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Energy Statement
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5-17 HAVERSTOCK HILL
FINAL ENERGY STATEMENT FOR PLANNING

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FINAL ENERGY STATEMENT FOR PLANNING

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No responsibility is accepted for the advice of the Client's independent consultants which may be reflected in our own reports.

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EXECUTIVE SUMMARY

ChapmanBDSP has been appointed to provide an Energy Statement to support the forthcoming planning application for the proposed mix-use development at 5-17 Haverstock Hill, located in the London Borough of Camden. This report has been developed to detail the energy strategy for the development and demonstrates how it relates to the following guidance documents:

- National Planning Policy Framework (2012);
- London Plan and minor alterations (2016);
- Greater London Authority (GLA) guidance on preparing energy assessments (April 2015);
- London Borough of Camden Core Strategy (2010) - Policy CS13: 'Tackling climate change through promoting higher environmental standards';
- Camden Development Policies (2010-2015) – Policy DP22: 'Promoting Sustainable Design and Construction';
- London Borough of Camden Planning Guidance CPG 3 – Sustainability (2015)).

The Approved Document Part L1A:2013 / Part L2A:2013 assessments and results have been used as a starting point for this analysis as per London Plan Policy 5.2: 'Minimising carbon dioxide emissions' guidance.

The Energy Strategy for the scheme has been developed following the principles of the London Plan Energy Hierarchy: 'Be Lean', 'Be Clean' and 'Be Green' also detailed in Camden Planning Guidance CPG 3 – 'Sustainability'. The overriding objective in the formulation of the Energy Strategy for the scheme has been to maximise the viable reductions in total carbon dioxide emissions from the development within the framework of the energy hierarchy:

'Be Lean': The proposed energy strategy has, as its first priority, minimised energy consumption through the performance of the building envelope, facades and plant. The energy efficiency features proposed for the scheme include optimised thermal performance of the facade, low air permeability through a very high standard of construction. The development will meet or exceed all of the building fabric performance standards suggested within Camden guidance document CPG 3 and exceed the minimum requirements of Part L1A and L2A for fabric efficiency standards. The proposed energy conservation measures will reduce the regulated carbon dioxide emissions of the scheme in comparison to the 2013 Building Regulations compliant case by approximately **6.1%**. The 'Be Lean' approach has also followed the cooling hierarchy sets out in London Plan Policy 5.9: 'Overheating and Cooling'.

'Be Clean': The use of Combined Heat and Power (CHP) has been assessed and it has been determined that due to the consistent base heating load throughout the year (hot water load), CHP would be suitable as the lead heat generator in combination with communal gas boiler sized to provide **70% of the heating demand of the scheme**. The proposed CHP unit is expected to reduce carbon dioxide emissions in comparison to the 2013 Building Regulations compliant case by approximately **26.5%** for the whole development. The opportunity for the proposed development to link into an existing or planned decentralised energy network has been reviewed but the London Heat Map tool indicates that there is no proposed decentralised heat network within proximity of the site. The scheme will however be future-proofed to ensure it can connect in the future to the Community Energy Scheme (space for heat exchangers, pipes routes, water based centralised heating system).

'Be Green': A feasibility study has been undertaken to establish the most suitable renewable technology for integration at the proposed development. Due to practical constraints, photovoltaics arrays on the flat roofs of the scheme located on tilted structure orientated South and South-West are considered as the most viable and practical option for the scheme. A 150 m² photovoltaic system mounted on the tilted south-orientated roof of the scheme, combined with the 'Be Lean' energy conservation measures and 'Be Clean' CHP system will provide a further **4.3%** reduction in the CO_2 emissions over the Building Regulations compliant case.

The proposed highly optimised energy strategy based on passive design, building fabric performance and building services systems and controls, and suitable Low and Zero Carbon (LZC) systems will allow the scheme to achieve an improvement over Part L1A: 2013 and Part L2A:2013 of approximately **36.9%** exceeding the requirement of the London Plan (Policy 5.2: 'Minimising Carbon Dioxide Emissions') and of the London Borough of Camden Core Strategy (2010) (Policy CS13: 'Tackling climate change through promoting higher environmental standards') and London Borough of Camden Planning Guidance CPG 3 – Sustainability (2015). Please refer to Table 11 and Figure 16.

It is worth noting that due to the current calculation methodology used for Part L compliance and the GLA Energy Assessment methodology, the CO_2 savings achieved through the provision of energy efficient appliances (unregulated loads) and the implementation of an energy management system for the scheme are not included in the conservative CO_2 savings presented in this report. It is however expected that this scheme will lead to unregulated CO_2 emissions significantly lower than those of a standard scheme.

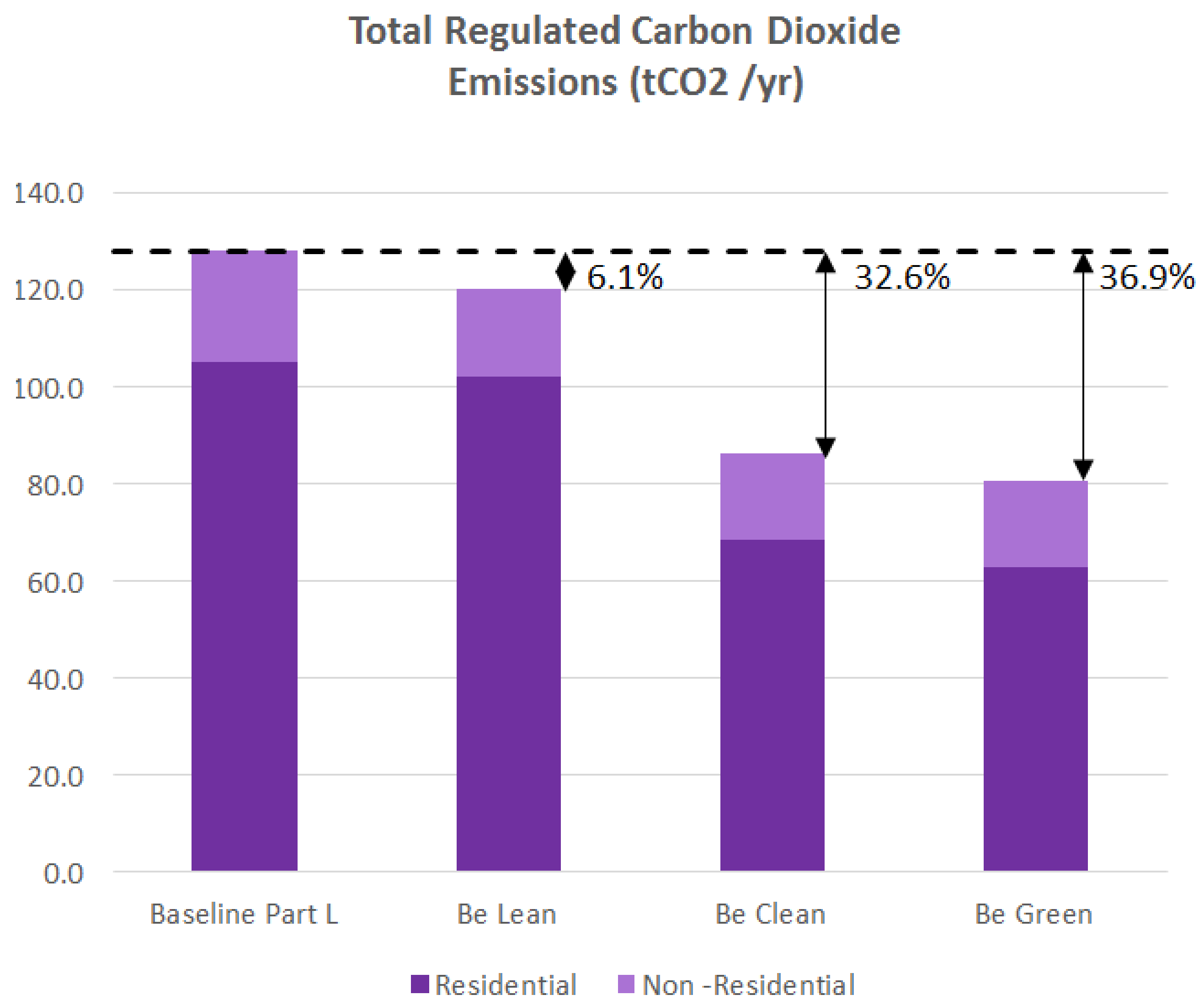
The energy strategy of the scheme has considered measures to adapt and mitigate effects of climate change, in particular through an optimised design minimising risk of overheating (compliant with the London Plan Cooling Hierarchy) and the specification of energy efficiency systems and LZC leading to significant CO_2 emission reductions compared to the baseline **(47.2 tonnes of CO_2/yr).** The table and figure below summarises the energy and CO_2 emission reductions for the stages of the energy hierarchy for the proposed development.

CARBON DIOXIDE EMISSIONS AFTER EACH STAGE OF THE ENERGY HIERARCHY	CARBON DIOXIDE EMISSIONS (TONNES CO_2 PER ANNUM)	
	REGULATED	UNREGULATED
Baseline: Part L2A:2013 - Building Regulations Compliant Development	127.97	451.07
Be Lean - After energy demand reduction	120.19	451.07
Be Clean - After CHP	86.29	451.07
Be Green - After PV	80.74	451.07

Copy of Table 11: Proposed Energy Strategy - London Plan - Energy Hierarchy – Regulated and Unregulated CO_2 emissions

REGULATED CARBON DIOXIDE SAVINGS FROM EACH STAGE OF THE ENERGY HIERARCHY	REGULATED CARBON DIOXIDE SAVINGS	
	TONNES CO_2 PER	%
'Be Lean' - Savings from energy demand reduction	7.8	6.1
'Be Clean' - Savings from CHP	33.9	26.5
'Be Green' - Savings from Renewable Energy	5.6	4.3
Total cumulative savings	47.2	36.9

Copy of Table 12: Proposed Energy Strategy - London Plan - Energy Hierarchy – Regulated CO_2 emissions reductions



Copy of Figure 16: London Plan - Energy Hierarchy – Proposed Energy Strategy

1 INTRODUCTION

ChapmanBDSP has been commissioned by CBRE to provide an Energy Statement in support of the detailed planning application for the proposed development at 5-17 Haverstock Hill (NW3 2BP) in the London Borough of Camden.

1.1 SITE LOCATION AND DESCRIPTION

The Site, as shown on Figure 1, is located in Chalk Farm, north London, within the London Borough of Camden (LBC). It is located northwest of Camden town centre and approximately 4km north of the city of London.

The Site is bounded by residential development to the North-west, Haverstock Hill to the North-east and Adelaide Road to the south. The surrounding area is predominantly comprised of residential developments with buildings of two to three storeys. Chalk Farm London Underground station is situated directly adjacent to the Site, and Haverstock School Business and Enterprise College is located close to the Site on Haverstock Hill. A protected retail parade comprising six retail units currently forms the southern boundary of the Site which fronts Adelaide Road.

The current Site comprises a 2,070m² quadrilateral parcel of land north of Adelaide Road. The current property at the Site is a six storey purpose built brick building for the storage of vehicles, with ten staggered parking levels inside the property. The Site has been vacant since Summer 2015 but was formerly used as a car storage facility by the British Transport Police, with the property containing 227 car parking spaces and ancillary office space. Six A1 retail units totalling 428m². remain operational and are located at ground level fronting Adelaide Road.

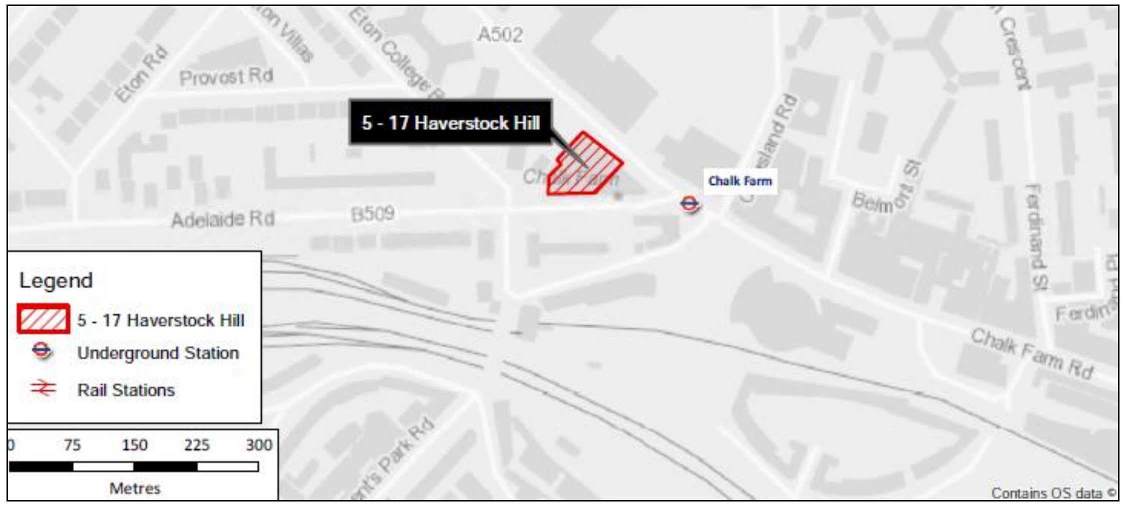


Figure 1: Site Location

1.2 PROPOSED DEVELOPMENT

The scheme consists of the demolition of the existing building at 5-17 Haverstock Hill and redevelopment of the site to provide 77 residential units (8 x studios, 18 x 1 bedroom, 32 x 2 bedroom, 19x 3 bedroom) in two 7 storey blocks around a central raised courtyard and reception. The proposals include the re-provision of 283 m² retail floorspace at ground floor level on Adelaide Road. The proposed development will include residential (C3) and retail (A1- A5).

Figure 2: Proposed Scheme

1.3 REPORT OBJECTIVES

The objectives of this report are to:

- Demonstrate how the proposed development will meet the policy requirements of the London Borough of Camden and of the London Plan, including its associated Energy Hierarchy (Policy 5.2 'Minimising carbon dioxide emissions' and Policy 5.7 'Renewable Energy') and Cooling Hierarchy (Policy 5.9 'Overheating and Cooling') relevant to the scale and nature of the development;
- Identify the most suitable passive and energy efficient design approach for the scheme, the feasibility of Low and Zero Carbon technologies and operational Best Practice;
- Identify the drivers relating to an energy efficient design over and above minimum compliance with current Building Regulations and other appropriate regional and national policies.

1.4 REPORT STRUCTURE

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

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

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 environmental design features and opportunities across all measures of the development. The planning criteria for energy and emissions are generally dictated by the following:

- National Planning Policy Framework;
- Greater London Authority – via the 'London Plan', the SPG on Sustainable Design and Construction and the GLA guidance on preparing energy assessment; and
- London Borough of Camden Policies.

The targets and strategies which require demonstration are as follows:

- Lean – Clean – Green approach;
- Achieving Part L 2013 with energy efficiency measures only;
- Overall 35% lower regulated emissions; and
- Where feasible, 20% CO_2 emissions reduction through the use of on-site renewable energy generation.

2.1 NATIONAL PLANNING POLICY FRAMEWORK (NPPF)

The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and how these are expected to be applied. Taken together, these policies articulate the Government's vision of sustainable development, which should be interpreted and applied locally to meet local aspirations. The ministerial foreword of this NPPF highlights that 'the purpose of planning is to help achieve sustainable development' and that sustainable development 'should go ahead, without delay – a presumption in favour of sustainable development that is the basis for every plan, and every decision.'

