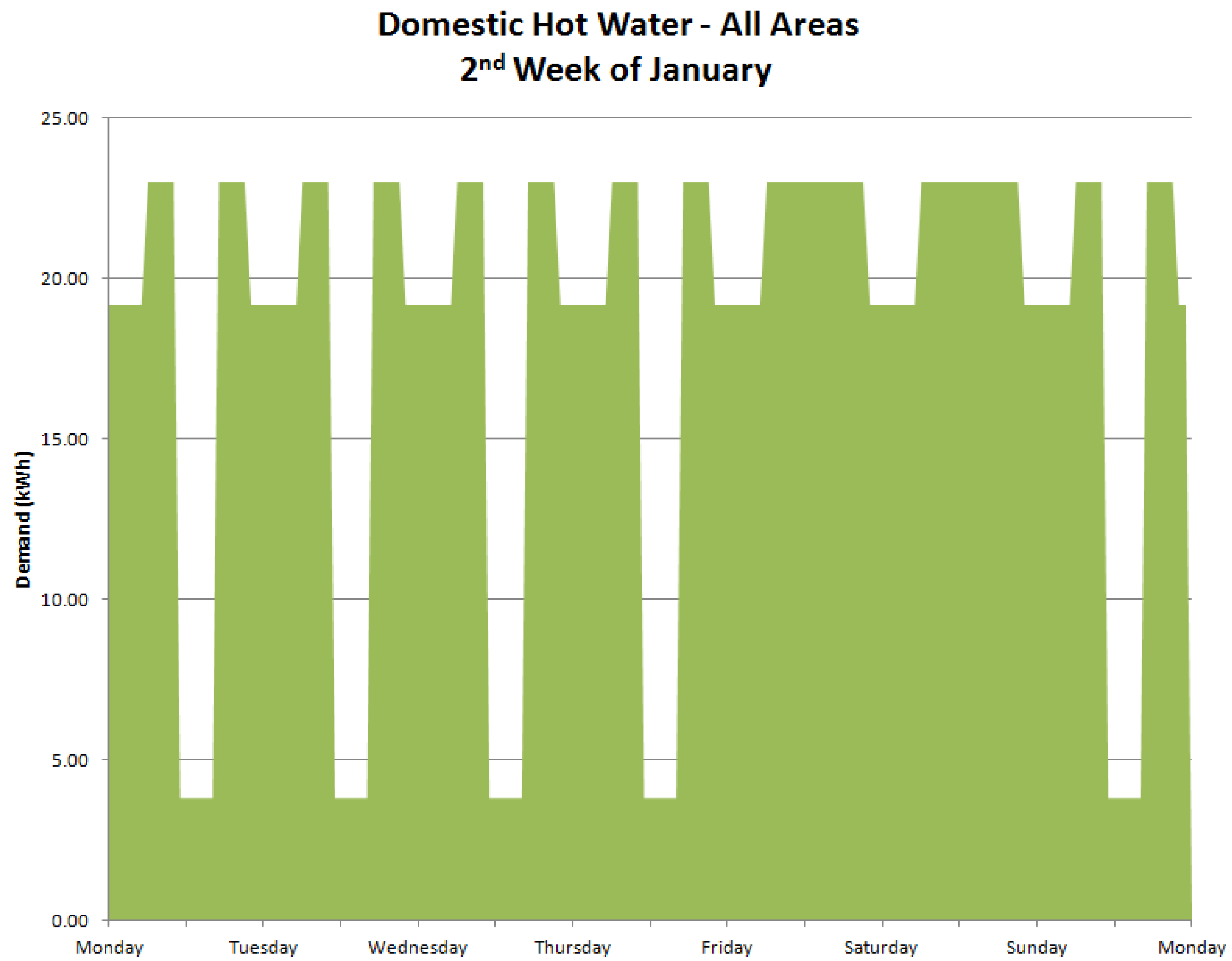


Figure 6.7: *Indicative DHW profile of Greenwood Place showing typical 7 days during heating period (based on NCM profiles)*

The heat load profiles are 'peaky' and therefore require thermal storage in order to enable the CHP to run for appropriately long periods, in order to limit plant depreciation and any increase in emissions from stop/start operation. The development's plant space can accommodate this additional requirement.

CHP is considered to be viable and its estimated key operational specifications are summarised as follows:

CHP summary	Unit	Value
CHP electrical output	kWe	20
High grade heat output	kWh	40
CHP availability	% of year	83%*

CHP summary	Unit	Value
Estimated operating hours	hours/annum	5,600*
Thermal storage capacity	kW hours/annum	*To be determined*
Total electrical output	kW hours/annum	111,587
Total heat output	kW hours/annum	361,865
CO_2 displaced	tonnes CO_2/annum	30.97
CO_2 emissions reduction of the scheme	% of regulated loads	14.35%

**Numbers are indicative only at this stage and based on the NCM profiles. These are preliminary figures which will be further developed at the detailed design stage.*

Figure 6.8 *Proposed CHP system indicative figures*

Is CHP recommended for this development	Yes

7. 'Be Green' (Utilise Renewables)

All of the currently available 'Be Green' or renewable technologies have been assessed in detail for viability within the built environment and for the development.

The following summary table sets out the complete list of potential renewable technologies along with their concluding viability at this design stage of the development. Further details of each technology and their associated assessment in relation to the development are provided on the subsequent sections:

Energy Hierarchy	Design approach /technology	Viable?	Notes	Tonnes/annum CO_2 reduction	% regulated CO_2 reduction	% regulated CO_2 reduction
Be Green	Photovoltaics	No	Electrical Output from CHP anticipated to serve regulated electrical demand from the commercial and residential common areas. PV is not considered viable as it would compete with the CHP for electrical demand.	-	-	**0.77%**
	Solar thermal	No	CHP has been prioritised and sized to serve the hot water demand for the commercial office, Self Storage facility and the residential dwellings.	-	-	
	Biofuelled heating	No	Local urban constraints in relation to air quality and fuel delivery and storage makes biofuel heating an unviable option in this context (Appendix A).	-	-	
	Ground/Water source heat pump	No	This technology is considered unviable due to the limited footprint of the development relative to energy demand and the complexity of contextual and environmental issues of dock water heat pump integration (Appendix A).	-	-	
	Aerothermal energy for heating	Yes	Air Source Heat Pumps (ASHP) have been assessed as a renewable option in heating mode only and considered viable due to its high operational efficiency.	1.42	0.77%	
	Wind power	No	There is considerable evidence of urban wind turbines failing to perform to manufacturer's output estimates. Significant planning and integration issues also exist and consequently wind turbines are not viable (Appendix A).	-	-	
	Hydro/ocean energy	No	Hydro/ocean energy is not appropriate for this urban development due to an absence of the resource.	-	-	

7.1. Aerothermal Energy for Heating (Heat Pumps)

Using ambient air as a thermal resource for a heat pump can provide lower emissions heating, although typically the highest heating loads occur when the outside ambient air temperature, and subsequent heat pump efficiency, is at their lowest. Rejected heat from typical non-domestic buildings are traditionally used for pre-heating of incoming air within a simpler heat recovery system.

Additionally, recovered heat cannot be truly classed as 'renewable' by relevant guidance including BSRIA Guidance BG 1/2008 and EU Directive 2009/28/EC.

Local Planning Issues
Where viable, heat pumps are relatively quiet in operation and are typically contained within plant spaces without any significant impact on the local environment. Any essential pipework will be contained within the building or concealed by being buried.

Grants and subsidies
Compliant and viable air source heat pumps systems benefit from the Renewable Heat Incentive (RHI). Heat pump systems installed on non domestic developments attract an RHI rate of 2.54p per kWh of generated heat.

Integration of heat pumps for heating into the development

Air Source Heat Pumps (ASHP) have been assessed as being the most effective heat pump option in terms of operational efficiency and associated emissions performance. The use of ASHP enables comfort cooling and heating provision for the commercial offices, self storage facility and the cafe with the following advantages:

- There is no limit to fresh air, providing the low grade heat source, so the only practical limit to the heating amount would be the size and cost of the plant;
- Separation of plant for different tenancy arrangement and types of use enables heating and cooling to be provided to the office spaces, Self Storage reception and cafe at a local level, preventing unnecessary and inefficient plant operation of the system when only part of the space is occupied;
- High levels of local control with associated levels of operational energy efficiency;
- Good controllability and turndown capability, enabling small loads to be served efficiently;
- Small packaged plant suitable for the restricted plant space;
- Whilst ASHP can have lower performance than ground source options during very cold weather, however, they have improved efficiencies during milder weather which occurs for a more significant proportion of the year.

The efficiency of the mechanical systems has been carefully assessed and selected to exceed Part L2A:2013 minimum compliance requirements. High efficiency Air Source Heat Pump systems are selected to provide heating and cooling and their indicative savings are indicated in the table below. Please note that savings reported in this section reflect the operation of the heat pump in heating mode only.

ASHP performance summary	Unit	Value
System Efficiency (Offices and Self Storage)	-	SCOP: 5.4 SEER: 7.4
System Efficiency (Cafe)	-	SCOP: 3.5 SEER: 4
CO_2 displaced	tonnes CO_2/annum	1.42
CO_2 emissions reduction of the scheme	% of regulated loads	0.77
CAPEX (approximate)	£	*To be calculated*
Renewable Heat Incentive rate	p/ kWh	2.57*
Indicative payback	years	*To be calculated*

**Tariffs that apply for installations with an accreditation date on or after 1 October 2016*

Is an air source heat pump installation recommended?	Yes

8. Summary

This Energy Strategy has assessed all opportunities under the 'Energy Hierarchy' in order to target the overall reduction of CO_2 emissions, in compliance with relevant policy and guidance detailed in section 2.