2.2 THE LONDON PLAN AND MINOR ALTERATIONS (2016)

This Spatial Development Strategy for Greater London includes objectives to reduce the capital's impact on, and exposure to, the effect of climate change. The GLA in March 2016 adopted their Minor Alterations to the London Plan, this included an update on their housing and parking policies including a number of revised standards to bring them in line with the national standards. The most relevant policies for this Energy Statement are:

POLICY 5.2: 'MINIMISING CARBON DIOXIDE EMISSIONS'

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

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

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

For major developments between 2016-2019 reductions are expected to be as per the regulation requirements.

Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction are to be met within the framework of the energy hierarchy.

POLICY 5.5: 'DECENTRALISED ENERGY IN DEVELOPMENT PROPOSALS'

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

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

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

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

POLICY 5.7: 'RENEWABLE ENERGY'
Within the framework of the energy hierarchy (see Policy 5.2), major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.

POLICY 5.9: 'OVERHEATING AND COOLING'
Major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy.

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

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

2.3 LONDON BOROUGH OF CAMDEN – CORE STRATEGY (2010)

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

POLICY CS13: 'TACKLING CLIMATE CHANGE THROUGH PROMOTING HIGHER ENVIRONMENTAL STANDARDS' provides the overarching policy requirements with respect to minimising the effects of climate change, adaptation measures and improved environmental standards during construction and occupation. The main requirements relevant to this energy statement are:

- Ensuring patterns of land use that minimise the need to travel by car and help support local energy networks;
- Promoting the efficient use of land and buildings;
- Minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing, in order, all of the elements of the energy hierarchy;
- Ensuring buildings and spaces are designed to cope with, and minimise the effects of climate change.

2.4 LONDON BOROUGH OF CAMDEN – DEVELOPMENT POLICIES (2010-2015) CORE STRATEGY

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

POLICY DP22: 'PROMOTING SUSTAINABLE DESIGN AND CONSTRUCTION'

- Non-domestic developments of 500sqm of floor space or above to achieve "Very Good" in BREEAM assessments and "Excellent" from 2016 and encouraging zero carbon from 2019;
- Developments are required to be resilient to climate change.

Further details on the BREEAM assessment and an appraisal of the wider sustainability issues can be found within the Sustainability Statement prepared by ChapmanBDSP in support of the planning application.

2.5 LONDON BOROUGH OF CAMDEN PLANNING GUIDANCE – CPG 3 – 'SUSTAINABILITY' (2015)

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

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

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

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

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

2.6 GREATER LONDON AUTHORITY (GLA) SUPPLEMENTARY PLANNING GUIDANCE (SPG) ON SUSTAINABLE DESIGN AND CONSTRUCTION (APRIL 2014)

This Supplementary Planning Guidance (SPG) provides guidance on what measures developers can include in their building designs and operations to achieve the carbon dioxide and water consumption targets set out in the London Plan. This SPG also provides guidance on how boroughs can take forward the new approaches set out in the London Plan, such as carbon-dioxide off-setting, retrofitting and 'air quality neutral'. The most relevant section of this Energy Statement is the section dealing with the Mayor's priorities associated with energy and carbon dioxide emissions:

The overall carbon dioxide emissions from a development should be minimised through the implementation of the energy hierarchy set out in London Plan Policy 5.2. To avoid complexity and extra costs for developers, the Mayor will adopt a flat carbon dioxide improvement target beyond Part L 2013 of 35% to both residential and non-residential development. Developers should aim to achieve Part L 2013 Building Regulations requirements through design and energy efficiency alone, as far as is practical.

The energy strategy for the scheme, detailed in the sections 3-6 of this report, achieves the Mayor's Priorities for Energy and Carbon Dioxide Emission.

2.7 GREATER LONDON AUTHORITY (GLA) GUIDANCE ON PREPARING ENERGY ASSESSMENTS (APRIL 2015)

This GLA guidance note provides further details on how to prepare an energy assessment to accompany strategic planning applications as set out in London Plan Policy 5.2. The guidance note reiterates that the purpose of energy assessments is: 'to demonstrate that climate change mitigation measures comply with London Plan energy policies, including the energy hierarchy'. The energy assessment carried out for the scheme (Please refer to Sections 3-6), follows the principles of this GLA guidance note.

2.8 BUILDING REGULATIONS APPROVED DOCUMENT PART L1A:201 AND PART L2A: 2013

Part L of the current Building Regulations considers the reduction of carbon emissions in new and existing buildings. The current proposals for the new residential and retail scheme fall under L1A of the Building Regulations (Conservation of fuel and power in new dwellings) and L2A of the Building Regulations (Conservation of fuel and power in new buildings other than dwellings) respectively. The three main 2013 Building Regulations criteria considered within this report are:

- **Criterion 1** - Building Emission Rate (BER) should be better than the Target Emission Rate (TER);
- **Criterion 2** - Limit on design flexibility; and
- **Criterion 3** - Limiting effects of heat gain in summer.

The Approved Document Part L1A:2013 and L2A:2013 assessments and results have been used as a starting point for the energy assessment of the scheme as per the London Plan Policy 5.2: 'Minimising carbon dioxide emissions' guidance.

3 ENERGY APPROACH FOR THIS DEVELOPMENT

The energy efficiency strategy for 5-17 Haverstock Hill has been developed following a hierarchical approach. The strategy aims to reduce energy demands through:

- 'Be Lean' - First incorporating passive design measures to promote natural ventilation and daylight penetration and also provide efficient building fabric;
- 'Be Clean' - Supply energy efficiently, review feasibility of connection to a district heating system, review of use of low carbon system such as Combined Heat and Power (CHP); and
- 'Be Green' - A renewable energy feasibility study is carried out to determine the suitability of renewable energy systems for the scheme.

This approach will provide a holistic means to ultimately reduce the energy demand, consumption and CO_2 emissions throughout the life of the building.

4 ENERGY EFFICIENCY STRATEGY – 'BE LEAN' – ESTABLISHING CO_2 EMISSIONS AND DEMAND REDUCTION

The proposed energy strategy has, as its first priority, minimised energy consumption through suitable orientation and the performance of the building envelope, facades and plant. The following section details the energy efficiency features of the development. The cooling hierarchy set out within the London Plan has been followed.

This analysis includes:

- Building Regulations Approved Document ADL1A (2013) and ADL2A (2013) initial compliance assessment, identifying the potential for the design to comply with and exceed Building Regulations requirements; and
- An energy consumption assessment of the proposed scheme contained within this document provides carbon dioxide emissions estimates from the analysis of energy efficiency enhancements. This utilises building regulations 2013 carbon dioxide factors.

In further detail, the energy efficiency strategy of the scheme has been achieved by incorporating the following design and technology features:

4.1 ENERGY EFFICIENCY STRATEGY FOR 5-17 HAVERSTOCK HILL - RESIDENTIAL

PHYSICAL FORM AND ORIENTATION OF THE BUILDING

Whilst the orientation of the development is relatively fixed due to the size of the site and the roads closely surrounding the site, the facade has been optimised in order to provide a balance of thermal control, both from within and outside of the building. Passive solar design involves adapting the buildings massing; layout and glazing to best respond to the local climate and annual sunpath, with the aim of reducing energy demands and improving occupant comfort through the use of heat and light from the sun.

Overall good levels of natural daylight will be achieved for the scheme, in particular for perimeter façades due to adapted area of windows and shallow room plans. This will reduce reliance on artificial lighting and thus limit energy consumption (Please refer to daylighting report for the scheme).

Shading control systems in the form of occupier controlled interior blinds/curtains will offer efficient solar control as they provide both solar shading and glare control, which in turn improves occupier comfort and reduces the risk of overheating within the rooms. Moreover, the glazing will include a solar transmittance specified to optimise solar control of the overall unit and provide a good balance of solar protection / free solar gain / daylighting.

BUILDING ENVELOPE SPECIFICATION AND THERMAL PERFORMANCE

The building fabric performance will be mostly improved compared to the values recommended by Camden within their guidance document CPG 3.Table 1 below shows the fabric performance levels assumed in relation to the values stated in guidance document CPG 3 and the minimum requirements of the Building Regulations.

BUILDING FABRIC	PROPOSED 5-17 HAVERSTOCK HILL DOMESTIC ASSET	CAMDEN PLANNING GUIDANCE CPG 3
Ground Floor U-value	0.13 W/m²K	0.20 W/m²K
Floor U-value between Residential and Non-residential	0.13 W/m²K	0.20 W/m²K
External wall U-value	0.18 W/m²K	0.20 W/m²K
Walls to unheated spaces (such as lift shafts) U-value	0.18 W/m²K	0.20 W/m²K
Roof U-value	0.13 W/m²K	0.13 W/m²K
Windows U-value	1.2 W/m²K	1.5 W/m²K
Glazing g-value	0.6	N/A
Windows Frame Factor	Between 79 and 87 % (based on façade drawings)	Between 79 and 87 % (based on façade drawings)
Door u-value	1 W/m²K	1 W/m²K (solid) 1.5 W/m²K (glazed)
Y-value – Thermal Bridges	Default Accredited Construction Details have not been assumed for all junctions	Default Accredited Construction Details have not been assumed for all junctions
Thermal mass	Assumed to be Medium	N/A
Air permeability	3m³/h.m²	3m³/h.m²
Corridors Heated	Yes	N/A

Table 1: Building Fabric Performance - Residential

VENTILATION STRATEGY

High efficiency Mechanical Ventilation with Heat Recovery (MVHR) will be used for the residential flats of the scheme. Please refer to Table 2 for details of the ventilation system assumed for the scheme:

VENTILATION	PROPOSED 5-17 HAVERSTOCK HILL DOMESTIC ASSET
Ventilation type	Balanced with Heat Recovery Sentinel Kinetic VS - Vent Axia
Specific Fan Power (SFP)	0.61 W/L/s – one bathroom 0.74 W/L/s – two bathrooms 0.95 – three bathrooms
Mech. Vent. Heat recovery eff	90%

Table 2: Ventilation systems specifications - Residential

THE CHOICE AND DESIGN OF BUILDING SYSTEMS AND PLANT

The building systems and plant have been designed to optimise the efficiency of the systems by matching installed capacity to anticipated building demand. Items of equipment, which make up the building's mechanical building services installation, will be specified to achieve high annual energy efficiency in operation and will be regularly serviced to maintain their performance. Please note that all systems have efficiencies and controls which will meet or exceed the requirements of Part L1A:2013 Domestic Building Services Compliance Guide:

The low carbon feasibility study (Please refer to the 'Be Clean' - Section 4 and Appendix C of this report) concludes that a gas Combined Heat and Power (CHP) system is very well suited to the development due to its relatively high constant hot water demand throughout the year. The use of CHP will lead to CO_2 savings compared to conventional systems.

The proposed main method of supplying heating and hot water will therefore be via a CHP system supplying 70% of the heating demand of the scheme (100% of hot water demand). The remaining load will be provided via condensing low NOx community gas boilers which will be highly efficient (Efficiency ≥ 95.5%) with low NOx emissions. Use of efficient system time and temperature zone controls for local temperature adjustment will be incorporated to reflect the user demands.

Please refer to Figure 3 below for the location of the CHP plant and gas boilers.

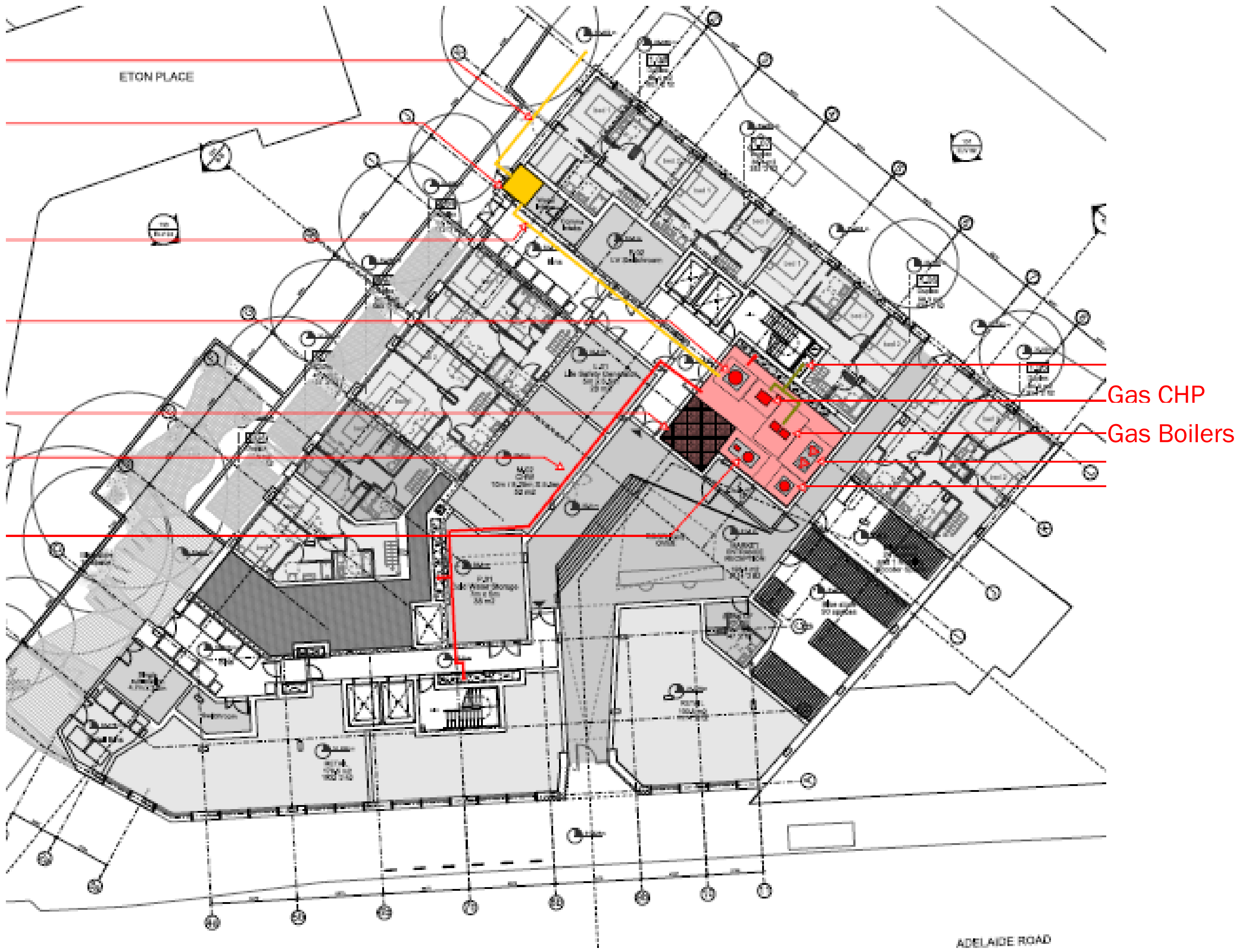


Figure 3: Ground Flood – Location of proposed CHP and gas boilers - plant room

Effective active cooling (EER 4.5) for the scheme will be provided to the intermediate and private flats.

The dwellings Pass CIBSE TM 52/TM49 adaptive overheating criteria with blinds without comfort cooling. We therefore expect the comfort cooling to be used in times of climatic extremes only.

LIGHTING

High efficiency low energy lighting and controls will be specified throughout.