All viable measures for the development and their CO_2 emissions reduction contribution are summarised in the following table:

<table>
<tr><th>Energy Hierarchy</th><th>Design approach /technology</th><th>Notes</th><th>Tonnes/annum CO_2 reduction</th><th>% regulated CO_2 reduction</th></tr>
<tr><td>Baseline</td><td colspan="3">The outline design of the scheme has been optimised for energy and CO_2 emissions performance across all stages of the best practice 'Energy Hierarchy'.
These identified measures and associated levels of CO_2 emissions reduction (estimated via dynamic thermal modelling and SAP) will be used to inform the detailed design of the evolving Greenwood Place scheme</td><td>-</td></tr>
<tr><td rowspan="5">Be Lean</td><td>Optimised glazing/facade</td><td>High performance building fabric, including low U-values, thermal bridging and air-permeability;
Dwellings compliant with Part L1Aoverheating requirement and commercial compliant for summer and winter thermal comfort using the Design Summer Year;
Majority of dwellings compliant when assessed under the CIBSE TM 52 'The Limits of Thermal Comfort: Avoiding Overheating in European Buildings' overheating methodology;
Solar control glass (g-value ≤ 0.42) for commercial and residential;
Balcony shading for living areas.</td><td rowspan="5">0.89</td><td rowspan="5">0.41%</td></tr>
<tr><td>Lighting</td><td>High light transmittance glass;
Energy efficient lighting;
Automated controls in common areas.</td></tr>
<tr><td>HVAC plant</td><td>Mechanical ventilation with heat recovery in dwellings
Mechanical ventilation with heat recovery where applicable in offices and Self Storage facility</td></tr>
<tr><td>Cooling</td><td>Highly efficiency VRF System to serve the cooling requirement for the offices, Self Storage facility and cafe.</td></tr>
<tr><td>Resident education/ Tenant fit out and unregulated energy and emissions management</td><td>A home/ building user guide will be handed over to tenants and will contain recommendations on how to reduce unregulated energy consumption through the procurement of energy efficient equipment.</td></tr>
<tr><td>Be Clean</td><td>CHP & future connectivity to district heating / cooling network</td><td>Gas-fired CHP with backup boilers;
Adoption of a robust approach to enable future connectivity to any forthcoming district heat network.</td><td>30.97</td><td>14.35%</td></tr>
<tr><td>Be Green</td><td>ASHP</td><td>ASHP has been proposed to serve the heating requirements for the relevant areas in the office and Self Storage.</td><td>1.42</td><td>0.77%</td></tr>
<tr><td>Total Energy Hierarchy</td><td colspan="3">The optimised Energy Strategy of Greenwood Place will allow the development to achievement an improvement over Part L:2013 of 15.35%</td><td>15.35%</td></tr>
</table>

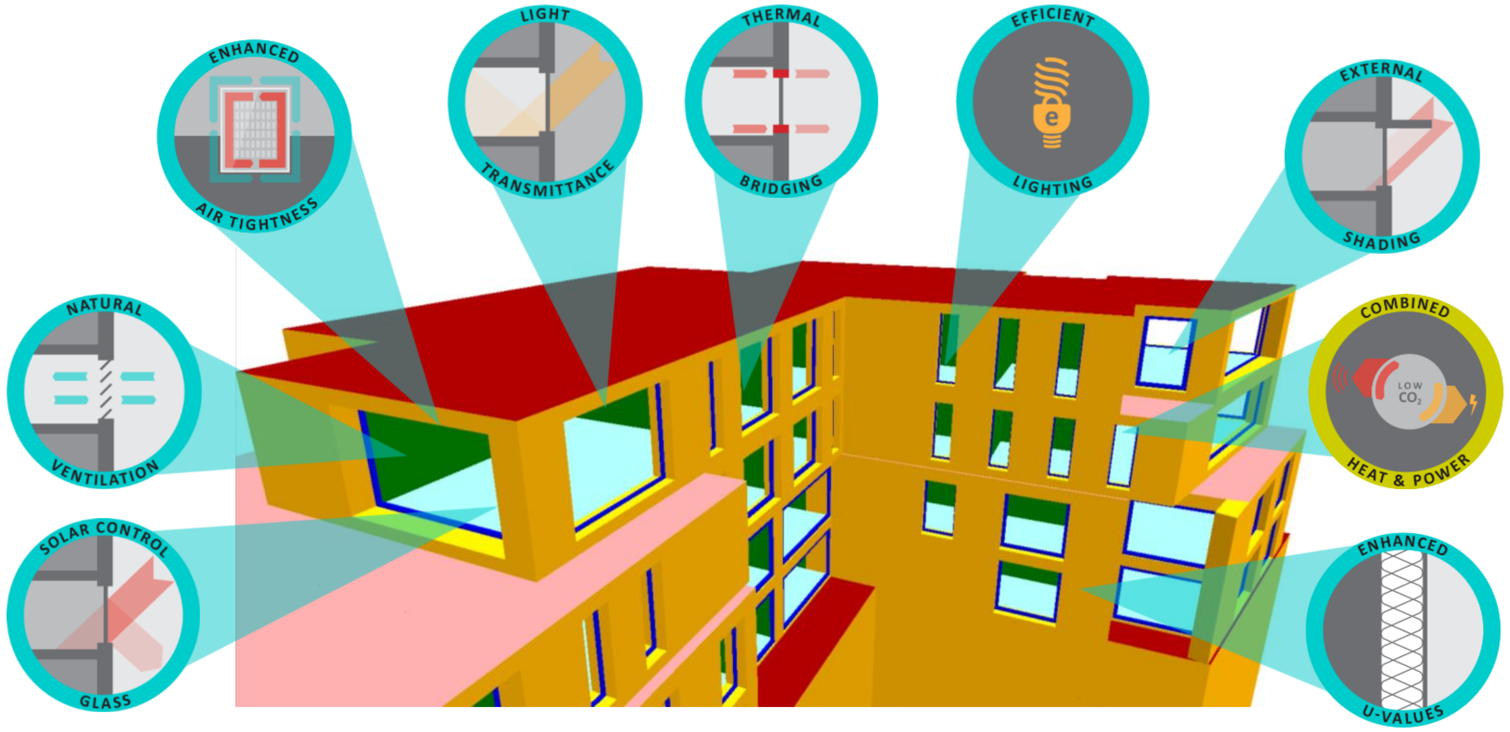


Figure 8.1 Energy strategy measures incorporated in the residential component of the scheme

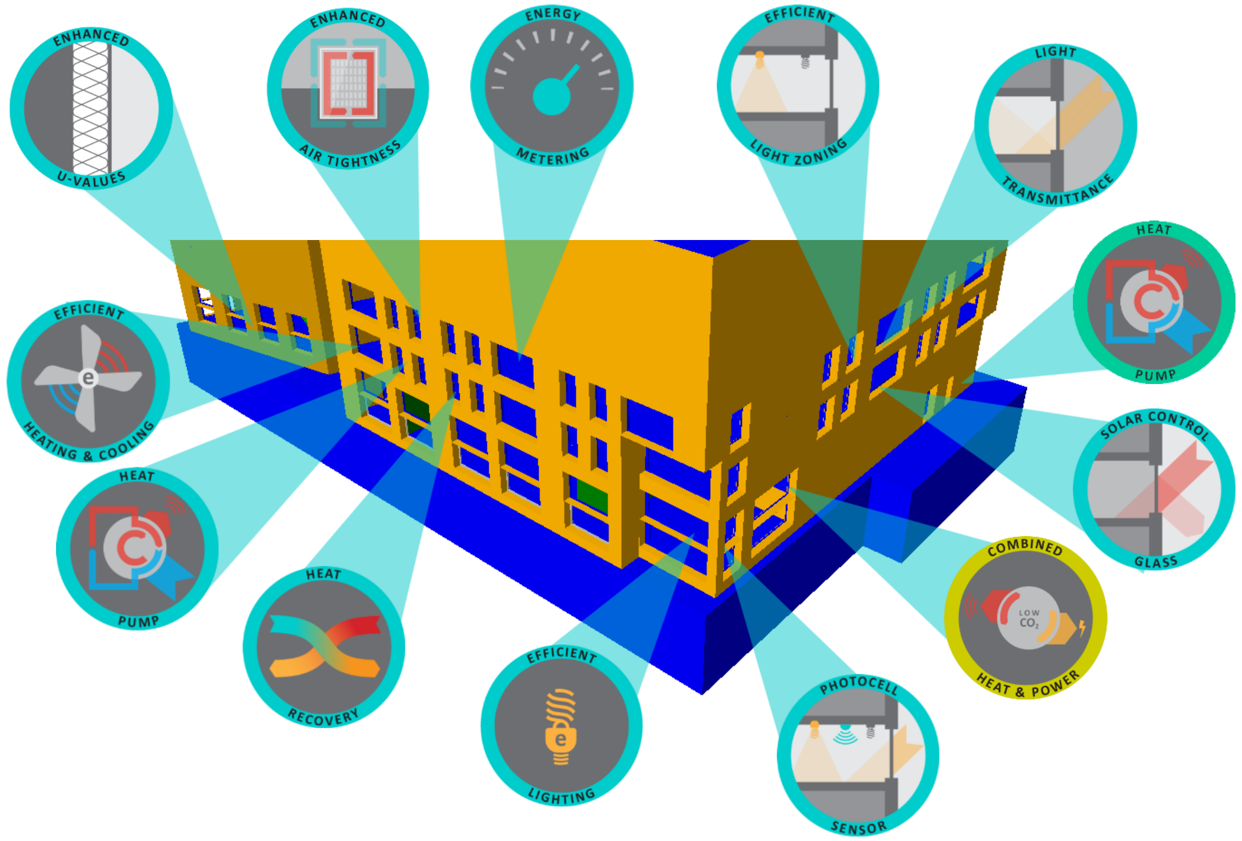


Figure 8.2 Energy strategy measures incorporated in the commercial component of the scheme

Appendix A: Unviable Low and Zero Carbon Technologies

Combined Cooling Heat and Power (CCHP)

The potential integration of a CHP plant (either traditional gas fired engine or fuel cell), with which to drive an absorption chiller to provide cooling along with power from site based plant, has been considered for the development, in compliance with industry best practice and appropriate planning policies. This arrangement of CCHP is also referred to as tri-generation.