4.2 ENERGY EFFICIENCY STRATEGY FOR 5-17 HAVERSTOCK HILL – NON RESIDENTIAL (INCLUDING RETAIL)

In addition to the measures taken for the residential spaces, specific energy efficient features for the commercial areas have been incorporated to reduce the building's energy consumption such as:

- Optimised building fabric - please refer to Table 3 below;
- Glazing to incorporate solar gain reducing (low g-value - please refer to Table 3 below;) layers. For areas subject to particularly high and prolonged, solar gains shading systems can be incorporated into the window openings;

BUILDING FABRIC	PROPOSED 5-17 HAVERSTOCK HILL NON-DOMESTIC ASSET	CAMDEN PLANNING GUIDANCE CPG 3
Ground floor U-value	0.13 W/m²K	0.20 W/m²K
External Wall U-value	0.18 W/m²K	0.20 W/m²K
Walls to unheated spaces (such as lift shafts) U-value	0.18 W/m²K	0.20 W/m²K
Roof U-value	0.18 W/m²K	0.20 W/m²K
Windows U-value	1.2W/m²K	1.5 W/m²K
Glazing g-value	0.4 for vertical windows; 0.14 for roof light	N/A
Frame Factor (% of frame for the windows)	20%	N/A
Air permeability	3m³/h.m²	3m³/h.m²

Table 3: Non-Residential Asset - Building Fabric Assumptions

Although the commercial areas are to be designed as 'Shell' only, assumptions have to be made with regards to fit-out systems in order to carry out the carbon emissions reductions assessment required for the energy assessment of the scheme. Subsequently, a comprehensive legally binding tenant agreement will be required to ensure the implementation of these assumptions, which will exceed the requirements of Building Regulations Part L2A:2013. This will ensure that the CO_2 emissions reduction predicted within the energy assessment submitted for planning will be achieved for the fully fitted scheme. These will include requirements such as local systems and lighting efficiencies, systems zoning/control requirements:

- High efficiency lighting scheme (use of LED lighting) and daylight linking potential;
- Optimised lighting controls – please refer to Table 4 below for assumptions used in this energy statement:

LIGHTING CONTROL	PROPOSED 5-17 HAVERSTOCK HILL NON-DOMESTIC ASSET
Occupancy control	plantrooms, communal circulations, stairs, bike stores, back of house toilet
Daylight Control	reception area and retail
Lighting Efficacy	80 Lumens/circuit watt: retail, plantrooms, bike store 75 Lumens/circuit watt : everywhere else
Display Lighting Efficacy	40 Lumens/circuit watt

Table 4: Non-Residential Asset – Lighting controls

- Efficient mechanical ventilation – please refer to Table 5 below for assumptions used in this energy statement:

VENTILATION	PROPOSED 5-17 HAVERSTOCK HILL NON-DOMESTIC ASSET
System (AHU) SFP (Extract+Supply)	1.6 W/L/s
Fan coil unit SFP	0.3 W/L/s
Heat Recovery efficiency	80 %

Table 5: Non-Residential Asset – Ventilation systems specifications

- Sub-metering for all major energy loads;
- High efficiency space cooling (SEER 5.5);
- Heating and hot water supply for these areas are to rely on the low carbon communal heating system which will also supply heating to the residential scheme (minimum efficiency = 95.5);
- Thermal zoning/controls where appropriate.

4.3 LONDON PLAN COOLING HIERARCHY

The section below details how the different measures implemented have followed the London Plan cooling hierarchy developed in Policy 5.9: 'Overheating and Cooling' and the requirements detailed in the London Legacy Development Corporation Local Plan Policy S.7: 'Overheating and Greening':

- Passive Design
  - Low energy lighting throughout;
  - High efficiency appliances;
  - Well insulated hot water systems;
  - Optimised solar transmittance of the glazing units; and internal blinds
  - Building fabric highly insulated and air tight.

- Passive ventilation
  - Natural ventilation during summer can be used in all the bedrooms, living spaces and circulation spaces.

- Mechanical ventilation
  - High efficiency Mechanical Ventilation with Heat Recovery (MVHR) all the spaces except for the communal circulation

- Active cooling systems will provide additional comfort (ensuring they are the lowest carbon options)
  - High efficiency cooling system (SEER = 5.5) used for the Retail, Entrance hall, Bedrooms and living spaces of all flats except the affordable ones.
  - All the flats meet CIBSE TM 52 and TM 49 adaptive comfort criteria for current and future climate. Comfort cooling will therefore be expected to be use on exceptional circumstances only. Please refer to Section 4.4 detailing the CIBSE TM 52/49 adaptive overheating study carried out for the scheme.

4.4 CIBSE TM 52/49 - ADAPTIVE OVERHEATING ANALYSIS

OVERHEATING CRITERIA

Overheating was assessed through the CIBSE TM52 methodology in line with the GLA recommendations for current and future climate (CIBSE TM49) This methodology is based on an 'adaptive' comfort model, i.e. the comfort band varies as a function of the outdoor running mean temperature based on the ambient temperature of the preceding days, assuming that occupants perception of thermal comfort is influenced by the external temperatures experienced over the previous days.

The following three criteria are reviewed for the rooms analysed as part of CIBSE TM52 analysis during the simulation period May-September for a free running building.

- Criterion 1: Hours Of Exceedance (Frequency)

The operative temperature (composite of air and radiant temperatures) cannot exceed the threshold comfort temperature by more than 1K for 3% of occupied hours. The comfort (or neutral) temperature is proportional to the operative temperature and generally within 3-4K of the operative temperature. If there is air movement inside the room the comfort temperature increases.

- Criterion 2 Daily Weighted Exceedance (Severity)

This criteria refers to the severity of daily overheating by calculating a weighted exceedance which must be inferior or equal to 6 in any day.

- Criterion 3 Upper Limit Temperature

The operative temperature must not be more than 4K higher than the threshold comfort temperature.

A room fails the overheating test if it fails any two out of the three criteria detailed above. In the conducted analysis, a residential unit is considered to have failed the overheating criteria if it includes one or more rooms failing to meet the CIBSE TM 52 criteria.

OVERHEATING ANALYSIS: BACKGROUND

The London Plan Supplementary Guidance: Sustainable Design and Construction (April 2014) states the following in Section 3.2.3:

"Overheating is not fully assessed by carbon dioxide emission models, therefore developers are encouraged to undertake dynamic thermal modelling to ensure that their development does not overheat. This is particularly important for small south facing and top floor living accommodation".

The overheating risk under current and future climate was assessed following the guidance of CIBSE TM52 and CIBSE TM49: 2014 (Probabilistic Design Summer Years for London). CIBSE TM49: 2014 provides new weather data for London. It analyses variations in climate across London based on the 'urban heat island' effect, as well as taking account of future climate change projections, allowing designers to predict more accurately the risk of overheating. The new future weather data included in CIBSE TM49 considers that more extreme summer weather will be experienced as average conditions in the future.

OVERHEATING ANALYSIS: METHODOLOGY

A sample 1 bedroom apartment has been selected and modelled using approved dynamic thermal modelling software (EDSL TAS 9.3.3) to estimate the overheating risk of the residential areas of the development. The flat selected is south oriented, located at 4th level and its layout is frequently repeated through all floors of the building (Please refer to Figures 4-6).

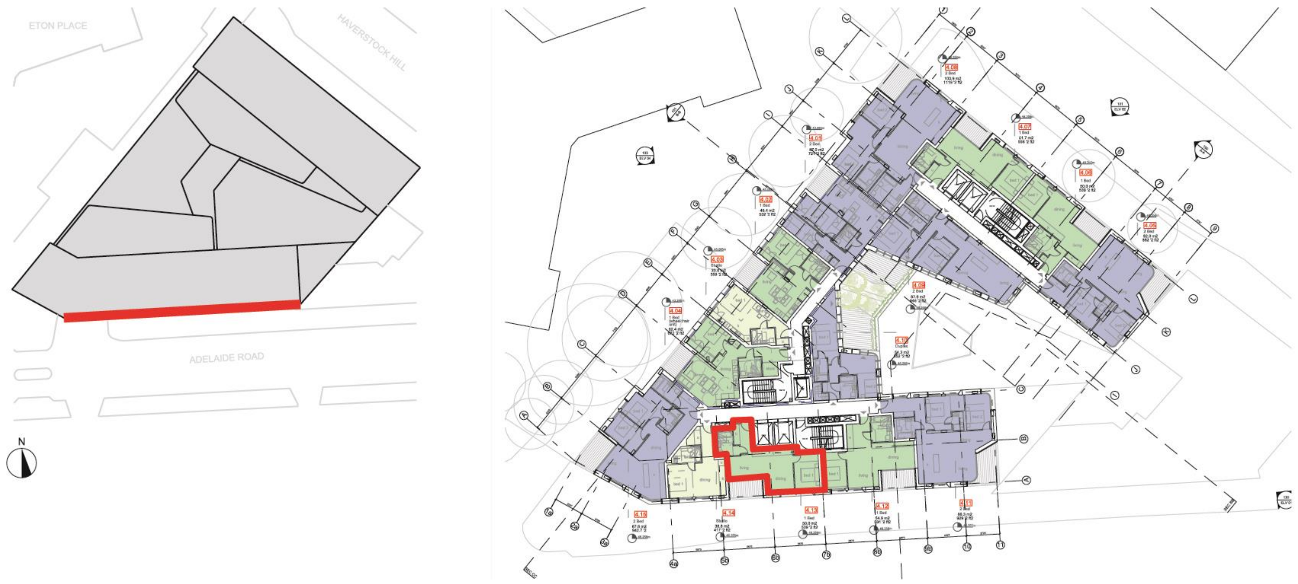


Figure 4: Indication of orientation and location of the sample dwelling on floor plan.

Figure 5: Location of sample dwelling: South elevation, 4th floor.

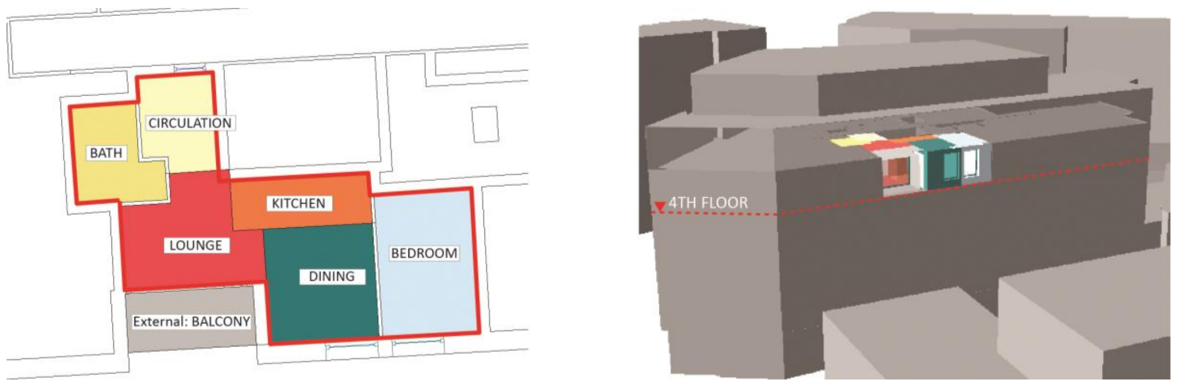


Figure 6: TAS EDSL model used for overheating risk assessment: zoning and 3d view.

The apartment selected includes two different window types: window 1 in the lounge and window 2 in the dining area and in the bedroom (Please refer to Figure 7).
The flat has been zoned according to the main functions of the flat and NCM_v5.2 internal conditions have been assigned to each zone (Please refer to Figure 6)

OVERHEATING ANALYSIS: CURRENT AND FUTURE SCENARIOS

CIBSE TM49 provides current and future weather files which should be used in building simulation for thermal comfort and energy analysis. The selected residential unit of 5-17 Haverstock Hill has been simulated using both current and future climates from CIBSE TM49.
London Heathrow weather station has been chosen as the most representative of project site.

CIBSE TM49 comprises 3 baseline Design Summer Years (DSY) London weather files for current analysis: 1976, 1989 and 2003. These 3 years were selected by CIBSE due their particularly high overheating risk with regards to recent historical weather data.

For this planning overheating study, thermal comfort analysis have been conducted with all three current DSY to investigate the sensitivity of the design to the current weather conditions.

- CIBSE TM 49 London Heathrow LHR1976_baseline;
- CIBSE TM 49 London Heathrow LHR1989_baseline;
- CIBSE TM 49 London Heathrow LHR2003_baseline.

The future weather files are provided by CIBSE based on the IPCC projections on climate change. Each of the future weather file is developed as a future projection based on a respective baseline year (1976, 1989 and 2003). All datasets are available for three time periods 2010–2040 (2020s), 2041–2070 (2050s) and 2071–2100 (2080s), for three emissions scenarios (Low, Medium and High) and for variable probability levels, consistent with the UKCP09 Climate Change Projections based on 'probabilistic' scenarios.

Future climate changes scenarios are given according to different likelihoods of change. The likelihood is expressed in terms of percentile change. For the analysis, a percentile change of 50% has been considered, since it would encompass 50% of the projected changes (i.e. would represent the middle of the range, or the 'best guess').

Climate change strongly depends on greenhouse gas emissions and CIBSE TM49: 2014 guide proposes three greenhouse emissions scenarios to choose from: High, Medium and Low.
For this study a Medium scenario of greenhouse gas emissions was chosen. 2050s period (2041–2070) has been selected as reference data set since it should give a good indication of the building's exposure to future increases in temperature and the most effective solutions to mitigate those risks.

Since the development scheme is expected to last more than 30 years, additional thermal comfort analysis for two future DSY have been run:

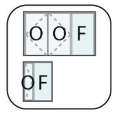
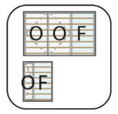
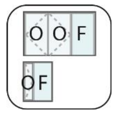
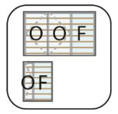
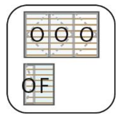
- CIBSE TM 49 London Heathrow LHR1976_2050 Medium50%;
- CIBSE TM 49 London Heathrow LHR1989_2050 Medium50%.

DSY LHR1989_baseline represents a year with a moderately warm summer whilst DSY LHR1976_baseline represents a more extreme year with a long period of persistent warmth.
Simulations for current climate confirmed that current LHR1976_baseline weather file was the worst case assumption for overheating analysis.

Future DSY LHR1976_2050 Medium50% and LHR1989_2050 Medium50% have been chosen to simulate the sensitivity of the design to "mild" (moderate warm summer) or long lasting "extreme" (extreme warm summer) weather conditions respectively.

RESULTS

Five cases have been run to test the sensitivity of the design to different weather conditions under the current and future scenarios:

CURRENT CLIMATE SCENARIOS	
	Base case – CURRENT 3 DSY climate scenarios – current design.
	Case 1 – CURRENT 3 DSY climate scenario – current design + internal retractable blinds.
CURRENT CLIMATE SCENARIOS	
	Base case – FUTURE 2 DSY climate scenarios – current design.
	Case 1 – FUTURE 2 DSY climate scenarios – current design + internal retractable blinds.
	Case 2 – FUTURE 2 DSY climate scenarios – optimised design (additional openable area) + low emissivity internal retractable blinds.

The apartment has two window types, named 'Window type 1' and 'Window type 2' in this study (Please refer to Figure 7): the former is the recessed opening of the lounge area that gives access to the balcony, the latter is the opening of the bedroom and of the dining area.