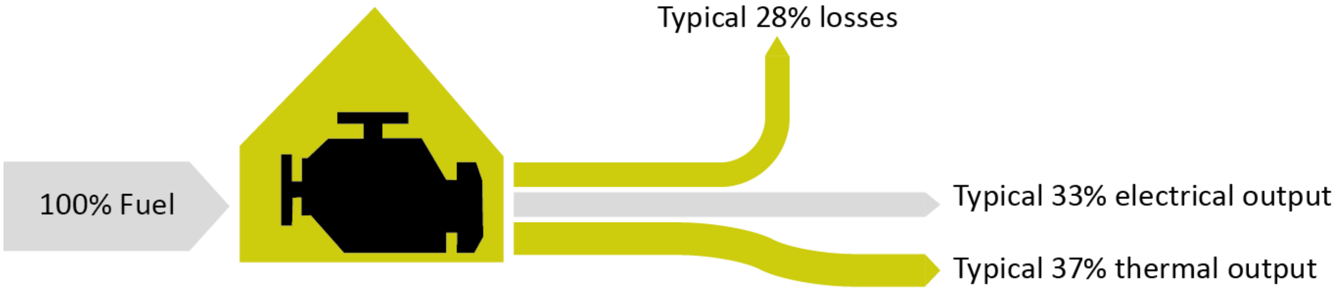


Figure 0.1 *Typical energy proportions generated by a CCHP arrangement*

Decentralised CCHP recovers the waste heat from a site based power generation prime mover (either a conventional natural gas fired engine or fuel cell) via the engine water jacket, exhaust gases and oil cooler (dependent on model). This heat is then used to drive an absorption chiller, the efficiency of which depends primarily on the temperature of the heat source, with typical absorption chiller coefficient of performance tending to be in the low range of 0.7 – 1.1.

Where optimised, this can provide lower cost heat, cooling and electricity, potentially with lower CO_2 emissions than the electricity grid. However, it is essential that the plant is optimised with regards to maintaining constantly high loads and extended operating periods throughout the year, with industry best practice and CIBSE guidance advising minimum viable operating periods of typically greater than 4,000-4,500 hours per annum. Absorption chillers in particular do not operate efficiently or reliably with erratic loads or stop-start operation, thereby requiring relatively consistent cooling baseloads and/or significant thermal storage.

CCHP viability is highly sensitive to the CO_2 emissions factors per unit of primary energy, which are considered under both the current published Part L figures, but also by undertaking high level predictions of future emissions for the anticipated life of the plant. CHP and absorption chiller plant life is typically 20 years.

Local Planning Issues
Air quality issues must be considered early on and in detail when assessing CCHP viability for a development. Measures that should be adopted include careful plant selection, operating a plant efficiently to prevent start-stop operation, flue location and flue gas treatment, where viable. An air quality assessment and associated discussions with the local authority will be required at an early opportunity.

Feasibility for the scheme

- The cooling demand for the development is expected to be low due to the limited commercial floor area.
- Absorption chillers are best selected to meet the cooling baseload, with high efficiency vapour-compression chillers making up peak cooling loads and standby cooling under maintenance conditions; consequently theoretical savings are only made with respect to baseload cooling which accounts for only a fraction of the cooling load;
- Extended yearly plant operation is required in order to provide worthwhile emissions reductions, with continuous and significant cooling baseloads. Low cooling loads and not throughout the whole year are expected to be required for this project;
- Absorption chillers have lengthy lag times and are therefore not appropriate for continual start/stop operation or wide variation in loads;
- The heat rejection from an absorption chiller will be greater than that from an equivalent vapour-compression chiller, for the same output of cooling. This will require greater heat rejection plant and systems, and may increase this scheme's impact on the 'heat island effect';
- Carbon dioxide emissions reductions can be very low to zero over the proposed high efficiency vapour compression chillers, depending on operational parameters and on fuel or energy carbon factors:
- Overall, revised emissions factors have essentially resulted in tri-generation becoming significantly less effective in reducing emissions. This applies across all CCHP technology types (micro-turbine CCHP, reciprocating SI CCHP and fuel cell CCHP);
- Decarbonisation of the electricity grid is expected in the medium term and particularly within the lifespan of any CCHP plant. This is driven by the replacement of ageing power stations with higher efficiency modern plant, an increase in low carbon and renewable energy systems contributing to the grid, along with government policy. Likely trends in grid supply are indicated by a number of documents including DECC's 'Updated energy and emissions projections '.Their predictions indicate 'dirtier' power generators being replaced by 'cleaner' ones;
- Additionally, the CLG report 'Zero carbon in non domestic buildings' projects a reduction in the grid electricity factor of 20.3% by 2019. Consequently, consideration should be given to a reduction in grid electricity factors whilst undertaking CCHP assessments;
- Any future minor reductions in the grid electricity emissions factor would render a proposed CCHP system carbon positive.
- Overall, cooling load profiles with wide daily variations are difficult to match with absorption chillers, unless high base load cooling demand exists. This is not the case within this scheme, consequently emissions savings are not possible with tri-generation plant, either using a traditional prime mover or a fuel cell, with the real risk that overall emissions related to cooling provision will actually increase.