For the first four cases, the proposed design has been tested based on the following percentage of openable areas for the following openings:

- Window type 1 - 67% openable areas;
- Window type 2 - 6% openable areas.

Case 2 – FUTURE 2 DSY climate scenarios has been tested considering the following:

- Window type 1 - 100% openable areas;
- Window type 2 - 6% openable areas.

Please refer to Figure 7-9 for a graphic illustration of the cases and the percentage of opening.

All internal blinds considered are retractable and controlled by the users of the building.

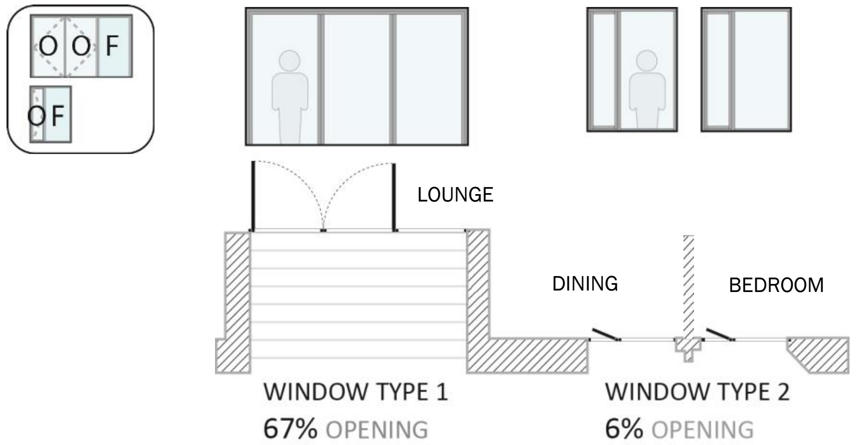


Figure 7: Opening assumptions – Current design used for Base case current and future climates.

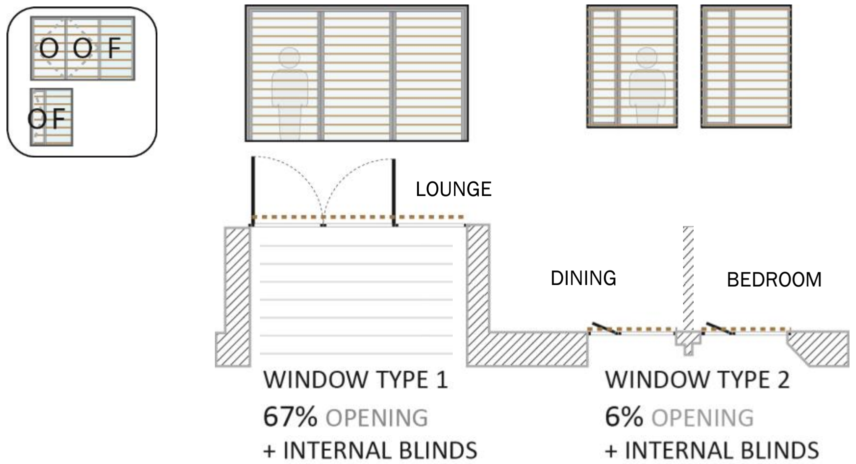


Figure 8: Opening assumptions – Current design + Internal retractable blinds, used for Case 1 current and future climates.

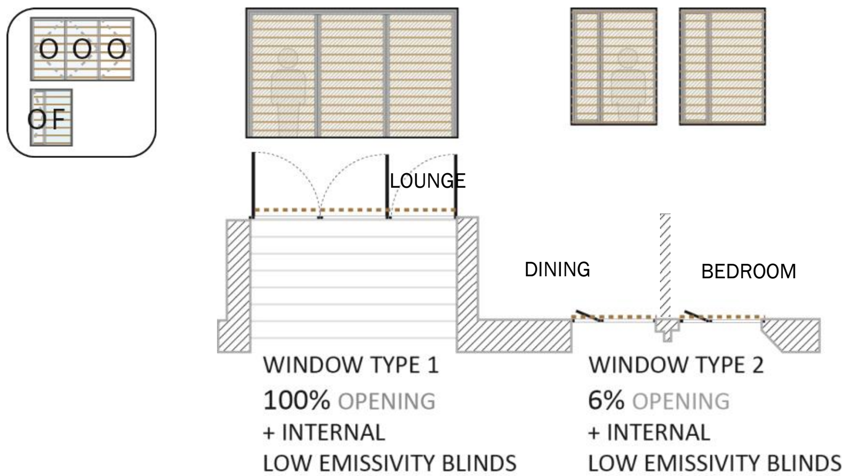


Figure 9: Opening assumptions – Optimised design (Window type 1, 100% opening) + Low emissivity internal blinds, used for Case 2 future climates.

Table 6 below illustrates the results of the overheating analysis carried out for the scheme for the three cases considered.

The analysis of the proposed design (Base case) confirms that all rooms meet the CIBSE TM52 adaptive overheating criteria for current DSY 1989_baseline that represents a moderately warm summer.
However, some of the rooms fail under current DSY 1976 and 2003 baselines.

Additional passive design measures required to ensure all rooms meet the adaptive overheating criteria have been tested using CIBSE TM52/49 methodology. In particular, the introduction of internal retractable blinds (Case 1) has been assessed as being the most simple and efficient strategy to pass the adaptive overheating criteria for current DSY 1976 and 2003_baseline.

In order to assess the future risk of overheating, the 1 bedroom apartment selected has been tested for moderate warmth and long lasting extreme warmth summers.

Simulations have confirmed that current DSY 1976_baseline is the worst case assumption for the baseline weather file and the most difficult to “pass”. Hence, additional analyses with future DSY LHR1976_2050 Medium50% have been run to test the proposed compliant design against the worst case scenario for future climate.
As expected, the results show that some rooms fail both the adaptive overheating criteria for the Base case and Case 1 design.
In order to pass all criteria under these weather conditions Window type 1 has been considered to be fully openable and low emissivity internal blinds have been applied to all windows (Case 2).

Simulations run using future DSY LHR1989_2050 Medium50% gave better results and confirmed that all rooms pass the criteria if internal retractable blinds are installed (Case 1 design).

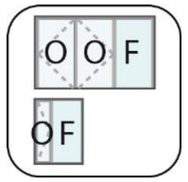
CASES		CURRENT CLIMATES			FUTURE CLIMATES	
		1976	1989	2003	1976	1989
Base Case						
Case 1						
Case 2		/	/	/		

Table 6: CIBSE TM52 / TM49 Adaptive overheating analysis – Summary of results
All internal blinds considered are not fixed and controlled by the users of the building.

The architect has confirmed that internal retractable blinds could be installed (Case 1 design) and that Case 2 could be implemented in the future. The dwelling design should therefore ensure that it 'PASS' CIBSE TM 52/TM49 adaptive overheating criteria for current and future climate without comfort cooling.

4.5 ASSESSMENT OF CARBON DIOXIDE EMISSIONS - PART L COMPLIANCE

Part L1A and L2A compliance for the scheme has been checked based on energy modelling carried out on the residential and non–residential development using Part L1A 2013 and Part L2A 2013 compliance software from Stroma (FSAP 2012) and EDSL (TAS version 9.3.3).

Please note that Part L compliance and CO_2 emissions for the residential part of the scheme have been calculated based on the modelling of 16 representative dwellings using SAP2012 calculation methodology (used for Part L1A 2013 compliance). These dwellings have been selected to ensure all types of residential units were represented. Weighted average of individual DER (Dwelling Emissions Rate) and FEE (Fabric Energy Efficiency) values were extrapolated to determine whole building performance.

The energy efficiency strategy proposed for the scheme which has aimed at first reducing its energy demand via the incorporation of suitable passive design measures, followed by proposed enhancements to provide an efficient building fabric (Be Lean) has led to an overall projected improvement over Part L1A and L2A: 2013 of 6.1% exceeding the Mayor's priority for Energy and Carbon Dioxide Emissions detailed in the SPG for Sustainable Design and Construction (Please refer to Tables 7 & 8, Figure 10 and Appendix B BRUKL documents).

CARBON DIOXIDE EMISSIONS AFTER EACH STAGE OF THE ENERGY HIERARCHY	CARBON DIOXIDE EMISSIONS (TONNES CO_2 PER ANNUM)	
	REGULATED	UNREGULATED
Baseline: Part L2A:2013 - Building Regulations Compliant Development	127.97	451.07
Be Lean - After energy demand reduction	120.19	451.07

Table 7: Summary Table - CO_2 emissions for the Notional and, 'Be Lean' scheme

REGULATED CARBON DIOXIDE SAVINGS FROM EACH STAGE OF THE ENERGY HIERARCHY	REGULATED CARBON DIOXIDE SAVINGS	
	TONNES CO_2 PER ANNUM	%
Savings from energy demand reduction	7.8	6.1

Table 8: Regulated CO_2 emissions reduction achieved for the 'Be Lean' scheme

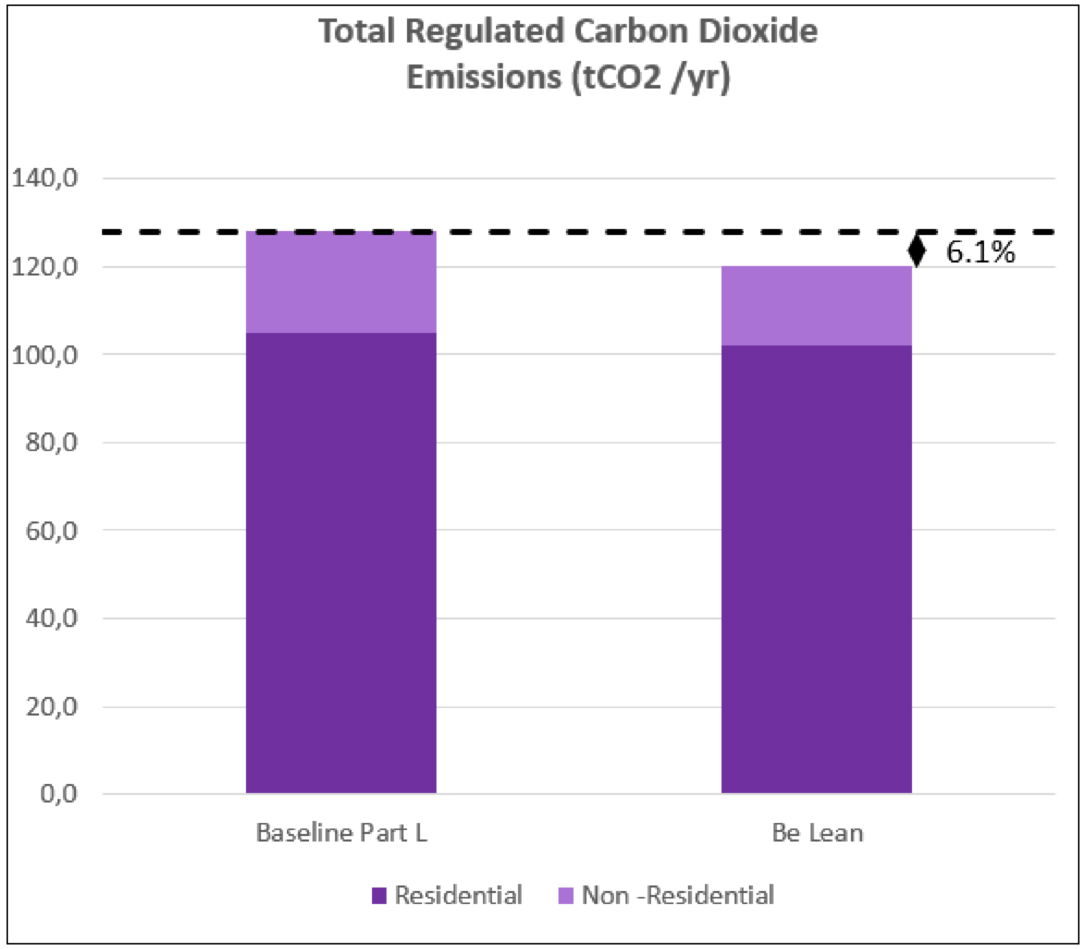


Figure 10: CO_2 emissions reduction for the 'Be Lean' scheme

5 'BE CLEAN': SUPPLY ENERGY EFFICIENTLY

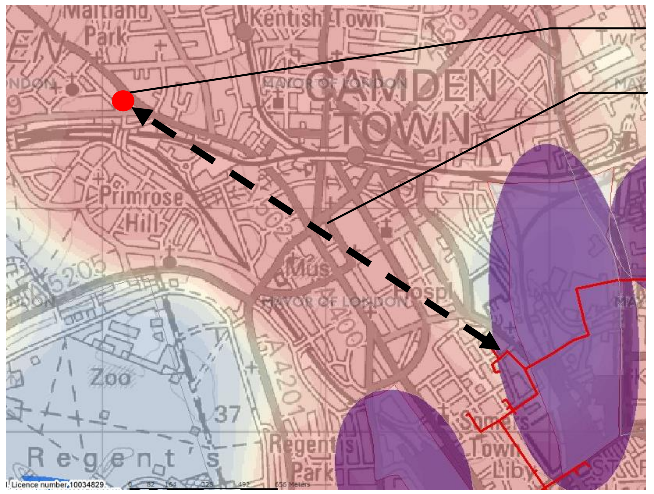
Connection to a decentralised energy network and the use of combined heat and power is a recognised method of generating energy more efficiently. The London Plan Policy 5.6: 'Decentralised Energy in Development Proposals' *and* the London Borough of Camden Core Strategy Policy CS13 and guidance document CPG 3 'Sustainability' requires development proposals to explore the opportunities to link into an existing or planned decentralised energy network using the London Heat Map tool. Where an existing decentralised energy network is not present, an assessment of the feasibility of establishing a decentralised energy system for the proposed development should be undertaken; including an assessment of the feasibility of a Combined Heat and Power (CHP) communal heating system.

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

5.1 DECENTRALISED ENERGY NETWORKS

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

The London Heat Map tool indicates the location of a decentralised energy network approximately 1.05 miles from the scheme (Please refer to Figure 11). The site is not located within a viable distance of the heat networks; therefore connection to a decentralised energy network is considered unfeasible at the present time.



Site location

Distance to the closest District Heating network (proposed): 1.05 mile

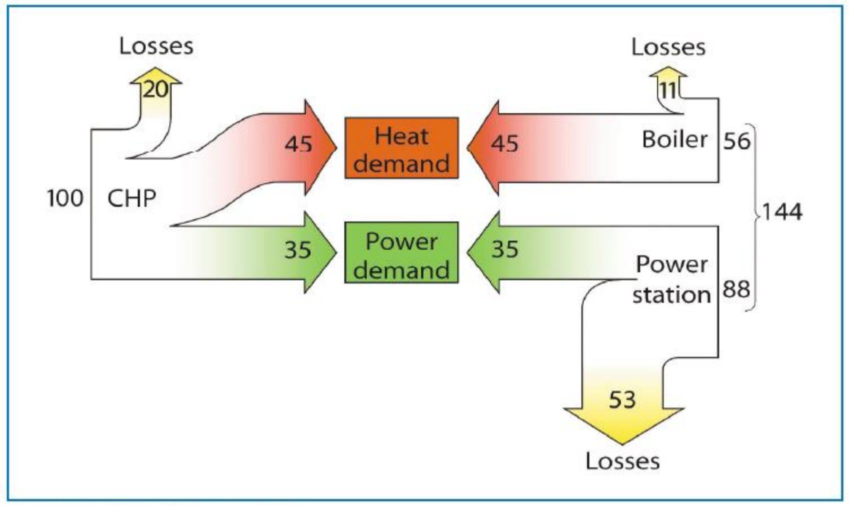
Figure 11: Location of the proposed site in relation to existing and proposed energy networks

Based on the proposed centralised heating strategy, the space heating and hot water service from the scheme could be connected to an external district heating system should a district scheme become reality, subject to future detailed feasibility analysis. The central plant will be located in the basement and will include space allowance for a new heat exchanger and pipe routes required to connect the scheme to an adjacent larger district heating network at an appropriate point in the future.

5.2 COMBINED HEAT AND POWER SYSTEM

A Combined Heat and Power system (CHP) is a system that concurrently produces electricity and heat. Conventional processes for electrical power generation have low efficiencies in the range of 30 – 50%. The considerable heat associated with the electric power generation is mostly released to the atmosphere unexploited. A combined heat and power system maximises the use of energy fuels to reach up to 80 – 90% by directing the heat produced for useful purposes. This makes a substantial contribution to the reduction of CO_2 emissions and fuel costs.

The sizes of combined heat and power systems can vary from small domestic systems (<10kW) to large scale industrial systems (≈140MW).



Energy flow diagram - CHP vs. conventional

Figure 12: Typical energy flow diagram, CHP vs Conventional

APPLICATION FOR THE PROJECT

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

A CHP installation would typically be the lead heat generator in a sequenced boiler system to ensure maximum run time and efficiency. For a scheme such as 5-17 Haverstock Hill which includes residential accommodation, the base heat load is likely to be the domestic hot water demand. To meet a domestic hot water demand, a CHP system would likely need a proportionally large thermal store to account for the typical hot water usage profile, which will be subject to daily peaks in demand, primarily in the morning and early evening. Such a system would need a suitably sized plant room area and a site wide insulated distribution pipe network to supply heated water to all 'residential' units. A central energy centre should be sufficient to house the expected thermal store and distribution infrastructure. The thermal store would also likely be required for any future connection to a district heat network.

There are two fundamental ways the feasibility of CHP system can be evaluated thermally; sizing to base heat loads to maximise the running hours, or sizing to large winter heating demands to maximise potential offset. For a scheme such as 5-17 Haverstock Hill the domestic hot water is deemed the dominant heating demand, the building's space heating demand is relatively small due to improvements to the fabric. Sizing of the CHP is therefore based on the hot water demand alone, maximising the running hours of the CHP. The CHP system requires >3,500 running hours a year to be practically and financially viable.

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

The preliminary sizing of the CHP unit has been carried out based on the heat demand loads for the scheme. An in-house CHP tool has been used to estimate the optimum size of the CHP unit leading to the maximum CO_2 savings. This tool estimates for different size of CHP unit the CO_2 emissions reduction achieved for a scheme using a CHP unit compared to a base case scheme using conventional high efficiency gas boiler. Please refer to Figure 13:

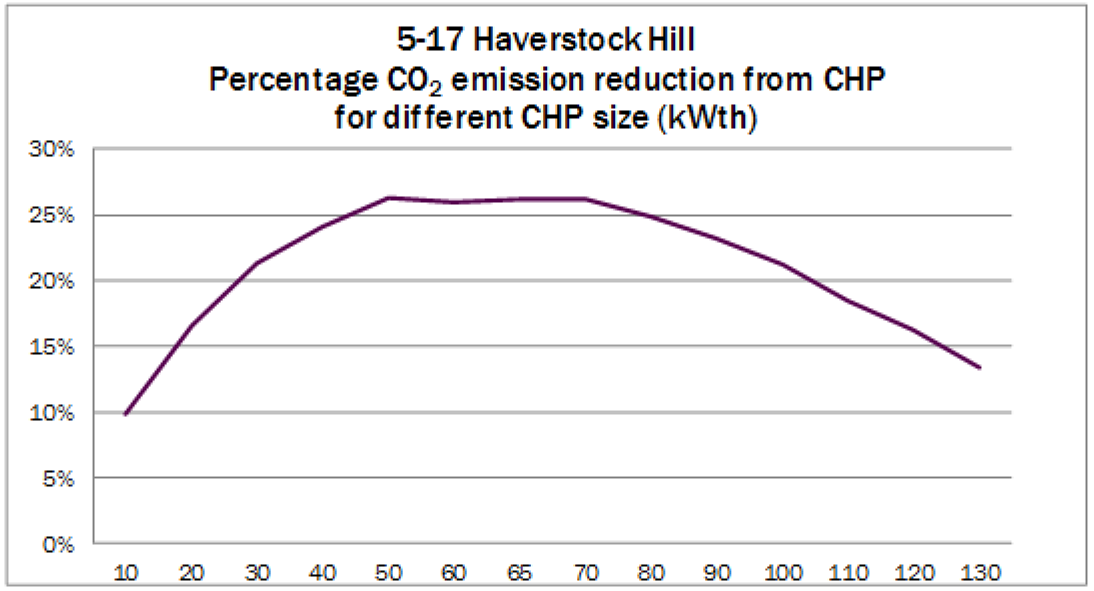


Figure 13: 5-17 Haverstock Hill – CHP size sensitivity analysis

This study concludes that a CHP unit of 43kWe/65kWth such as Hoval EG-43 with a thermal storage unit (1,000L) would lead to the maximum CO_2 savings for the scheme and an optimised number of running hours. Please see below the efficiencies assumed for the CHP unit selected for this energy statement:

- Electrical Efficiency ≥ 33.3%.
- Heat Efficiency ≥ 50.3%.

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

This system is expected to provide 70% of the domestic heating demand of the scheme. The remaining load will be provided via gas fired community water heaters which will be highly efficient (efficiency ≥95.5%) with low NOx emissions.

5.3 CLEAN CASE CO_2 EMISSIONS REDUCTION

The effect on CO_2 emissions and energy requirements of incorporating a CHP system and the energy efficiency measures proposed for the scheme will be as follows:

CARBON DIOXIDE EMISSIONS AFTER EACH STAGE OF THE ENERGY HIERARCHY	CARBON DIOXIDE EMISSIONS (TONNES CO_2 PER ANNUM)	
	REGULATED	UNREGULATED
Baseline: Part L2A:2013 - Building Regulations Compliant Development	127.97	451.07
Be Lean - After energy demand reduction	120.19	451.07
Be Clean - After CHP	86.29	451.07

Table 9: Summary Table - CO_2 emissions for the Notional 'Be Lean' scheme and 'Be Clean' scheme

The use of Combined Heat and Power (CHP) system providing in a highly efficient combined way heating and electricity will lead to **26.5%** CO_2 emissions reduction compared to a Part L1A:2013 and L2A:2013 compliant scheme and will lead combined to the 'Be Lean' measures to an improvement over Part L 2013 of **32.6%** - Please refer to Table 10 and Figure 14:

REGULATED CARBON DIOXIDE SAVINGS FROM EACH STAGE OF THE ENERGY HIERARCHY	REGULATED CARBON DIOXIDE SAVINGS	
	TONNES CO_2 PER ANNUM	%
Savings from energy demand reduction	7.8	6.1%
Savings from CHP	33.9	26.5%
Total cumulative savings	41.7	32.6%

Table 10: Regulated CO_2 emissions reduction achieved by the 'Be Lean' and 'Be Clean' scheme

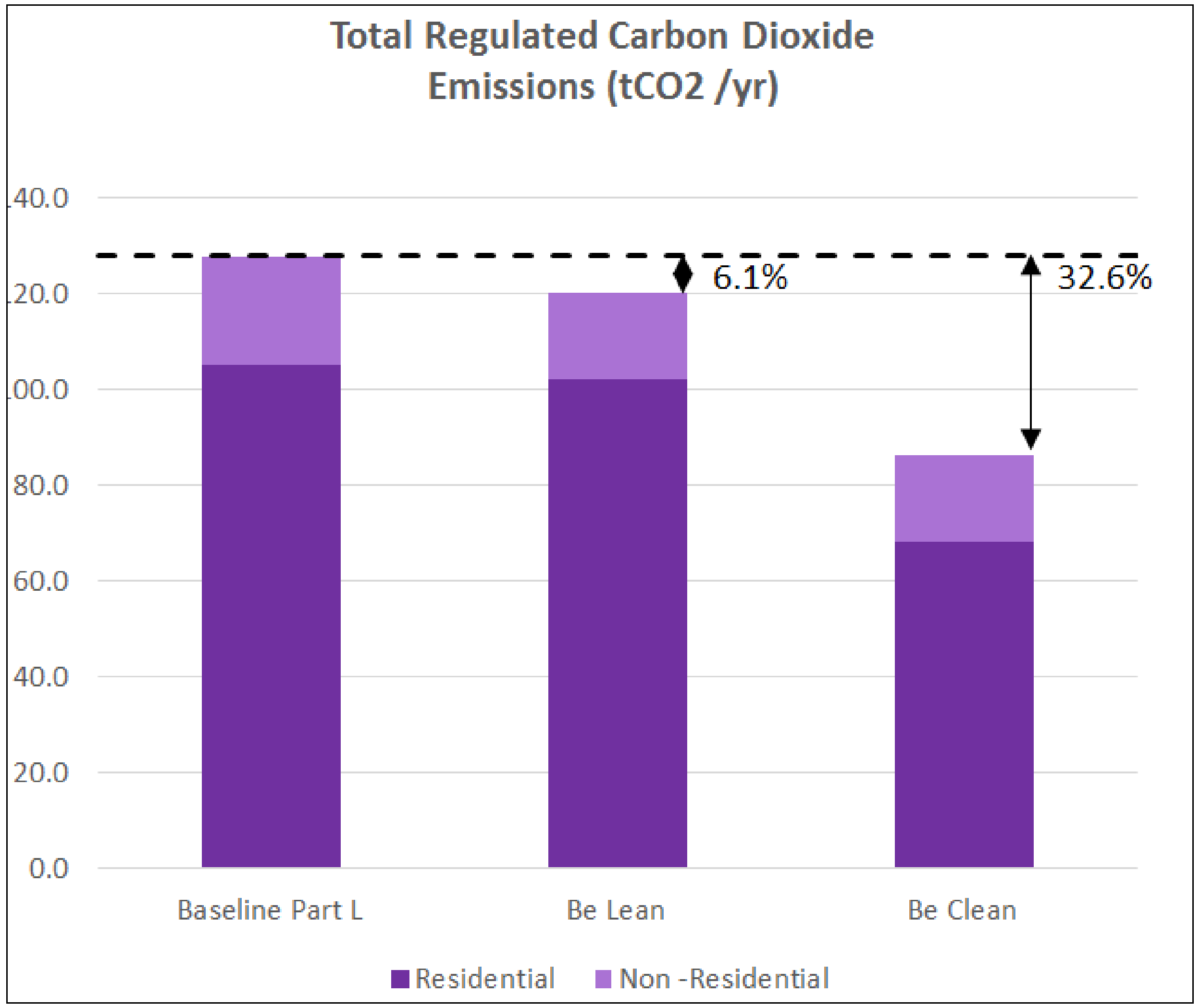


Figure 14: Energy Hierarchy – Base Case, 'Be Lean' and 'Be Clean' Cases

Please note that the LZC study carry out for the scheme, detailed in this section and following Section 6 meets the requirements of BREEAM New Construction UK 2014– Ene 04 – Low Carbon Design – Low and Zero Carbon (LZC) feasibility study. Please see Appendix C (LZC technology feasibility matrix) for additional details on the LZC feasibility study carried out for the scheme.

6 'BE GREEN': USE RENEWABLE ENERGY

The final step in the energy hierarchy requires the generation of energy by renewable energy technologies to be examined in line with the London Plan Policy 5.2: 'Minimising Carbon Dioxide Emissions', Policy 5.7:'Renewable Energy' and Camden Core Strategy Policy CS13 and CPG3 – 'Sustainability'.

The following technologies have been investigated:

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

Key parameters which have been considered in this feasibility study include:

- Current and future planning policies/aspirations;
- Opportunities of the site and energy demand/profile of the development;
- Practical implementation considerations;
- Installation and maintenance issues;
- Implications for internal arrangement and space allocation, infrastructure and site layout;
- Public acceptability;
- Environmental and visual impact;
- Deliverability;
- Security and availability of fuel supply;
- Capital and life cycle costs, payback and grants;
- Carbon contribution and cost per CO_2 saving; and
- Interactions of the technologies with one another.

6.1 HEAT PUMPS

OVERVIEW:

Ground Source Heat Pumps (GSHPs) are an established technology with over half a million units installed worldwide. They operate like a refrigerator, consisting of a vapour compression cycle heat pump linked to a closed loop heat exchanger buried in the ground. They are used to extract heat from the ground to provide space and water heating (and cooling in some cases) in a very efficient way, giving improved annual running costs and CO_2 savings compared to gas boilers, as well as having low maintenance requirements.

Open loop ground source heat pumps function in a similar way to GSHP with a closed loop except that they function through pumping water from an aquifer rather than through a closed loop. The water is then rejected away from the extraction point

Air Source Heat Pumps (ASHPs) operate in a similar way to GSHPs but extract heat from external air rather than from the ground. Air temperature is much less consistent than ground temperature, so the efficiency of the process is reduced when compared to GSHPs. ASHPs however are cheaper to install because they do not require ground collector loops, particularly when compared to GSHPs with vertical collector loops.

APPLICATION FOR THE PROJECT:

Heat Pumps utilising low grade, ground source or recovered heat as a thermal resource have been reviewed in the context of this development, with the following outcomes:

- There is no space around the building for a horizontal system;
- It is not considered economically or practically feasible to integrate pile/loop under the development (space not sufficient to allow for required distance between boreholes);
- Significant ground investigation required;
- The Coefficient of Performance (COP) of ASHPs and GSHPs in cooling mode has little improvement over the high efficiency cooling plant provisionally selected for the scheme;
- The viability of a heat pump system depends on the heat load and usage profile of the building to be served. Heat pumps can generally offer efficient space heating but are less efficient for domestic hot water heating. As a result, the latter typically requires either immersion heaters or a separate dedicated hot water heating system. Given the high standard of build fabric of the scheme, the hot water heating load will be dominant for this scheme while space heating load will be relatively low; and
- The use of heat pumps would also be difficult to integrate with a central energy centre and future connection to the decentralised heat network.

Consequently air source heat pumps are not considered viable for this scheme.

6.2 SOLAR THERMAL HOT WATER PANELS

OVERVIEW:

Solar hot water systems, usually placed upon the roof of a building, harness solar radiation in order to generate a heated water supply. Such systems generally are used to preheat hot water prior to water temperature being boosted further through integration with 'conventional' heating systems (e.g. gas-fired boilers). The main components of the system are the solar collector and a pump/fan to circulate a heat transfer fluid. The location and positioning of solar thermal array is very important in achieving acceptable performance.