Is CCHP recommended for this development	No

Ground/Water Source Heat Pumps

Heat pumps, utilising low grade, aerothermal, ground source or recovered heat, can potentially provide high efficiency, low carbon heating and/or cooling. Utilising low grade heat enables the heat pump to operate at higher efficiencies, as well as potentially recovering 'waste' heat, that may otherwise be rejected, for beneficial use.

Closed loop GSHP
The potential for ground source heat pumps (GSHP) to provide heating and cooling for this development has been reviewed and is considered an unviable option at this stage due to the limited site footprint and the large floor area to footprint ratio, meaning that the building demand for heating and cooling will be far greater than could be supplied by a GSHP.

Open loop boreholes, GSHP and integration
An 'open loop' borehole system requires groundwater to be pumped to and from boreholes, in order to support the cooling system via a heat exchanger and chilled beam or a pre-cooling or pre-heating arrangement.

Open loop boreholes incorporate a number of technical challenges. These include minimum borehole separation requirements, potentially not being met due to the site's footprint. An extended level of pre-assessment of potential boreholes is required, which may impact on construction programmes. Several stages of ground condition analysis are necessary.

There are also high capital costs of borehole drilling, with other licensing costs applicable and limitations to abstraction volumes, with the potential reduction in the quality and quantity of water abstracted over time.

Again, the high floor area to footprint ratio for a 16 storey building means that extracting sufficient quantities of water to meet the building's heating and cooling demands is likely to be highly impractical.

Water source heat pumps for cooling
The potential to access the cooling potential of the adjacent dock basin has been considered.

There is very little circulation in the dock area compared to, say, a fluvial situation, and so heat rejection relies heavily on surface heat transfer, and therefore the local microclimate. The fluvial exchange towards the North of the dock should help control the temperatures. Factors that will determine the viability of this approach are seasonal thermal capacities and permissible temperature limits. In addition, a calculation about the impact on dock water ecology and quality will be required by the environment

The cooling demand for the Proposed Development is expected to be too low for dock water cooling to be a viable option.

Local Planning Issues
Heat pumps are relatively quiet in operation and are typically contained within plant spaces without any significant impact on the local environment. Any essential pipework will be contained within the building or concealed by being buried.

Grants and Subsidies
Compliant heat pumps systems benefit from the renewable heat incentive (RHI).

Tariffs that apply for installation with an accredited date on or after 1 October 2016	Eligible sizes	p/KWh
Ground-source heat pumps & Water-source heat pumps	all capacities Tier 1	8.95
	Tier 2	2.67

Table 0.1 *Non-domestic RHI for PV Ground/Water Source Heat Pumps*

Applicability for the scheme
Ground source heat pumps have been deemed to be impractical due to small site footprint (relative to the treated floor area of the building).

Is a ground source heating system installation recommended?	No

Photovoltaics (PV)

Photovoltaic cells directly convert sunlight into electrical current using semi-conductors. The output of a cell is directly proportional to the intensity of the light received by the active surface of the cell. Exposure to sunlight causes electricity to flow through the cells. Direct sunlight produces the greatest output, but power is produced even when overcast.

- Photovoltaic panels can either be integrated modules (incorporated into glazing, the facade or roof tiles of a pitched roof, etc) or mounted in angled arrays on a flat roof.
- PV modules are based on silicon cells are the most common type, with corresponding cost and performance benefits: Poly-silicon panels are moderately cheaper with corresponding lower performance; Mono-silicon panels are more expensive but with higher levels of performance.
- Electrical integration – electricity from the PV array is fed via inverters into the distribution network of the building where it is anticipated the majority of the electricity will be consumed. A further connection will enable unconsumed electricity to be sold back to the electricity grid.
- Optimum electrical output is obtained from:
  - PV panels facing +/- 45° of South.
  - PV panels are inclined at 10° to 30° from the horizontal, thereby optimising electricity generation and allowing the self-cleaning by the action of rain.
- Shading – it is important to avoid locating PV on surfaces that are permanently shaded, even transient shadows should be avoided where possible.
- Ventilation of the panel and location over green roofs can enable the PV panel to remain cooler, so improving its performance.
- Panels are typically warranted for 20 years.

Local Planning Issues
Roof mounted PV panels, particularly angled arrays, must not exceed the maximum design envelope imposed on the development. Safe access around the panels and to other roof plant should be maintained.

Integration of PV onto building
Limited roofspace in urban environments

Grants and Subsidies

The following table sets out the tariff rates for the Feed-in Tariff scheme from 1 October 2016 but before 31 December 2016, for photovoltaic installations only. (See Table 0.2 below).

Ofgem Tariffs for Installations with an eligibility date on or after 1 Oct to 31 Dec 2016 (p/kWh, 2016/17 values)	
<10 kW	4.18
10 – 50 kW	4.39
50 – 250 kW	2.03
250– 1 MW	1.69
> 1 MW	0.57

Table 0.2 *Proposed consultation feed-in tariffs for PV systems*

Applicability for the scheme
Electrical Output from the CHP is anticipated to meet the electrical demand from the commercial and residential common areas with any surplus electricity exported to the grid. Electrical output from the PV would compete with the CHP and is not recommended.

Is integrated PV recommended?	No

Solar Thermal Systems

A solar thermal array converts sunlight into heat, typically to integrate into a building's hot water service. The system can be further supported by traditional 'top up' boilers when the solar resource is insufficient or the relative hot water demand is too great for the solar thermal system alone to support.

A solar water heating system usually consists of solar collector(s) that absorbs solar energy, a hot water storage tank, a back-up energy source, a pump and controls. Performance of solar thermal systems can vary depending on the technology and the location, with a typical installation being an angled array that is roof mounted.

Optimum solar collector thermal output is obtained from:

- Panels facing +/- 45° of South.
- Panels are inclined typically at 30° from the horizontal, thereby optimising heat generation and allowing self-cleaning (particularly of flat panels) by the action of rain.
- It is important to avoid locating solar thermal panels on surfaces that are permanently shaded, even transient shadows should be avoided where possible.
- The two main types of solar thermal collectors are;
- Flat Panel collectors (typically less efficient but less expensive)
- Vacuum tube collectors (typically more efficient but more expensive)
- Solar thermal panel lifespan is typically 25 years.

Integration of a solar thermal system into the development

- System integration – solar hot water systems work in combination with traditional hot water systems. A back up domestic hot water system, including hot water storage, is required to match seasonal variations in solar energy and hot water demands. A controls system should ensure the solar thermal output is optimised and overall CO_2 emissions relating to the hot water is minimised.
- The solar thermal panels can be roof mounted in arrays, with a layout to ensure sufficient maintenance access is provided, as well as to avoid shading from fixed objects and to prevent self-shading.
- Consideration is given for both competition for roof space relating to other essential plant, along with heat load competition from other low carbon heat sources, such as CHP.
- Maintenance for solar thermal systems is relatively straightforward, involving cleaning the collectors on an annual basis, as well as confirming the system's mechanical and controls operation and water quality.

Local Planning Issues

Roof mounted solar thermal panels must not exceed the height restrictions imposed on the development. Safe access around the panels and to other roof plant should be maintained.

Grants and Subsidies

Solar thermal systems of up to 200kW$_{th}$ are eligible for the renewable heat incentive (RHI). Eligible solar thermal systems attract an RHI rate of 10.16p per kWh of generated heat.

Applicability for the scheme

Specific issues relating to the scheme that will impact on the successful integration of solar thermal systems, include:

- Heat load competition with proposed gas-fired CHP plant
- Potential limited consistent average hot water demand.
- Relatively long pipework runs with associated parasitic losses.
- Solar thermal systems tend to be bulkier with corresponding integration and maximum roof height and structural load issues becoming more significant.
- The daily solar output would not match the load profiles and therefore require significant solar thermal storage and associated plant space; plant space is limited.

Is a solar thermal system installation recommended?	No

Biofuel



Biofuels 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, in place of fossil fuels. 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. CO_2 emissions attributed to bio-fuels are those associated with the collection, processing and distribution of the biofuels, and are available as liquid or solid fuels.

- Liquid fuels are generally named biodiesel and are available in various blends with traditional fossil fuel oil, up to 100% biofuel (B100). Biodiesels can be produced from virgin crops or by recycling waste oils.
- Solid biofuel or biomass is typically wood chips or wood pellets. Wood pellets have a greater density and subsequent heat to volume ratio, with benefits regarding on site storage requirements. They also ‘flow’ better, improving the delivery process, but carry a cost premium over wood chips.
- Other biofuels broadly include biogases from waste, sewage or landfill gas processes. However, this is not usually available or compatible with the urban built environment.
- The actual biofuel availability and cost cannot be guaranteed due to variations in fuel stock supplier, demand, the energy input in processing the fuel and CO_2 emissions due to growing, harvesting, processing and delivering the base fuel.
- Whilst biomass boilers have efficiencies on a par with more traditional natural gas fired boilers, CO_2 emissions benefits can be realised due to the significantly lower emissions attributed to this more sustainable fuel source, over traditional fossil fuel.
- Transporting this type of fuel could potentially increase lorry movements into and out of urban areas, affecting congestion and transport emissions. However, indicative estimates of fuel deliveries are likely to be modest.
- Socio-economic issues are considered from growing and harvesting the feedstock, with potential impacts on food production, particularly for biodiesel that is imported. Solid biofuels have a lesser impact in this area, which can be further mitigated via the use of carefully selected and approved suppliers. ‘Second generation’ fuel supplies, carefully provided through non-food source routes and respected suppliers, have significantly improved sustainability credentials.
- Costs of fuels are currently greater than more traditional fossil fuels, which are factored into the assessment. Whilst electricity and gas costs will almost certainly continue to increase in the future, this impact on the cost of biofuels is uncertain.
- Biomass boilers have a typical lifespan of 20 years. Biomass CHP units sized for typical developments tend to be less commercially proven, with product and plant sizing being limited to certain sizes. Maintenance and reliability issues remain a key factor in specifying biomass CHP, which subsequently carry a greater risk.

Local Planning Issues

- There are potential air quality considerations with combusting bio-fuels in urban areas, in particular the potential risk of minor increases in NOx emissions and particulates. These will need to be addressed via appropriate plant selection, flue location, mitigation measures and a detailed air quality assessment.
- The frequency of fuel deliveries will be calculated with respect to on site storage space and also be optimised to prevent any nuisance noise. Travel distances of fuel suppliers will be considered; plant will be located and selected under an acoustic review.

Grants and Subsidies

Technology & Renewable Heat Incentive (RHI)	Capacity	RHI p/KWh
Small biomass	<200 kWth	4.43
Medium biomass	200 – 600 kWth	3.47
Large biomass	>=600 kWth	1.30

Table 0.3 *Renewable heat incentive payments for biomass systems (Tariffs that apply for installations with an accreditation date on or after 1 October 2016)*

Integration of biofuel boilers onto the development

- There are potential air quality issues with combusting biofuels, in particular elevated NOx and particulate emissions.
- Potential plant space limitations, with corresponding integration issues for any biomass unit and associated distribution systems.
- Biodiesel may be better suited to the transport industry rather than heating applications.
- The requirements for fuel handling, regular deliveries, storage and combustion for wood chip and wood pellet applications are not considered to be practical for the development.
- Fuel supply uncertainties and associated elevated costs over traditional fuels add risk and cost.
- Increased plant maintenance is generally required, adding to costs and plant down-time.
- Consequently, performance assessments of any bio-fuel technologies are not appropriate to the proposed development and are subsequently considered unviable.

Is a biomass boiler recommended?	No

Wind Power

Wind turbines have the potential to generate renewable electricity, using turbine blades to capture the wind in order to turn a generator. Wind turbines have been designed and sized to suit the urban and rural environment, as well as the more traditional larger machines serving the electricity grid. However, it is important that a conservative and detailed assessment approach is taken for both the technical and planning criteria, when reviewing the viability of integrating wind turbines within the built environment.

- Turbines sized for the urban environment are likely to produce very modest power outputs and corresponding reduction in the sites total CO_2 emissions. Turbulent air is likely to increase turbine wear and noise.
- Turbulence from building density will affect 'clean' air streams and reduce turbine output.
- There is currently considerable evidence of urban wind turbines failing to perform to manufacturer's output estimates. Urban wind turbines are rarely successful from an integration, technical or planning perspective.
- All turbines have a minimum wind speed necessary to start the turbine as well as to generate useful levels of power; minimum wind speeds depend on the turbine size and type. Where wind speeds are consistently below this target throughout the year, as can be the case within the urban environment, the turbine will not turn and may present the 'wrong' sustainability image for visible turbines.
- Desktop wind speed analysis tools are available in order to provide initial technical viability analysis.
- Wind turbines have a typical lifespan of 20 years.

Integration of wind power into the development

- Taller masts would be necessary in order to improve air speed availability, quality and turbine output, with resulting architectural and townscape conditions, along with structural and maintenance access impacts.
- Wind turbines are likely to be better suited to the rural environment, rather than the urban environment.
- Where viable, wind power generated renewable electricity is connected to the building's electrical LV panel via dedicated inverters, which can also meter, report and export the electricity generated. Turbines related to the built environment are generally sized to serve part of the estimated electrical load without the need for export.

Local Planning Issues

- Significant planning issues are likely to exist for wind turbine masts proposed within this urban and London location, with respect to height and townscape impact issues. Turbines located within the urban environment can also result in blade flicker and stroboscopic effects under certain conditions.

Grants and Subsidies

Technology	Capacity	FIT p/KWh
Small-Medium wind turbine	<=50kW	8.33
Medium turbine	50-100kW	6.75
Large	100kW-1.5MW	4.35
	>1.5 MW	0.83
Export tariff	-	

***Table 0.4** Current feed-in tariffs for wind power systems (1 October 2016 to 31 December 2016)*

Applicability for the scheme

Due to major practical reasons and the limited potential CO_2 savings achievable by this technology, wind power is not considered suitable for the zero carbon electricity supply of the development.

Is a wind turbine installation recommended?	No