APPLICATION FOR THE PROJECT:

An overview of solar thermal technical issues in relation to scheme includes:

- Solar thermal can only provide up to 45-55% of the hot water demand of the development leading to very limited CO_2 savings;
- Solar thermal systems are not compatible with some other technologies more suitable for this development, such as CHP, as they would reduce the water heating demand, which would in turn reduce the CHP run time and efficiency of the CHP system;
- Integration with a central energy centre would also be problematic, resulting in a large energy demand to circulate a relatively small volume of solar heated water from the collectors to the energy centre;
- Only the top floors can be provided with solar hot water without risk of increasing significantly the delivery thermal losses, as well as pumping energy. The complexity of the delivery system may be an issue;
- Roof of the scheme used for other preferred technologies such as PV; and
- Relatively long pipework runs with associated parasitic losses.

Consequently, for reasons of integration issues, along with limited emissions reduction performance, solar thermal system is not appropriate for the scheme.

6.3 BIO-FUELS

OVERVIEW

Bio-fuels have the potential to contribute to the reduction of CO_2 emissions of various developments by using this fuel within a boiler or CHP plant. Biofuels are considered to have low or zero CO_2 intensities as theoretically the CO_2 released when these fuels are combusted is no greater than the CO_2 that has been absorbed from the atmosphere when the plants grew. The only CO_2 emissions attributed to bio-fuels are those associated with the collection, processing and distribution of the bio-fuels, and are available as liquid or solid fuels.

APPLICATION FOR THE PROJECT

There are a number of issues which must be considered with this type of fuel in urban locations:

- Potential air quality impacts with combusting bio-fuels in urban areas, in particular elevated NOx emissions and particulates and must be addressed;
- Transporting this type of fuel increases lorry movements into and out of London, affecting congestion and transport emissions. The relatively rapid degradation of biodiesel would require appropriately sized on-site storage tanks with regular fuel deliveries;
- Importantly, the actual bio-diesel CO_2 intensity cannot be guaranteed due to variations in fuel stock supplier, demand, the energy input processing the fuel and CO_2 emissions due to growing, harvesting and processing the base fuel;
- Biofuel availability is currently uncertain due to unknown future supply and demand. Whilst an increase in demand for larger developments may stimulate the supply chain, availability could change with variation in demand. Transport is likely to have the most significant impact on the biofuel industry over emerging building demand;
- Socio-economic issues from growing and harvesting feedstock, with potential impacts on food production, particularly for biodiesel that is imported. Solid biofuels have a lesser impact in this area;
- On-site fuel storage requirements requiring additional space, along with regular access to the on-site fuel storage area;
- Increased plant maintenance is generally required, adding to costs and plant down-time; and
- Biomass CHP using solid fuels is not considered viable for this scheme as this technology is not sufficiently commercially developed.

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

6.4 WIND TURBINES

OVERVIEW:

Wind energy is a cost effective method of renewable power generation. Wind turbines can produce electricity, ranging from watts to megawatt outputs, without carbon dioxide emissions. The most common design is for three blades mounted on a horizontal axis, which is free to rotate into the wind on a tall tower. The blades drive a generator either directly or via a gearbox (generally for larger machines) to produce electricity.

Roof-mounted wind turbines are a new breed in the development of small scale wind technology. In this case, the wind turbine is directly installed on to a building, usually on the rooftop. These turbines must reliably generate sufficient energy to be useful, but still be small enough to mount on the building. They must also be sufficiently quiet to be acceptable to both building users and the occupants of surrounding buildings. Vibration must also be limited so that damage is not caused to the building or turbine.

APPLICATION FOR THE PROJECT:

The following key issues exist for wind turbines sited within an urban environment:

- Significant planning issues are likely to exist for wind turbine masts proposed within this Central London location, with respect to height and townscape impact issues;
- 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;
- There is currently considerable evidence of urban wind turbines failing to perform to manufacturer's output estimates;
- Turbulence from building density will affect 'clean' air streams and reduce turbine output;
- Turbines sized for the urban environment are likely to produce very modest power outputs and corresponding reduction in the sites total carbon dioxide emissions;
- Turbulent air is likely to increase turbine wear and noise; and
- Turbines located within the urban environment can also result in blade flicker and stroboscopic effects under certain conditions.

Consequently, the site is not considered viable for the installation of wind turbines.

6.5 PHOTOVOLTAIC PANELS

OVERVIEW:

Photovoltaic cells directly convert sunlight into electrical current using semiconductors. The output of a cell is directly proportional to the intensity of the light received by the active surface of the cell. The location and positioning of PV cells is therefore critical to achieving acceptable performance. Exposure to sunlight causes electricity to flow through the cells.

Mono-crystalline PV cells provide higher levels of electricity generating performance over other panel types. PV panels can be incorporated into a range of building designs and positions, provided they are located in a shade-free environment and facing as close to south as possible.

APPLICATION FOR THE PROJECT:

The following issues are considered in relation to the feasible integration of PV: An overview of solar thermal technical issues in relation to scheme includes:

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

PV panels are a viable option for this development. The available roof area suitable for locating the PV panels is constrained by the orientation and roof layout of the development. Please refer to Figure 15.

REGULATED CARBON DIOXIDE SAVINGS FROM EACH STAGE OF THE ENERGY HIERARCHY	REGULATED CARBON DIOXIDE SAVINGS	
	TONNES CO_2 PER	%
'Be Lean' - Savings from energy demand reduction	7.8	6.1
'Be Clean' - Savings from CHP	33.9	26.5
'Be Green' - Savings from Renewable Energy	5.6	4.3
Total cumulative savings	47.2	36.9

Table 12: Proposed Energy Strategy - London Plan - Energy Hierarchy – Regulated CO_2 emissions reductions

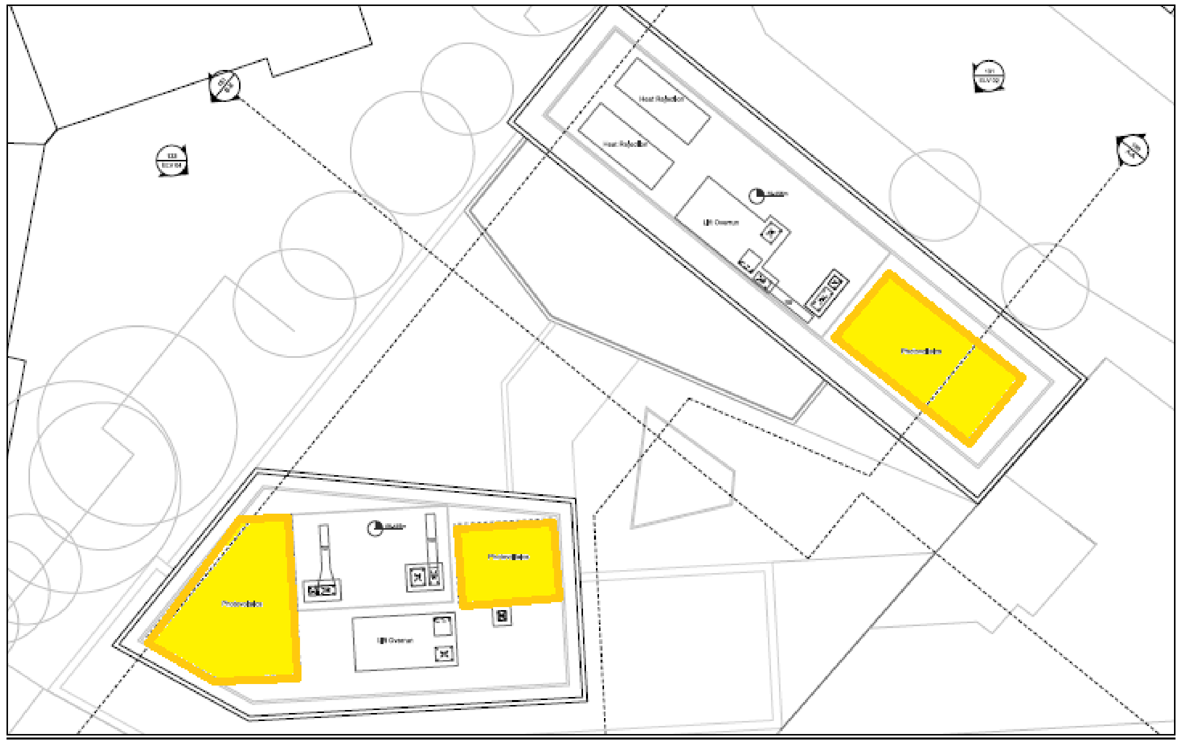


Figure 15: Proposed PV array – Roof of 5-17 Haverstock Hill

An array of 13.3 kWp has been proposed for the scheme (75-100m² active PV area depending on technologies - 150m2 roof area dedicated to PV).

The proposed PV array will lead to 4.3% CO_2 emission reduction. Please see Tables 11 & 12 and Figure 16 detailing and illustrating the CO_2 savings achieved for the different steps of the London Plan energy hierarchy:

CARBON DIOXIDE EMISSIONS AFTER EACH STAGE OF THE ENERGY HIERARCHY	CARBON DIOXIDE EMISSIONS (TONNES CO_2 PER ANNUM)	
	REGULATED	UNREGULATED
Baseline: Part L2A:2013 - Building Regulations Compliant Development	127.97	451.07
Be Lean - After energy demand reduction	120.19	451.07
Be Clean - After CHP	86.29	451.07
Be Green - After PV	80.74	451.07

Table 11: Proposed Energy Strategy - London Plan - Energy Hierarchy – Regulated and Unregulated CO_2 emissions

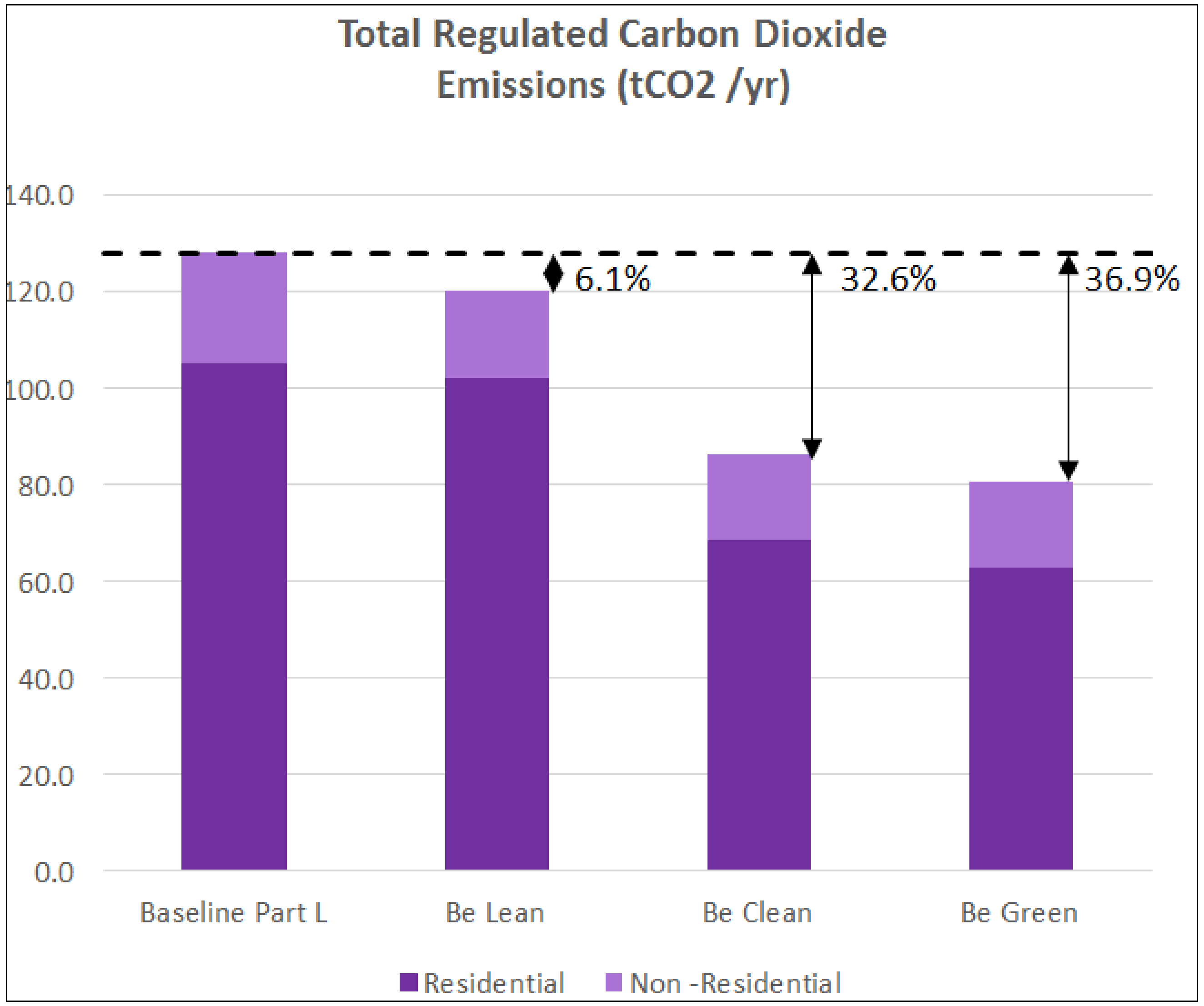


Figure 16 London Plan -Energy Hierarchy - CO_2 emissions reductions

7 CONCLUSIONS

This Energy Strategy has assessed all opportunities under the Best Practice 'Energy Hierarchy' in order to target the overall reduction of CO_2 emissions, in compliance with relevant policies and guidances detailed in section 2. All viable measures for the development and their CO_2 emissions reduction contribution are summarised in the following tables and chart:

ENERGY HIERARCHY	DESIGN APPROACH /TECHNOLOGY	NOTES	TONNES/ANNUM CO_2 REDUCTION	% REGULATED SITE CO_2 REDUCTION
Baseline	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) will be used to inform the detailed design of the scheme.			
Be Lean	Optimised glazing/facade	The fabric for the development has been optimised targeting thermal and air permeability performance level of that exceeds the Part L2A:2013 and Part L1A:2013 minimum standards, in order to retain heating and/or conditioned air within the space. Glazing with good levels of thermal performance has been selected under Dynamic Thermal Modelling analysis. This will help to contain the thermal energy within the space, allow a controlled and beneficial level of solar gain to enter the relevant spaces, as well as prevent overheating and excessive artificial cooling demands.	7.8	6.1%
Be Lean	Lighting	High efficiency artificial lighting will exceed Part L1A and L2A:2013 efficacy minimum standards with a current optimised performance standard up to 80 luminaire lumens per circuit Watt. Daylight control, photocell control dimming and /or presence detection to lighting systems will be installed so that lights can be turned off when there is sufficient daylight or when not needed.	7.8	6.1%
Be Lean	Ventilation	High efficiency Mechanical Ventilation with Heat Recovery (MVHR) used for all the spaces except for the communal circulation areas.	7.8	6.1%
Be Lean	Heating and Cooling Systems	The building systems and plant have been designed to optimise the efficiency of the systems by matching installed capacity to anticipated building demand. Items of equipment, which make up the building's mechanical building services installation, will be specified to achieve high annual energy efficiency in operation and will be regularly serviced to maintain their performance. The proposed main method of supplying heating and hot water will be via a Combined Heat and Power (CHP) system (used for 70% of the heating demand of the scheme). Low Temperature Hot Water underfloor heating (market flat), radiator (affordable flat, plantrooms and communal circulation) and fan coil units (retail and entrance hall) will be used throughout the scheme to optimise the output of the CHP. The remaining load will be provided via condensing community gas boilers which will be highly efficient. Use of efficient system time and temperature zone controls for local temperature adjustment will be incorporated to reflect the user demands. Cooling will be provided via high efficiency air cooled chillers (SEER ≥ 5.5) and will be limited to the market flats, the retail zone and entrance hall.	7.8	6.1%
Be Lean	Others	Power factor correction equipment, Low energy consuming lifts selected which will include energy efficiency features. Energy efficient equipment. Energy Management Best Practice –Commissioning & Seasonal Commissioning, Aftercare, Building User Guide, Soft Landings Framework, Energy Policy and Energy Management Strategy, Energy Awareness Campaign...	7.8	6.1%
Be Clean	Future connection to district heating network	Unviable as the development is located too far from the nearest district heating network available.	33.9	26.5%
Be Clean	Gas fired combined Heat and Power (CHP)	The use of Combined Heat and Power (CHP) has been assessed and it has been determined that due to the consistent base heating load throughout the year (hot water load), CHP would be suitable as the lead heat generator in a sequenced communal boiler sized to provide **70% of the heating demand of the scheme.**	33.9	26.5%
Be Green	150 m2 of PV panels	A feasibility study has been undertaken to establish the most suitable renewable technology for integration at the proposed development. Taking into account the nature of the site and the use of the roofs of the scheme for essential plant and amenity spaces, it has been considered economically and practically viable to install 150m2 of PV panel for the scheme.	5.6	6.1%
Total Energy Hierarchy	The optimised energy strategy of 5-17 Haverstock Hill development, will allow the development to achievement an improvement over Part L2A:2013 and Part L1A:2013 of 36.9% exceeding the requirement of the London Plan. An EPR of in the range of 0.52 is expected to be achieved for the retail allowing the award of 6 BREEAM Ene 01 credits.		47.2	36.9%

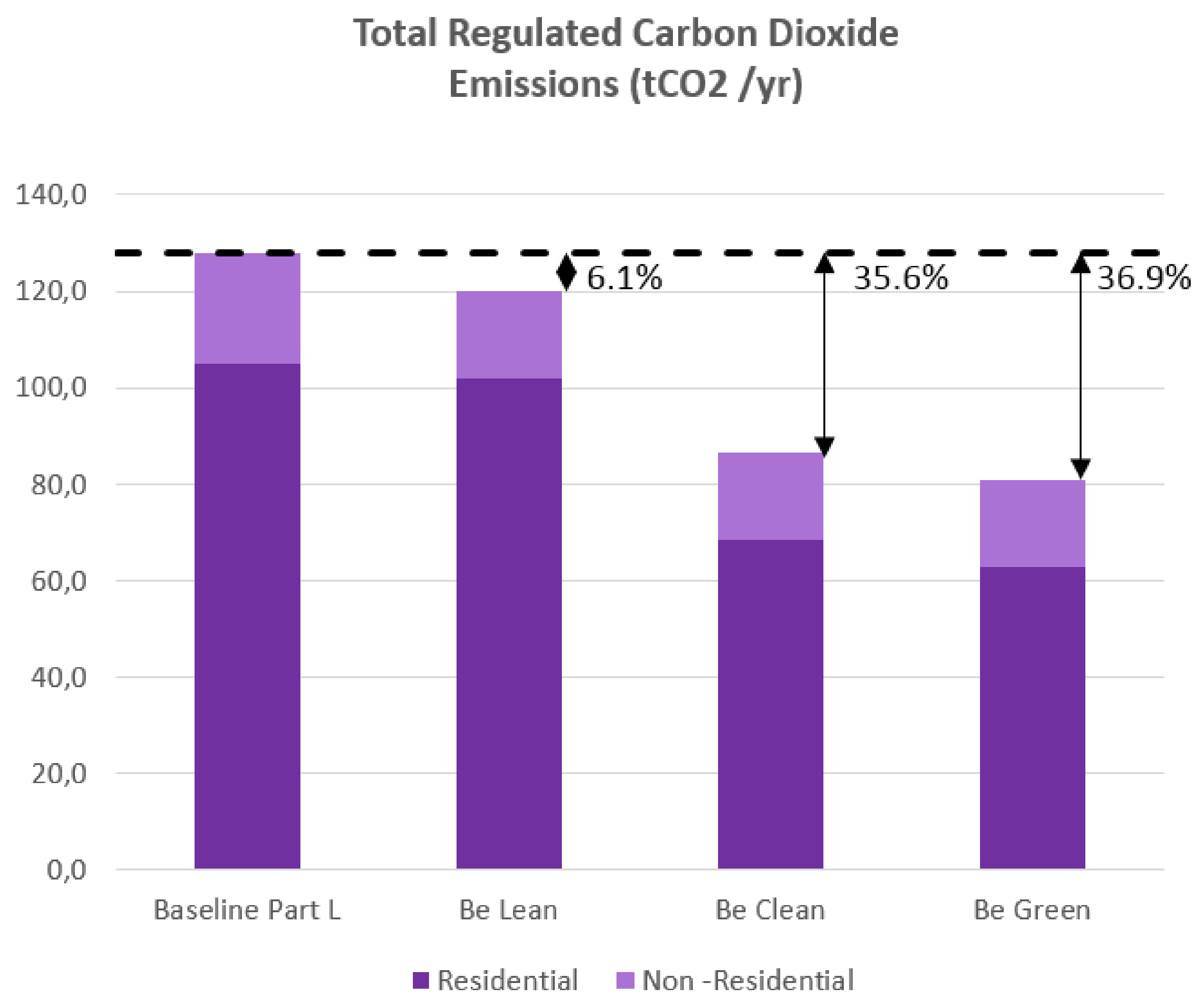
Table 13: Proposed Energy Strategy - London Plan - Energy Hierarchy

CARBON DIOXIDE EMISSIONS AFTER EACH STAGE OF THE ENERGY HIERARCHY	CARBON DIOXIDE EMISSIONS (TONNES CO_2 PER ANNUM)	
	REGULATED	UNREGULATED
Baseline: Part L2A:2013 - Building Regulations Compliant Development	127.97	451.07
Be Lean - After energy demand reduction	120.19	451.07
Be Clean - After CHP	86.29	451.07
Be Green - After PV	80.74	451.07

Copy of Table 11: Proposed Energy Strategy - London Plan - Energy Hierarchy – Regulated and Unregulated CO_2 emissions

REGULATED CARBON DIOXIDE SAVINGS FROM EACH STAGE OF THE ENERGY HIERARCHY	REGULATED CARBON DIOXIDE SAVINGS	
	TONNES CO_2 PER	%
'Be Lean' - Savings from energy demand reduction	7.8	6.1
'Be Clean' - Savings from CHP	33.9	26.5
'Be Green' - Savings from Renewable Energy	5.6	4.3
Total cumulative savings	47.2	36.9

Copy of Table 12: Proposed Energy Strategy - London Plan - Energy Hierarchy – Regulated CO_2 emissions reductions



Copy of Figure 16: London Plan - Energy Hierarchy – Proposed Energy Strategy

8 APPENDICES

8.1 APPENDIX A – ADAPTIVE OVERHEATING ANALYSIS - CIBSE TM 52/TM 49 RESULTS

Assumptions used for the overheating simulation:

- Infiltration: 0.2 ACH;
- Lighting gain: 3.33 W/m² for dining, lounge and bathroom areas; 6.66 W/m² for kitchen, 2.22W/m² for bedroom, circulation and common areas.
- Occupancy profile: NCM profile;
- Glazing with Internal blinds;
- Windows: Fully open during occupancy hours (manual opening) – openable area – min: 67% for window type 1 and 6% for window type 2 (refer to section 4.4);
- Rooms have been selected to represent the worst case scenario.

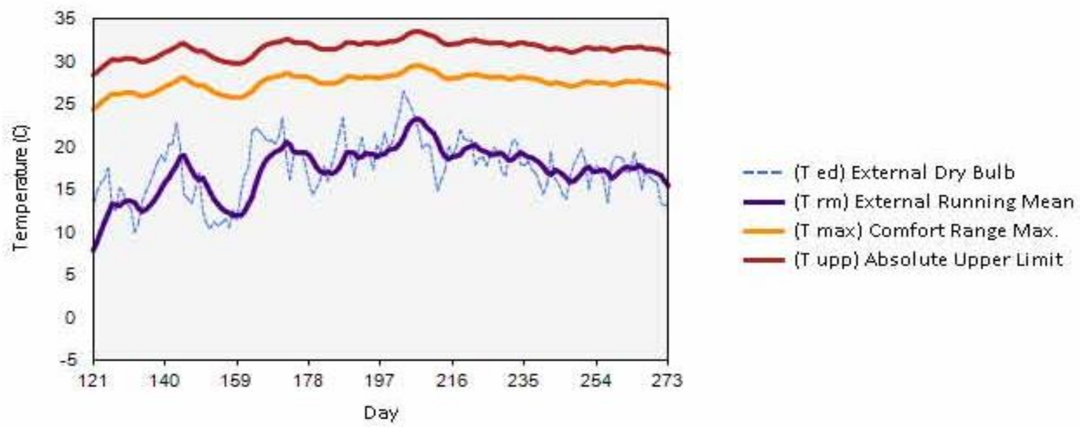
Current Climate_Base Case

haverstock_v4_Opening_1989

Tas Results Viewer

Adaptive Overheating Report (CIBSE TM52)

Adaptive Summer Temperatures for LHR1989_baselineDSY



The adaptive overheating assessment tests rooms against three criteria. If a room fails any two of the three criteria then it is said t overheat.
1. The first criterion sets a limit for the number of hours that the operative temperature exceeds the comfort temperature by 1°C more during the occupied hours over the summer period (1st May to 30th September).
2. The second criterion deals with the severity of the overheating within any one day. This sets a daily limit for acceptability.

Project Details

Simulation Results File (.tsd): haverstock_v4_Opening_1989.tsd
Building Designer File (.tbd): haverstock_v4_Opening_1989.tbd
Date: Friday, April 01, 2016

Results

Zone Name	Occupied Summer Hours	Max. Exceedable Hours (3%)	Criterion 1: #Hours Exceeding Comfort Range	Criterion 2: Peak Daily Weighted Exceedance	Criterion 3: #Hours Exceeding Absolute Limit	Result
Resi.Dining	1224	36	9	7.0	0	Pass
Resi.Bedroom	1683	50	3	2.0	0	Pass
Resi.Circulation	1541	46	17	20.0	0	Pass
Resi.Bath	1071	32	0	0.0	0	Pass
Resi.Kitchen	1071	32	6	4.0	0	Pass
Resi.Lounge	1071	32	19	12.0	0	Pass

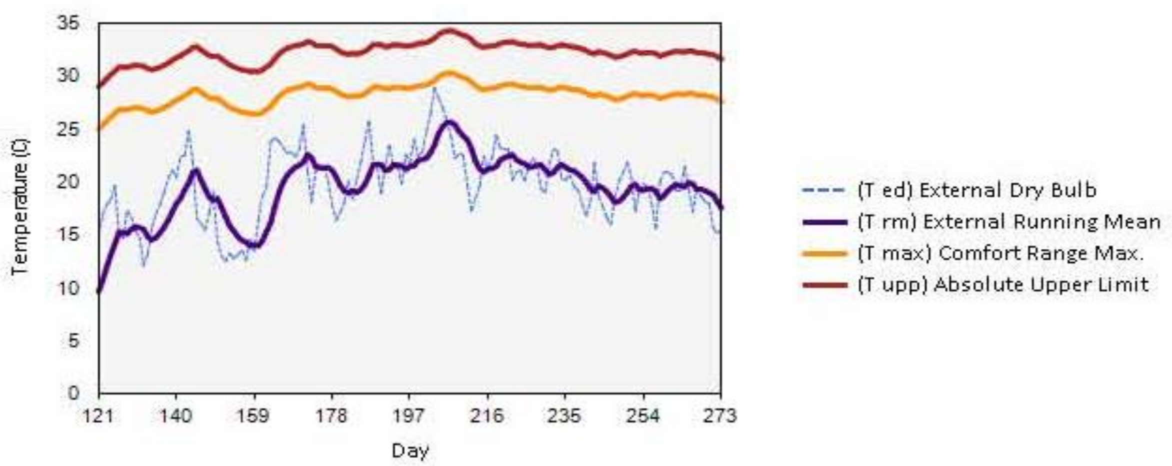
Future Climate_CASE 1

haverstock_v1_Opening_future_1989_2050Med50

Tas Results Viewer

Adaptive Overheating Report (CIBSE TM52)

Adaptive Summer Temperatures for LHR1989_2050Med50%DSY



The adaptive overheating assessment tests rooms against three criteria. If a room fails any two of the three criteria then it is said t overheat.
1. The first criterion sets a limit for the number of hours that the operative temperature exceeds the comfort temperature by 1°C more during the occupied hours over the summer period (1st May to 30th September).
2. The second criterion deals with the severity of the overheating within any one day. This sets a daily limit for acceptability.

Project Details

Simulation Results File (.tsd): haverstock_v1_Opening_future_1989_2050Med50.tsd
Building Designer File (.tbd): haverstock_v1_Opening_future_1989_2050Med50.tbd
Date: Tuesday, March 29, 2016

Results

Zone Name	Occupied Summer	Max. Exceedable	Criterion 1: #Hours	Criterion 2: Peak Daily	Criterion 3: #Hours	Result
Resi.Dining	1224	36	39	6.0	4	Fail
Resi.Bedroom	1683	50	12	6.0	0	Pass
Resi.Circulation	1541	46	34	18.0	6	Fail
Resi.Bath	1071	32	16	7.0	0	Pass
Resi.Kitchen	1071	32	21	10.0	1	Fail
Resi.Lounge	1071	32	67	10.0	7	Fail

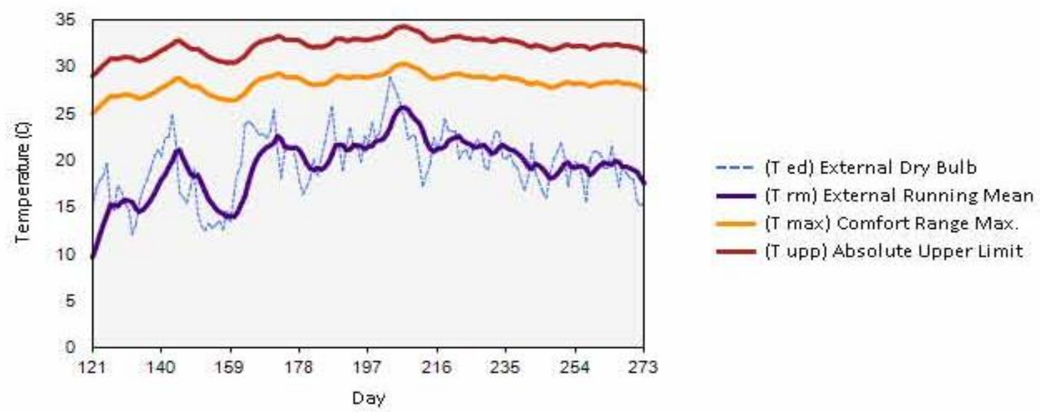
Future Climate_CASE 2

haverstock_v5_Opening6%+Blinds_future_1989_2050Med50

Tas Results Viewer

Adaptive Overheating Report (CIBSE TM52)

Adaptive Summer Temperatures for LHR1989_2050Med50%DSY



The adaptive overheating assessment tests rooms against three criteria. If a room fails any two of the three criteria then it is said t overheat.
1. The first criterion sets a limit for the number of hours that the operative temperature exceeds the comfort temperature by 1°C more during the occupied hours over the summer period (1st May to 30th September).
2. The second criterion deals with the severity of the overheating within any one day. This sets a daily limit for acceptability.

Project Details

Simulation Results File (.tsd): haverstock_v5_Opening6%+Blinds_future_1989_2050Med50.tsd
Building Designer File (.tbd): haverstock_v5_Opening6%+Blinds_future_1989_2050Med50.tbd
Date: Wednesday, March 30, 2016

Results

Zone Name	Occupied Summer Hours	Max. Exceedable Hours (3%)	Criterion 1: #Hours Exceeding Comfort Range	Criterion 2: Peak Daily Weighted Exceedance	Criterion 3: #Hours Exceeding Absolute Limit	Result
Resi.Dining	1224	36	12	9.0	0	Pass
Resi.Bedroom	1683	50	3	2.0	0	Pass
Resi.Circulation	1541	46	20	21.0	0	Pass
Resi.Bath	1071	32	2	2.0	0	Pass
Resi.Kitchen	1071	32	9	7.0	0	Pass
Resi.Lounge	1071	32	28	15.0	0	Pass

8.2 APPENDIX B – BRUKL DOCUMENTS – NON-DOMESTIC SCHEME

Be Lean / Be Clean – Criterion 1

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

As designed

Date: Thu Mar 31 12:45:00 2016

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.3.3"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.3.3

BRUKL compliance check version: v5.2.d.2

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	13.7
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	13.7
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	10.9
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	External Wall
Floor	0.25	0.13	0.13	Ground Floor
Roof	0.25	0.13	0.13	Roof
Windows***, roof windows, and rooflights	2.2	1.23	1.24	Roof light
Personnel doors	2.2	1.21	1.21	W.Entrance
Vehicle access & similar large doors	1.5	-	-	No vehicle doors in project
High usage entrance doors	3.5	1.21	1.21	W.Retail entrance

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
m³/(h.m²) at 50 Pa	10	3

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

As designed

Date: Thu Mar 31 14:07:54 2016

Administrative information

Building Details

Address: ,

Certification tool

Calculation engine: TAS

Calculation engine version: "v9.3.3"

Interface to calculation engine: TAS

Interface to calculation engine version: v9.3.3

BRUKL compliance check version: v5.2.d.2

Owner Details

Name:

Telephone number:

Address: , ,

Certifier details

Name:

Telephone number:

Address: , ,

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	13.7
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	13.7
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	10.7
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

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Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	External Wall
Floor	0.25	0.13	0.13	Ground Floor
Roof	0.25	0.13	0.13	Roof
Windows***, roof windows, and rooflights	2.2	1.23	1.24	Roof light
Personnel doors	2.2	1.21	1.21	W.Entrance
Vehicle access & similar large doors	1.5	-	-	No vehicle doors in project
High usage entrance doors	3.5	1.21	1.21	W.Retail entrance

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
m³/(h.m²) at 50 Pa	10	3

Be Lean / Be Clean – Final Result Page

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	1670	1670
External area [m²]	1787	1787
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	402	590
Average U-value [W/m²K]	0.22	0.33
Alpha value* [%]	7.85	7.85

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
32	**A1/A2 Retail/Financial and Professional services**
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
68	**Residential spaces**
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	0.99	2
Cooling	2.65	3.05
Auxiliary	4.64	4.61
Lighting	13.66	18.36
Hot water	0.36	0.38
Equipment*	51.66	51.66
TOTAL**	**22.31**	**28.41**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	55.76	47.88
Primary energy* [kWh/m²]	64.37	80.81
Total emissions [kg/m²]	10.9	13.7

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	1670	1670
External area [m²]	1787	1787
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
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Alpha value* [%]	7.85	7.85

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
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	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
68	**Residential spaces**
	D1 Non-residential Inst.: Community/Day Centre
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	1.78	2
Cooling	2.65	3.05
Auxiliary	4.64	4.61
Lighting	13.65	18.36
Hot water	0.68	0.38
Equipment*	51.66	51.66
TOTAL**	**22.6**	**28.41**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0.82	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	55.76	47.88
Primary energy* [kWh/m²]	63.2	80.81
Total emissions [kg/m²]	10.7	13.7

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

8.3 APPENDIX C – LZC MATRIX

5-17 Haverstock Hill
Low Zero Carbon Technologies Feasibility Matrix

	Low Zero Carbon Technology	Lifespan (yrs)	Lifecycle Carbon Savings* (tCO2/yr)	Applicable Grants	Life Cycle Cost*	Space Use	Local Planning Criteria	Noise	Feasibility of Export	Technology Appropriate for the site	Reasons for Exclusion
Solar Energy	Solar Thermal	20	Low	Renewable Heat Incentive (RHI)	Low	Not suitable (roof spaces either shaded or used by plant / amenity spaces)	Suitable	Suitable	Possible export of heat to future district heat network	No	An overview of solar thermal technical issues in relation to scheme includes: • The lower roof of the scheme will be shaded for a large part of the day, and the top roof will be entirely used for essential plant areas High levels of competition for roof space from plant areas, townscape and height limitations means that effective areas for the integration of solar technologies are very limited (Please refer to Figure 9 showing the use of the roof for plant's equipment); • Solar thermal can only provide up to 50% of the hot water demand of the development leading to very limited CO2 savings; • Solar thermal systems are not compatible with some other technologies more suitable for this development, such as CHP, as they would reduce the water heating demand, which would in turn reduce the CHP run time and efficiency of the CHP system; • Integration with a central energy centre would also be problematic, resulting in a large energy demand to circulate a relatively small volume of solar heated water from the collectors to the energy centre; • Only the top floors can be provided with solar hot water without risk of increasing significantly the delivery thermal losses, as well as pumping energy. • Roof of the scheme used for other preferred technologies such as PV; and • Relatively long pipework runs with associated parasitic losses. Consequently, for reasons of integration issues, along with limited emissions reduction performance, solar thermal system is not appropriate for the scheme. .
	Photovoltaics	25	Low (325 kgCO2/yr per 1kWpel)	Feed In Tariffs	Medium	Not suitable (roof spaces either shaded or used by plant / amenity spaces)	Suitable	Suitable	Possible (export of power to local grid)	Yes	The following issues are considered in relation to the feasible integration of PV: An overview of solar thermal technical issues in relation to scheme includes: • High capital cost; • Low maintenance; • Simple installation; • Photovoltaic panels are typically straightforward to integrate into a building's services strategy and would not conflict with a CHP installation; • Self cleaning if tilted at an angle of 10 degrees or more; • Electrical baseloads from pumps of the primary hot water distribution system and cold water booster system along with the communal residential space lighting will ensure that most of the generated electricity can be utilised on site. Any unused electricity can be sold back to the grid; • Performance output and emissions reduction is greater for PV over solar thermal systems for this arrangement, panel area and specific project loads; • Electricity Feed in Tariffs are available for this type of installation, improving the Return on Investment and payback periods; • Access issues / Mansafe system; • Lift overrun / Roof lights / Access hatch/ Green roof areas. PV panels are a viable option for this development. The available roof area suitable for locating the PV panels is constrained by the orientation and roof layout of the development. An array of 13.3 kWp has been proposed for the scheme (75-100m2 active PV area depending on technologies - 150m2 roof area dedicated to PV). The proposed PV array will lead to 4.3% CO2 emission reduction. Please see Tables 11 & 12 and Figure 16 detailing and illustrating the CO2 savings achieved for the different steps of the London Plan energy hierarchy:
Wind Power	Wind Turbines	20	Low (0.5 t/kWe per yr)	Feed In Tariffs	High	Not suitable (suitable space for stand alone of roof mounted wind turbine cannot be found for the scheme)	Not Suitable due to height restriction, significant visual impact, flicker.	Potentially not suitable due to noise from turbine's generator.	Possible (export of power to local grid)	No	The following key issues exist for wind turbines sited within an urban environment: • Significant planning issues are likely to exist for wind turbine masts proposed within this Central London location, with respect to height and Townscape impact issues; • 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; • There is currently considerable evidence of urban wind turbines failing to perform to manufacturer's output estimates; • Turbulence from building density will affect 'clean' air streams and reduce turbine output; • Turbines sized for the urban environment are likely to produce very modest power outputs and corresponding reduction in the sites total carbon dioxide emissions; • Turbulent air is likely to increase turbine wear and noise; • Turbines located within the urban environment can also result in blade flicker and stroboscopic effects under certain conditions. Consequently, the site is not considered viable for the installation of wind turbines.
Hydro, Wave, Tidal power	Small Scale Hydro Power	-	-	-	-	-	-	-	-	-	No river or sea located close to our development.
	Tidal Power	-	-	-	-	-	-	-	-	-	
	Wave Power	-	-	-	-	-	-	-	-	-	
District Heating and Cooling	Biomass Boilers	20	Medium	RHI	Low-Medium	Not suitable (large space required for fuel storage)	Suitable	Vehicle noise during regular fuel deliveries and also removal of ash from combustion	Possible export of heat to future district heat network	No	On-site fuel storage requirements requiring additional space, along with regular access to the on-site fuel storage area. Air quality impacts, transportation issue (increase lorry movements into and out of London, affecting congestion and transport emissions), actual bio-diesel CO_2 intensity cannot be guaranteed due to variations in fuel stock supplier, demand, the energy input processing the fuel and CO_2 emissions due to growing, harvesting and processing the base fuel. Biofuel availability, Socio-economic issues from growing and harvesting feedstock. Biomass CHP using solid fuels is not considered viable for this scheme as this technology is not sufficiently commercially developed. Additionally, commercially available plant sizes are generally of a larger output and less likely to suit smaller loads.
	Biomass Co-generation (CHP)	20	Medium-High	ROCs & RHI	Medium						
	District Heating and Cooling (based on gas-fired CHP/CCHP)	25+	Medium-High	Renewable Heat Incentive (RHI) + possible Feed-In Tariff (FiT)	Medium	Suitable (space have been allowed for future flat plate heat exchangers allowing future connection to a district heating system)	Suitable	Suitable	n/a	No (currently) but will be reviewed in the future	The London Heat Map tool indicates the location of a decentralised energy network approximately 1.05 miles from the scheme. The site is not located within a viable distance of the heat networks; therefore connection to a decentralised energy network is considered unfeasible at the present time. Based on the proposed centralised heating strategy, the space heating and hot water service from the scheme could be connected to an external district heating system should a district scheme become reality, subject to future detailed feasibility analysis. The central plant will be located in the basement and will include space allowance for a new heat exchanger and pipe routes required to connect the scheme to an adjacent larger district heating network at an appropriate point in the future.
Heat pumps	Ground Source Heat Pumps (Closed Loop System)	25 (50+ earth heat exchangers)	Medium (30-50% compared to gas heating system)	Renewable Heat Incentive (RHI)	Medium-High	Not suitable (space not sufficient for horizontal or vertical system)	Suitable	Suitable	Possible but unlikely	No	Heat Pumps utilising low grade, ground source or recovered heat as a thermal resource have been reviewed in the context of this development, with the following outcomes: • There is no space around the building for a horizontal system; • It is not considered economically or practically feasible to integrate pile/loop under the development (space not sufficient to allow for required distance between boreholes); • Significant ground investigation required; • The Coefficient of Performance (COP) of ASHPs and GSHPs in cooling mode has little improvement over the high efficiency cooling plant provisionally selected for the scheme; • The viability of a heat pump system depends on the heat load and usage profile of the building to be served. Heat pumps can generally offer efficient space heating but are less efficient for domestic hot water heating. As a result, the latter typically requires either immersion heaters or a separate dedicated hot water heating system. Given the high standard of build fabric of the scheme, the hot water heating load will be dominant for this scheme while space heating load will be relatively low; and • The use of heat pumps would also be difficult to integrate with a central energy centre and future connection to the decentralised heat network. Consequently air source heat pumps are not considered viable for this scheme.
	Ground Source Heat Pumps (Open Loop System)	25 (50+ boreholes)	Medium (40-60% compared to gas heating system)	Renewable Heat Incentive (RHI)	Medium	Not suitable (space not sufficient to allow for required distance between boreholes)	Suitable	Suitable	Possible but unlikely	No	
	Air Source Heat Pumps	20	Low-Medium (20-40% compared to gas heating system)	N/A	Low	Not suitable	Suitable	Suitable (Acoustically insulated engine)	Possible but unlikely	No	
Co-Generation	Gas-fired Co-generation (CHP)	15	Medium (30% CO2 reduction compared to condensing boilers)	N/A	Low-Medium	Suitable	Suitable (with integrated exhaust filters) Ultra low NOX CHP engine selected for the scheme meeting the requirement of the band B areas of the London SPG on Sustainable Design and Construction (2014) : 95 mg/kWh	Suitable (acoustically insulated engine)	Possible export of heat to future district heat network	Yes	The potential integration of conventional CHP plant has been evaluated for the proposed development, in compliance with appropriate planning policies, including the London Plan Policy 5.6 'Decentralised Energy in Development Proposals' and London Borough of Camden CPG 3 – 'Sustainability'. The energy demand assessment for the scheme has been reviewed with regard to the potential feasibility of CHP meeting a proportion of this heat demand, along with a proportion of the site's electricity demand, with an overall reduction in carbon dioxide emissions. A CHP unit is considered very well suited to the scheme due to its high consistent base heating load throughout the year (hot water load). The preliminary sizing of the CHP unit has been carried out based on the heat demand loads for the scheme.This study concludes that a CHP unit of 43kWe/65kWth such as Hoval EG-43 with a thermal storage unit (1,000L) would lead to the maximum CO2 savings for the scheme and an optimised number of running hours. The development will utilise a central communal heating system, distributing a heating flow to the scheme. The heat source will utilise sequenced high efficiency gas boilers. The use of sequenced gas boilers will allow the heating system to more efficiently match the heat load at any one time as only those boilers required would operate. This system is expected to provide 70% of the domestic heating demand of the scheme. The remaining load will be provided via gas fired community water heaters which will be highly efficient (efficiency≥95.5%) with low NOx emissions.
	Gas-fired Tri-generation (CCHP)	15	Low (compared to high efficiency chillers) - highly dependent on cooling profile of the scheme.	N/A	Low-Medium	Not suitable (space for absorption chillers cannot be accomodated for the scheme)	Suitable	Suitable (acoustically insulated engine)	Possible export of cooling to future district heat network	No	Cooling demand of the scheme too low to justify the use of tri-generation.
	Fuel Cells Gas-fired Co/Tri-generation (CHP)	20	Medium (40% CO2 reduction compared to condensing boilers)	N/A	(Very) High	Not suitable	Suitable	Suitable (Very low noise)	Possible (export of power to the grid and heat to district heating network)	No	Cooling demand of the scheme too low to justify the use of tri-generation. New technology, expensive £/kW installed
	Waste Heat Recovery	15	Low-Medium	N/A	Low	Not suitable	Suitable	Suitable	N/A	No	Insufficient waste heat available
	Energy Storage	15 (50+ for seasonal storage)	Low-Medium (technology dependant)	N/A	Medium-High (technology dependant)	Not suitable	Suitable	Suitable	Possible (integration within district network)	No	Large space required, energy use such that storage is not applicable

Key
Not applicable
Discarded
Considered
Implemented

Payback period:
Low: 1-7 years
Medium: 7-15 years
High: 15+ years

*** From industry standards and case studies (e.g. CIBSE, EST, Carbon Trust etc.)**

General comments: