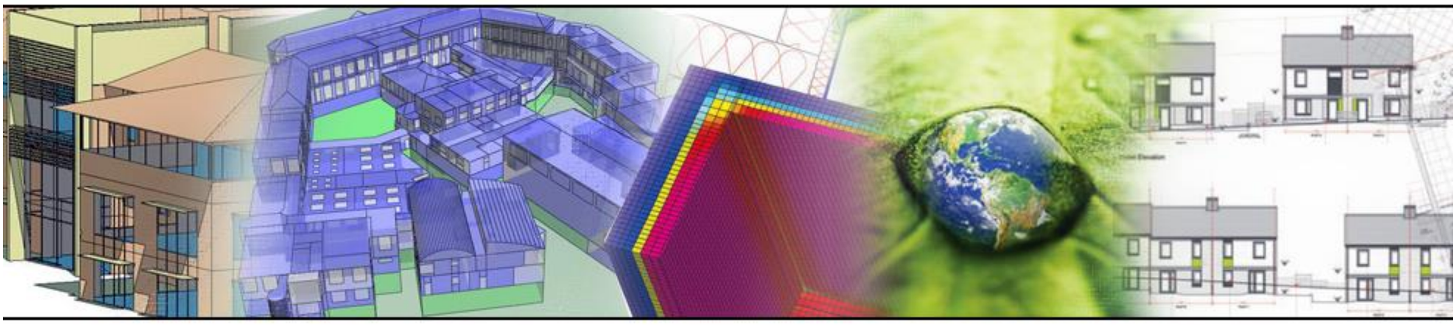

London Plan Energy Strategy Report

Crown Training Centre

Stroma Reference: PRO-062096 ES1
Date: 25/05/2022
Prepared for: EDC Engineers

1. Executive Summary

This Energy Strategy has been produced on behalf of EDC Engineers to support the planning submission for the proposed development at Crown Training Centre, Hayes.

The proposed works include the demolition of the existing buildings on-site and redevelopment to provide 407 residential apartments split between 1–3-bedroom, single storey and duplex apartments, across six blocks; ranging in height from three to nine storeys. The ground and mezzanine levels are proposed to house commercial office space and a gym, along with associated access, car parking, cycle storage, refuse storage, amenity space and landscaping. This report outlines the proposed preliminary specification for the development and the resulting savings implemented at each stage of the energy hierarchy in accordance with the New London Plan 2021.

The possibility of connecting to an existing District Heat Network had been found to be feasible although none currently exist in the local vicinity. The opportunity for on-site heat networks has been evaluated and found to be technically viable. Therefore, an ASHP system shall be implemented, with provision made to allow for connection to a future district heating scheme if one becomes available.

Additional energy and CO_2 savings will then be achieved through the use of a photovoltaic array which fills the available roof space.

The measures implemented at the Be Green stage produce a CO_2 reduction of 67% against the baseline using the SAP10 carbon factors. This exceeds the minimum required 35%.

The remaining emissions shall be offset via a £269,772 contribution to The London Borough of Hillingdon carbon offset fund in order to contribute to sustainable improvements elsewhere in the Borough.

The required tables and graphs can be seen on the next page and in the appended 'GLA Carbon Emissions Reporting Spreadsheet', where regulatory SAP2012 carbon emissions are reported, alongside new draft SAP10 carbon factors which have been used for the purposed of this report throughout.

1.1. Results Summary

Scenario	Regulated CO_2 emissions (Tonnes CO_2/annum)	Unregulated CO_2 emissions (Tonnes CO_2/annum)
Baseline	417.4	249.4
Be Lean	360.7	249.4
Be Clean	360.7	249.4
Be Green	126.7	249.4

Table 1. Carbon Dioxide Emissions after each stage of the Energy Hierarchy for domestic buildings

Scenario	Regulated CO_2 savings (Tonnes CO_2/annum)	CO_2 reduction (%)
Savings from 'Be Lean'	56.7	14%
Savings from 'Be Clean'	0	0%
Savings from 'Be Green'	234.0	56%
Cumulative on-site savings	**290.7**	**70%**
Remaining emissions to offset	126.7	-
	Tonnes (Co_2)	
Cumulative savings for offset payment (for 30 years)	**3,801**	-
Cash in-lieu contribution*	**£228,088**	-

**Carbon price is based on GLA recommended price of £60 per tonne of carbon dioxide*

Table 2. Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for non-domestic buildings

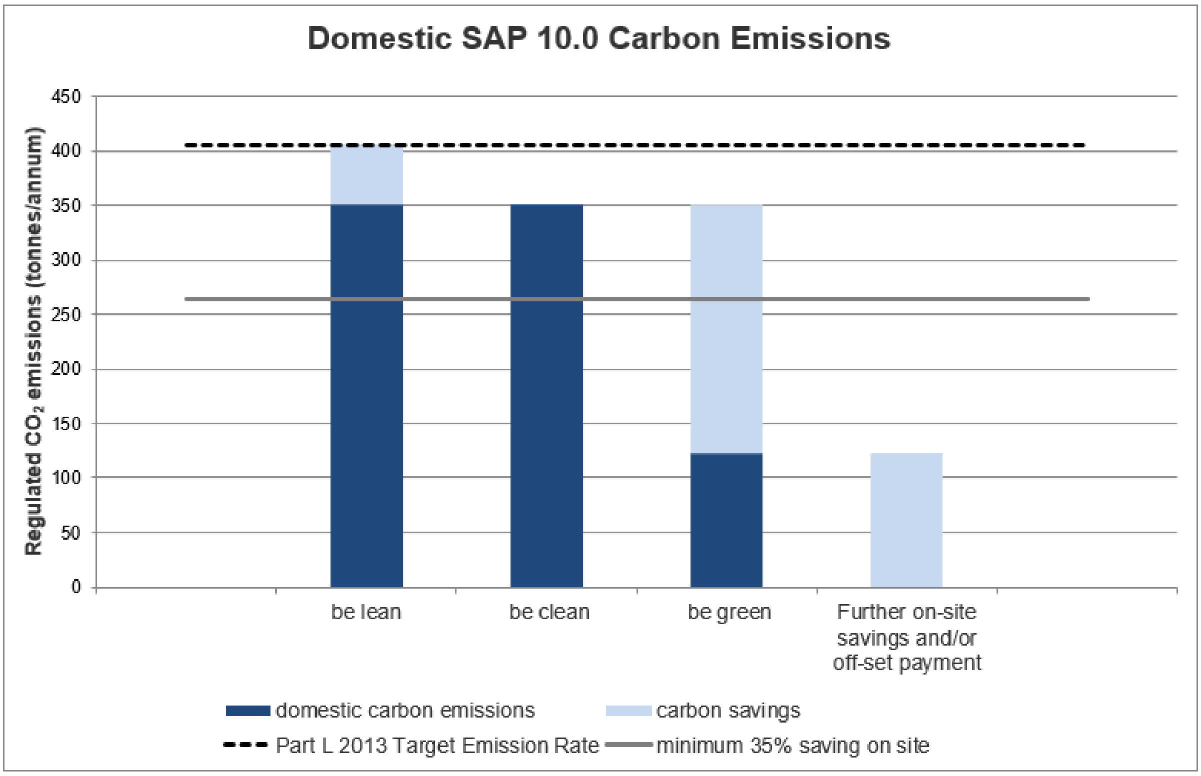

Figure 1. Domestic CO2 savings through the Energy Hierarchy

Scenario	Regulated CO_2 emissions (Tonnes CO_2/annum)	Unregulated CO_2 emissions (Tonnes CO_2/annum)
Baseline	34.5	12.2
Be Lean	31.5	12.2
Be Clean	26.1	12.2
Be Green	23.2	12.2

Table 3. Carbon Dioxide Emissions after each stage of the Energy Hierarchy for non-domestic buildings

Scenario	Regulated CO_2 savings (Tonnes CO_2/annum)	CO_2 reduction (%)
Savings from 'Be Lean'	3.0	9%
Savings from 'Be Clean'	5.4	16%
Savings from 'Be Green'	3.0	9%
Cumulative on-site savings	**11.4**	**33%**
Remaining emissions to offset	23.2	-
	Tonnes (Co_2)	
Cumulative savings for offset payment (for 30 years)	**695**	-
Cash in-lieu contribution*	**£41,684**	-

**Carbon price is based on GLA recommended price of £60 per tonne of carbon dioxide*

Table 4. Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for non-domestic buildings

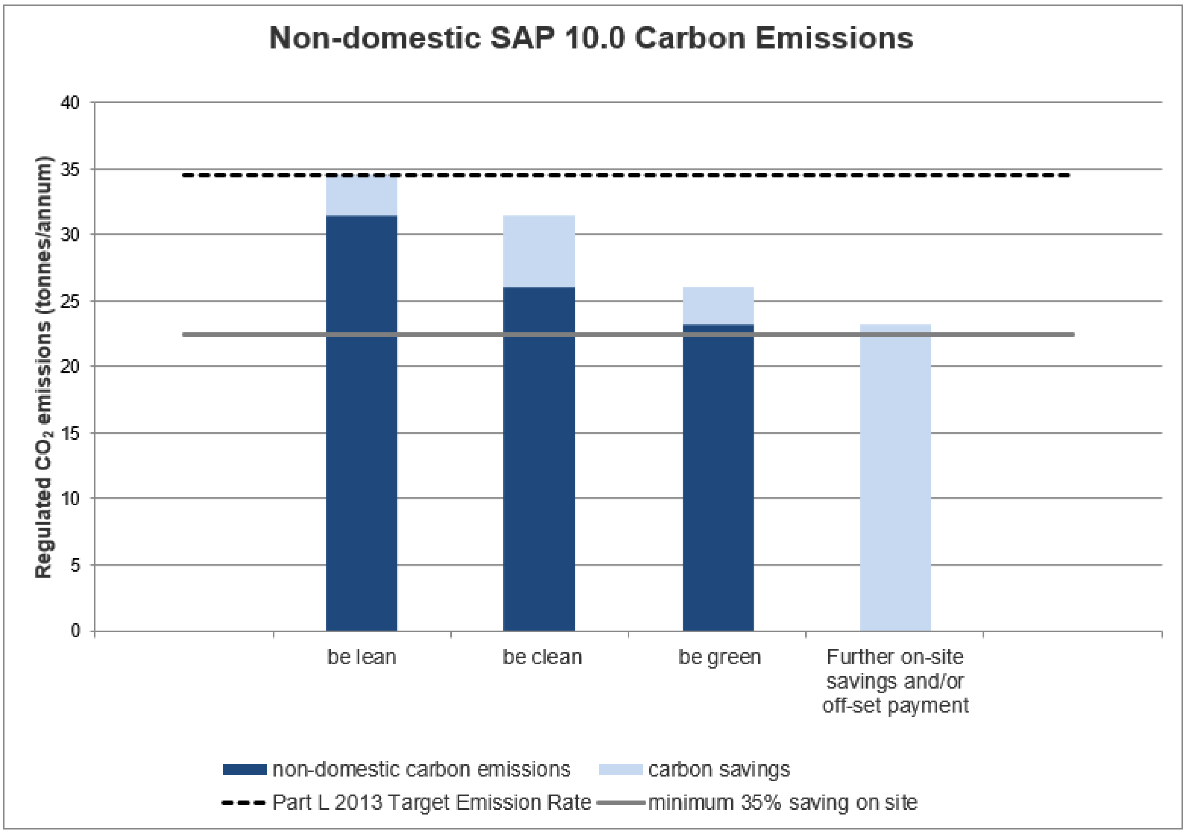

Figure 2. Non-domestic CO_2 savings through the Energy Hierarchy

	Total regulated emissions (Tonnes CO_2 / year)	CO_2 savings (Tonnes CO_2 / year)	Percentage savings (%)
Part L 2013 baseline	451.9		
Be lean	392.2	59.7	13%
Be clean	386.8	5.4	1%
Be green	149.9	237.0	52%
Total Savings	-	302.0	67%
	-	**CO_2 savings off-set (Tonnes CO_2)**	-
Off-set	-	**4,496.2**	-

Figure 3.Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy site wide

Contents

2. Quality Management

Prepared by	**Checked by**
Mitchel Armitage-Neiles	Rob Waiting BSc (hons) MSc
Sustainability Consultant	Principal Sustainability Consultant
Date: 25/05/2022	**Date:** 25/05/2022
File reference: PRO-062096 ES1	

Version	**Status**	**Date**	**Change Summary**
ES1	First Issue	25/05/22	-

3. Introduction

Stroma Built Environment has been commissioned by EDC Engineers to prepare an Energy Statement in support of the planning application for the proposed development at Crown Training Centre, Hayes.

The proposed works include the demolition of the existing buildings on-site and redevelopment to provide 407 residential apartments split between 1–3-bedroom, single storey and duplex apartments, across six blocks; ranging in height from three to nine storeys. The ground and mezzanine levels are proposed to house commercial office space and a gym, along with associated access, car parking, cycle storage, refuse storage, amenity space and landscaping

The site is bound between the Grand Union Canal to the North and Clayton Road to the south; and sandwiched between two industrial sites; the Clayton business Park to the west; and Fairview Industrial Park to the East.

This statement shall set out the applicable policies on energy for the proposed scheme, as well as the methodology for, and results from, an Energy Assessment.

It contains CO_2 emissions assessment in line with the guidance set out by the planning authority and shall detail the energy efficiency measures and low carbon technologies proposed within the design.

It must be understood that key to the acceptability of this strategy, is the GLA request for the applicant to design the scheme in line with the new Draft SAP10 carbon emission factors, rather than the current adopted factors used for Building Control purposes. This is to benchmark the development against future performance, rather than current standards.

4. Development Site

The proposed works include the demolition of the existing buildings on-site and redevelopment to provide 407 residential apartments split between 1–3-bedroom, single storey and duplex apartments, across six blocks; ranging in height from three to nine storeys. The ground and mezzanine levels are proposed to house commercial office space and a gym, along with associated access, car parking, cycle storage, refuse storage, amenity space and landscaping

The site is bound between the Grand Union Canal to the North and Clayton Road to the south; and sandwiched between two industrial sites; the Clayton business Park to the west; and Fairview Industrial Park to the East.

Figure 5. Ariel View of the development site

Figure 6. Proposed Roof Plans

5. Planning Policy

There are a wide range of energy-related planning policies that impact upon the design and construction of new developments. The National Planning Policy Framework (NPPF) 2021, indicates a presumption in favour of sustainable development. The regional policy '*The London Plan 2021'*, sets out a requirement to assess energy demand, adopt energy efficiency measures, and make use of decentralised energy and renewable technology where feasible.

The Hillingdon Local Plan follows the requirements of the London Plan and requires development to demonstrate how the principles of the London Plan have been followed.

5.1. London Plan Policy SI.2 Minimising greenhouse gas emissions

This policy requires that all developments meet set targets for CO_2 emissions. These targets are set in the context of the Building Regulations UK Part L (BRUKL) 2010.

The target under the London Plan is for zero net regulated emissions or 'zero carbon'. To achieve this target, carbon reduction should be maximised on site where possible, with the remaining emissions offset via a 'payment in lieu', to fund energy efficiency improvement measures elsewhere in the Borough.

The London Plan details an 'energy hierarchy' to be followed. This is to ensure that poorly designed buildings cannot be offset by renewable energy alone.

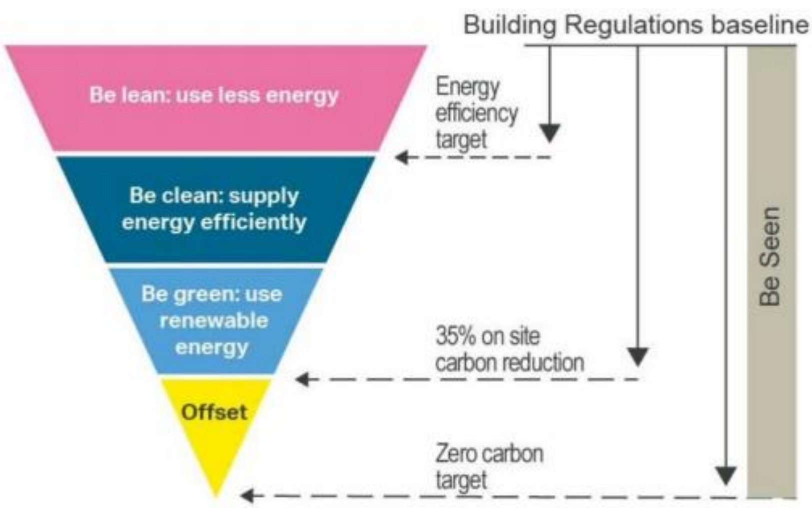

Figure 8.London Plan 2021 'energy hierarchy'

To demonstrate compliance with the policy it is necessary to assess the energy demand and emissions in detail, and to demonstrate how the energy hierarchy is being followed and how the emissions targets will be met using efficiency measures (Be Lean), decentralised energy systems (Be Clean), renewable energy technologies (Be Green) as appropriate.

Zero Carbon status is then demonstrated through off-setting the balance of regulated CO_2 emissions via a financial contribution to the respective borough. This carbon off-set payment will contribute to a fund which is then invested into other projects where equivalent CO_2 savings can be realised.

5.2. London Plan Policy SI.3 Energy Infrastructure

Major developments with Heat Network Priority Areas (HNPA's) are required to investigate the feasibility of efficient heating infrastructure, in accordance with the following hierarchy:

1. Connection to an existing or planned heating or cooling network
2. Implementation of a communal heating system, using zero-carbon or local secondary heat sources (in conjunction with heat pump, if required), which is designed to allow a cost-connection to a future network if one becomes available.
3. Individual heating systems (low-density individual housing only)

6. Assessment Methodology

6.1. Building Regulations – England Approved Document L1A –Domestic (SAP)

Approved document L1A – Conservation of Fuel and Power sets the standard for carbon emissions for new dwellings and was last revised in April 2014 (Part L: 2013). The properties will need to comply with the criteria set out in the document, as follows:

1. The predicted Dwelling Emission Rate of CO_2 emissions from dwellings (DER) are not greater than the Target Emission Rate (TER).
2. The performance of the building fabric and fixed building services should be no worse than the design limits set out in Table 2 of the Approved Document.
3. The dwellings will have appropriate passive control measures to limit the effect of solar gains on indoor temperatures in summer.
4. That the performance of dwellings as-built comply with the DER values achieved, including site testing of a representative sample of dwellings demonstrating that the 'air permeability' rate achieved is as per that specified, or better.
5. The necessary provisions for energy efficient operation of dwellings are put in place, including operation and maintenance instructions aimed at achieving economy in the use of fuel and power in a way that householders can understand.

The Standard Assessment Procedure (SAP) is the Government's approved methodology for assessing the predicted energy consumption and carbon dioxide emissions of new buildings. Results are derived in respect of floor area and consider energy use ($kWh/m^2/yr$) and associated CO_2 emissions ($kg.CO_2/m^2/yr$) from the following:

- Space heating
- Domestic hot water
- Ventilation
- Lighting
- Ancillary pumps and fans
- Energy generating technology

SAP is compliant with the EU Energy Performance of Buildings Directive and is carried out using approved software. A trained and accredited Stroma Energy Assessor has used Stroma FSAP 2012 software 1.0.4.10 to assess compliance and generate the necessary results data.

SAP calculations have been undertaken for 113 residential dwellings, which is in line with a 25% sample and results have been used to determine the predicted energy consumption and CO_2 emissions for the entire development. A summary of the input data used in the calculations can be seen in the Appendix. Supporting SAP calculations will be provided in the Appendix.

An indicative fabric and systems specification has been based upon information provided by EDC Engineers.

6.2. Building Regulations – England Approved Document L2A –Non-Domestic

Approved Document Part L2a: 2013 Conservation of Fuel and Power sets the standard for carbon emissions for new non-domestic buildings and came into force on 6th April 2014, superseding the former Part L2a: 2010.

Part L2a: 2013 document largely follows the same methodology as before with a number of key changes intended to reduce energy consumption and associated CO_2 emissions. The 2013 target emissions rate represents a 9% reduction in CO_2 emissions across an aggregated mix of non-domestic building types. The commercial unit will need to comply with the criteria set out in the document, as follows

1. Criterion 1: in accordance with regulation 26, the calculated CO_2 emission rate for the building (the Building CO_2 Emission Rate) must not be greater than the Target CO_2 Emission Rate (TER).
2. Criterion 2: the performance of the individual fabric elements and the fixed building services of the building should achieve reasonable overall standards of energy efficiency.
3. Criterion 3: demonstration that the building has appropriate passive control measures to limit solar gain.
4. Criterion 4: the performance of the building, as -built, should be consistent with the BER.
5. Criterion 5: the necessary provisions for enabling energy-efficient operation of the building should be put in place.

Compliance with the Approved Document Parts L1 & L2a should be demonstrated at detailed design stage, prior to construction.

6.3. GLA Energy Assessment Guidance

The Energy Assessment undertaken follows the detailed methodology set out within the Greater London Authority (GLA) guidance document "Energy Assessment Guidance – GLA guidance on preparing energy assessments as part of a planning application (April 2020)".

As such, the schemes regulated energy demand and carbon emissions have been calculated using a Dynamic Simulation Model (DSM). This is a Government approved tool for assessing regulated carbon emissions from non-domestic properties and are used to demonstrate compliance with Building Regulations Part L: Conservation of Fuel and Power. The unregulated energy for non-domestic buildings is extracted from the SBEM results.

The 'Baseline' case for emissions was determined by using the 'Target Emission Rate' (TER) from the compliance calculations. The emissions saving from energy efficiency proposals (BE LEAN) was determined by comparing the total emissions from the 'baseline' figures, with the predicted 'Building Emission Rate' (BER), based on the proposed specification. The potential emission savings from the district heat network (BE CLEAN) and renewable energy (BE GREEN) proposals, were then appraised, in line with the GLA requirements.

Following the latest guidance from the GLA, the emissions from the scheme have been adjusted to reflect the latest draft SAP10 carbon factors. These factors are regarded by the GLA to be more accurate than the currently adopted regulatory figures, and therefore have been used in order to report the potential emissions from the development proposals.

As such, the adjusted SAP10 emissions have been utilised and referenced within this report. The scheme will still have to comply with the currently adopted carbon factors for the purposes of the Building Regulations Part L, so these results are also provided.

It should also be noted that the compliance methodology was produced with the sole intention of demonstrating compliance with the Building Regulations Part L. As such, standardised assumptions are made regarding building occupancy, use, conditioning setpoints etc. It is therefore important to note that they are intended to be used on a comparable scale, rather than give accurate predictions of real energy use. The results herein are provided solely for the purposes of demonstrating compliance and are not intended as an accurate prediction of operational energy use.

The energy calculations have been undertaken by an accredited Energy Assessor, licensed to use all applicable assessment software's.

6.4. The thermal model

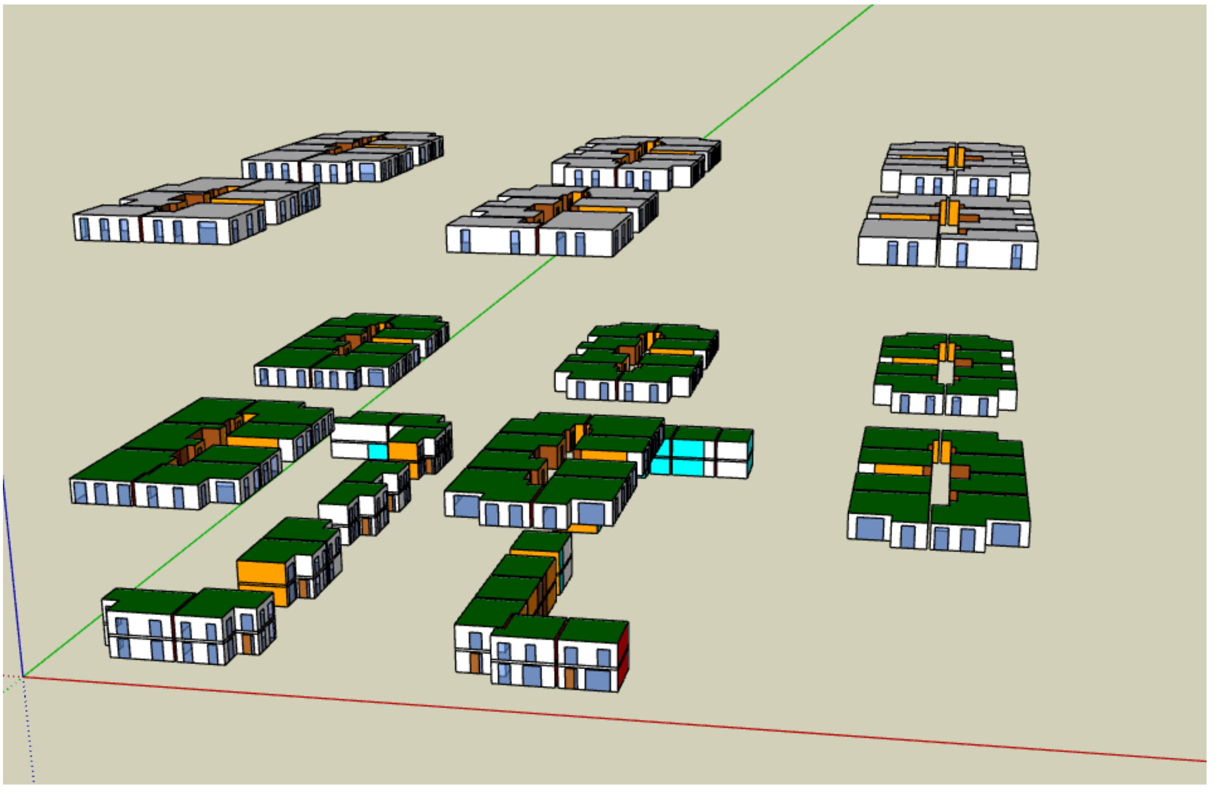

Figure 9.Sketchup Model

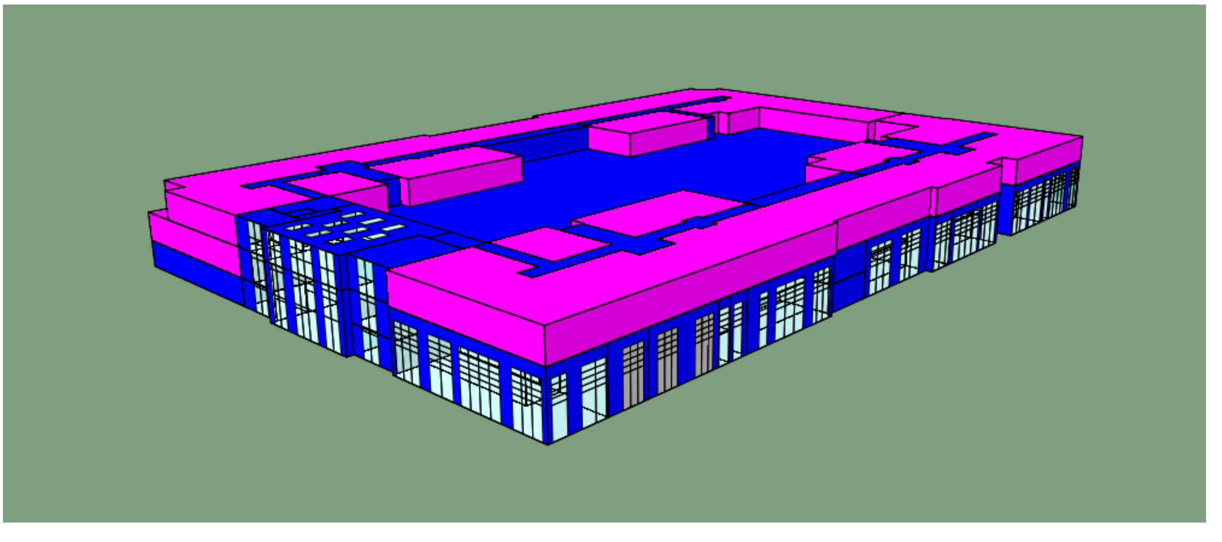

Figure 10.IES Thermal Model

7. Establishing the Baseline Emissions

Residential and Commercial assessments have been undertaken to assess regulated energy use, accounting for energy demands from space heating and hot water, and electricity for pumps, fans and lighting. Unregulated energy use was also determined using the assessments.

The energy assessment has first established the regulated CO_2 emissions assuming the development complied with Part L 2013 of the Building Regulations using the Building Regulations approved compliance software. When determining this baseline, it has been assumed that the heating would be provided by gas boilers and that any active cooling will be provided by electrically powered equipment.

The TER is the maximum permitted emissions for each new dwelling / non-domestic building and is expressed in $kgCO_2/m^2$.

The unregulated emissions from the for the domestic / non-domestic buildings are extracted from the SAP / SBEM calculations. However, since the developer has no control over this aspect of energy use, no energy saving measures can be proposed. Therefore, no change to the unregulated emissions will occur.

Scenario	Regulated CO_2 emissions (Tonnes CO_2/annum)	Unregulated CO_2 emissions (Tonnes CO_2/annum)
Baseline	417.4	249.4

Table 5. Carbon Dioxide Emissions at baseline stage of the Energy Hierarchy for domestic buildings

Scenario	Regulated CO_2 emissions (Tonnes CO_2/annum)	Unregulated CO_2 emissions (Tonnes CO_2/annum)
Baseline	34.5	12.2

Table 6. Carbon Dioxide Emissions at baseline stage of the Energy Hierarchy for non-domestic buildings

BE LEAN

Use Less Energy

8. Be Lean: Use Less Energy

This section outlines the energy efficiency proposals to minimise energy demand. Performance and savings are assessed against the previously calculated 'baseline' emissions.

At an early stage, the design team have explored a range of energy efficiency measures including enhanced U-values and the use of efficient mechanical ventilation systems. The London Plan target under the 'Be Lean' policy is to report an improvement on the baseline case with energy efficiency measures alone, as below:

1. Domestic developments should achieve at least a 10 per cent improvement on Building Regulations from energy efficiency
2. Non-domestic developments should achieve at least a 15 per cent improvement on Building Regulations from energy efficiency.

So that the improvements from energy efficiency alone can be properly understood, aspects of the proposals that relate to efficient supply of energy (energy centre proposals) or renewable energy generation, have not been included at this stage.

8.1. Thermal Envelope - Commercial

Fundamental to achieving energy efficiency in any building is a suitably designed and specified thermal envelope. Passive design features such as appropriate orientation, balancing solar gain and limiting heat loss are all proven techniques to reduce energy consumption. In addition, minimising thermal bridging and controlling air infiltration are important factors.

The following tables illustrate the proposed building fabric performance specification, with respect to the limiting values stipulated in Part L 2013. It is shown that the proposed specification represents a significant betterment of the minimum standards.

Element	Part L Average Minimum U-value (W/m²K)	Proposed U-value (W/m²K)	% Improvement	g-value	Light transmission
External Wall	0.35	**0.18**	48%	-	-
Ground Floor	0.25	**0.20**	20%	-	-
External Roof	0.25	**0.13**	48%	-	-
Roof Lights	2.20	**1.40**	36%	0.3	0.50
Windows	2.20	**1.40**	36%	0.4	0.71

Table 7. Proposed Building fabric specification
Table 8.

Element	Part L Maximum Permeability $m^3/(h.m^2)$ @50 Pa	Proposed Permeability $m^3/(h.m^2)$ @50 Pa	% Improvement
Air permeability	10.00	4.00	60%

Table 9. Building airtightness specification

It should also be noted that all specification is subject to review, and as such U-Values, G-Values and thermal bridging details will be investigated further throughout the design stage, with the aim of limiting heat loss, and to reduce emissions as much as practically possible.

8.2. Building Services – Commercial

Following on from the overheating assessment it has been determined that cooling will be required so a Variable Refrigerant Flow (VRF) system has been proposed to provide both heating and cooling to all occupied spaces using refrigerant. The use of refrigerant maximises efficiency by allowing for heat recovery and reduces gains internally via the distribution system. Furthermore, it minimises the size and space required by the distribution network.

The ventilation will be provided by zonal Mechanical Ventilation with Heat Recovery (MVHR) units which will also include a summer bypass.

Domestic Hot Water (DHW) will be provided by a central Air Source Heat Pumps (ASHP) system with storage and secondary circulation. As this is the dominant load in the building connections will also be left to connect to any future district systems.

Element	Specification
Heating	Air Source Heat Pumps (ASHP) using a Variable Refrigerant flow (VRF) system to supply fan coil units to spaces. The VRF system will also include for heat recovery within the refrigerant system to maximise efficiency. SCOP=2.8 (Note for Lean & Clean stage the ASHP is replaced with a Gas-fired boiler with a 96% gross seasonal efficiency in line with GLA guidance)
Cooling	Air Source Heat Pumps (ASHP) using a Variable Refrigerant flow (VRF) system to supply fan coil units to spaces. The VRF system will also include for heat recovery within the refrigerant system to maximise efficiency. SEER= 4.5-5.5; EER=3.5
Hot Water	Communal Air Source Heat Pumps (ASHP) connections will be left to connect to any future district systems SCOP=2.8 (Note for Be Lean stage the ASHP is replaced with a Gas-fired boiler with a 96% gross seasonal efficiency in line with GLA guidance)
Background Lighting	100 lamp lm/W with an LOR of 1.0 applied for all areas.
Display Lighting	100 lamp lm/W with and LOR of 1.0
Lighting Controls	PIR to all areas. Daylight dimming included within lobby.
Ventilation	Mechanical Ventilation with Heat Recovery (MVHR) units providing supply and extract. Specific Fan Power (SFP) – 1.1-1.4 W/l/s, heat recovery effectiveness - 75%
Power Factor correction (PFC)	A Power Factor Correction device has been assumed to achieve a factor of <0.90

Table 10. Building services specification

8.3. Thermal Envelope – Domestic

Compliance has been attained by targeting values closer to the notional u-values set out within Table 4: Summary of concurrent notional dwelling specification, Approved Document L1A. The Target Fabric Energy Efficiency (TFEE) has been achieved by incorporating targeted psi values into the calculations to reduce heat losses via thermal bridging.

Element	Part L Average Minimum U-value (W/m²K)	Proposed U-value (W/m²K)	Resultant U-value (W/m²K)	% Improvement	g-value	Shelter Factor
External Wall	0.30	**0.18**	-	40%	-	-
Walls to Core	0.30	**0.30**	**0.14**	53%	-	4
Walls to Corridor	0.30	**0.21**	**0.11**	63%	-	4
Walls to Refuse	0.30	**0.21**	**0.20**	33%	-	0.33
Ground / Exposed Floors	0.25	**0.13**	-	48%	-	-
External Roof	0.20	**0.13**	-	35%	-	-
Doors	3.00	**1.40**	-	53%	-	-
Windows	2.00	**1.40**	-	30%	0.4	-
Thermal Bridging	0.15	**0.072-0.186**	-	-24% - 52%	-	-

8.4. Building Services - Domestic

Space heating and domestic hot water (DHW) will be provided by a Communal Air Source Heat Pump. Individual heating controls will be installed in each dwelling which will incorporate a Charging system linked to use of community heating, programmer and at least two room thermostats.

Ventilation to all Dwellings will be via Mechanical Ventilation Heat Recovery Units (MVHR) which will have a low Specific Fan Power (SFP) and high heat recovery efficiency. These units will also incorporate summer bypass of the heat recovery.

Low energy lighting will be specified throughout. In line with the DBSCG this means having a having a luminous efficacy of greater than 45 lumens per circuit watt and an output of greater than 400 lamp lumens. Typically, this will be achieved with LEDs or compact fluorescent lights and not low voltage Halogen variants.

Element	Specification
Heating	Communal Air Source Heat Pumps (ASHP) SCOP=2.8 (Note for Lean & Clean stage the ASHP is replaced with a Gas-fired boiler with a 96% gross seasonal efficiency in line with GLA guidance)
Heating Emitter	System with Radiators
Heating Control	Charging system linked to use of community heating, programmer and at least two room thermostats
DHW	From main heating system
Water Consumption	≤105 litres/person/day
Internal fixed lighting	100% low energy.
Ventilation	Mechanical Extract Ventilation with Heat Recovery–Nuaire MRXBOX-ECO2 (or equivalent efficiency)
Thermal Bridging	Calculated Thermal Bridging Targeted: E2 LINTEL (TARGETED PSI VALUE 0.20) E4 JAMB (TARGETED PSI VALUE 0.05) E5 GROUND FLOOR (TARGETED PSI VALUE 0.16) E6 INTERMEDIATE FLOOR (TARGETED PSI VALUE 0.07) E7 PARTY FLOOR (TARGETED PSI VALUE 0.10) E23 INSET BLACONIES (TARGETED PSI VALUE 0.30) E18 PARTY WALL (TARGETED PSI VALUE 0.06)

8.5. Results Summary – Be Lean

Scenario	Regulated CO_2 emissions (Tonnes CO_2/annum)	Unregulated CO_2 emissions (Tonnes CO_2/annum)
Baseline	417.4	249.4
Be Lean	360.7	249.4

Table 11. Carbon Dioxide Emissions after Be Lean stage of the Energy Hierarchy for domestic buildings

Scenario	Regulated CO_2 savings (Tonnes CO_2/annum)	CO_2 reduction (%)
Savings from 'Be Lean'	56.7	14%

Table 12. Regulated Carbon Dioxide savings from Be Lean stage of the Energy Hierarchy for domestic buildings

Scenario	Regulated CO_2 emissions (Tonnes CO_2/annum)	Unregulated CO_2 emissions (Tonnes CO_2/annum)
Baseline	34.5	12.2
Be Lean	31.5	12.2

Table 13. Carbon Dioxide Emissions after Be Lean stage of the Energy Hierarchy for non-domestic buildings

Scenario	Regulated CO_2 savings (Tonnes CO_2/annum)	CO_2 reduction (%)
Savings from 'Be Lean'	5.4	9%

Table 14. Regulated Carbon Dioxide savings from Be Lean stage of the Energy Hierarchy for non-domestic buildings

BE CLEAN

Supply Energy Efficiently

9. Be Clean: Supply Energy Efficiently

9.1. District Heating

Where location and development permits; the opportunity of connecting to existing district heating networks (DHN) or the creation of new district heating networks should be considered. District heating networks have the potential to offer significant energy, carbon and cost savings over localised alternatives. District heating networks often utilise low-carbon energy generation/harnessing technologies such as Anaerobic Digestion (AD), Combined Heat and Power (CHP) and Waste Heat Recovery (WHR). Given the ongoing decarbonation of the national grid, more heat pump technology is expected to be introduced over time. District networks also enable heat loads to be balanced between sites and therefore plant to operate more continuously and efficiently.

District energy networks are only generally feasible where there is a high density of heat demand. Capital costs and distribution losses must be relatively insignificant to support their viability. Where an opportunity exists, the network operator should be contacted to assess the viability and costs of connection.

In London, there is a desire to generate at least 25% of heat and power through localised decentralised energy systems by 2025. As such, the London Boroughs were commissioned to identify the energy loads and energy densities within their region. This information has been used to develop The London Heat Map which shows the potential, proposed and existing district heat networks.

The London Heat Map has been investigated for the development site. There are no existing district heating networks within the vicinity of the development.

Given the above it is not feasible to connect to an existing DHN. However, where practicable the building systems will be designed to facilitate a potential future connection should one become available during the operational lifetime of the building.

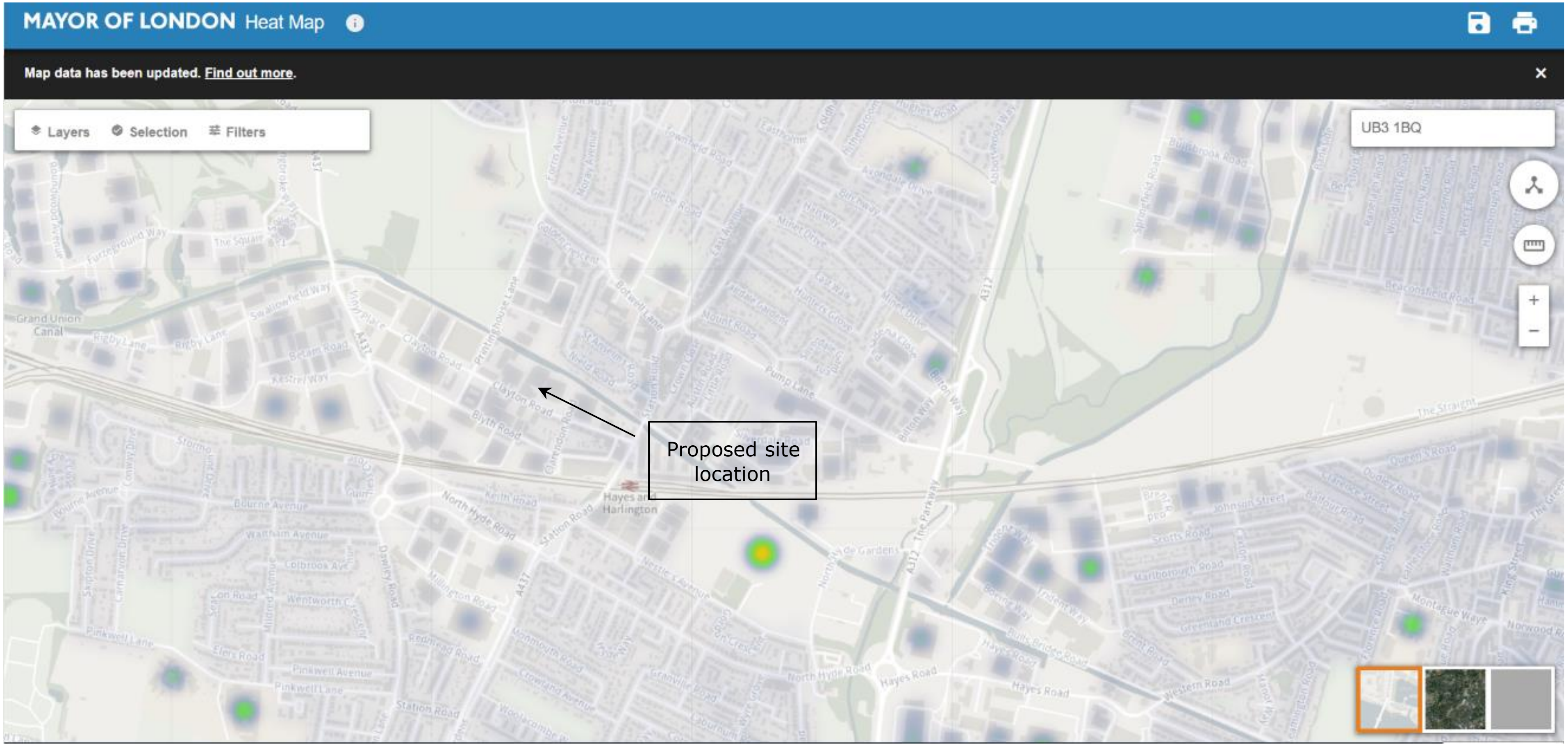

Figure 11.London Heat Map for the site region[1]

[1] https://www.london.gov.uk/what-we-do/environment/energy/london-heat-map/view-london-heat-map

9.2. Site wide heat network

As described above, the proposal in the commercial units is to provide individual VRF systems to each unit for heating and cooling with a connection to the building's ASHP driven LTHW network for DHW production, which is the dominant load, a communal air source heat pump array is proposed. For the residential aspect of the development the air source heat pumps supply all necessary energy for DHW and heating production in each apartment. This will be designed to allow for connection to any future district system which could then benefit the whole building.

The heat source incorporated within the energy centres has been explored to establish what kind is most feasible to provide the targeted carbon savings.

The heating hierarchy requires developments to assess the feasibility of using zero-emission or local secondary heat sources.

The are no sewage plants, enclosed tube networks or data centres close to the development. As such there is not considered to be any feasible secondary heat sources available.

The proposals are therefore to utilise heat pump technology as much as practical to generate heat for the development. Heat pumps are introduced into the energy hierarchy at the 'Be Green' stage, so are detailed in the Be Green section of this report.

9.3. Be Clean summary

There are currently no existing district heating networks within the vicinity of the development and so connection to an existing network is not currently an option.

In line with the London Plan requirements, a decentralised LTHW system is proposed, and shall be designed in such a way, as to allow for efficient connection to a future district scheme, should one become available. Accordingly, the proposals have shown that enough space has been allocated for sufficiently large plant area. A pipework route to the energy centre has been allow for on the layouts along with a manhole at the boundary for future connection.

Integration of heat sources within the plant room has been investigated, and it has been concluded that heat to the building shall be implemented utilising communal ASHP technology, which are considered at the 'Be Green' stage of the hierarchy for the domestic and the DHW is counted toward the 'Be Clean' stage within the commercial assessments.

There is therefore no change to the CO2 emissions after the 'Be Clean' assessment for the domestic elements, when compared to the 'Be Lean' assessment.

9.4. Results Summary – Be Clean

Scenario	Regulated CO_2 emissions (Tonnes CO_2/annum)	Unregulated CO_2 emissions (Tonnes CO_2/annum)
Baseline	417.4	249.4
Be Lean	360.7	249.4
Be Clean	360.7	249.4

Table 15. Carbon Dioxide Emissions after Be Clean stage of the Energy Hierarchy for domestic buildings

Scenario	Regulated CO_2 savings (Tonnes CO_2/annum)	CO_2 reduction (%)
Savings from 'Be Lean'	56.7	14%
Savings from 'Be Clean'	0	0%

Table 16. Regulated Carbon Dioxide savings from Be Clean stage of the Energy Hierarchy for domestic buildings

Scenario	Regulated CO_2 emissions (Tonnes CO_2/annum)	Unregulated CO_2 emissions (Tonnes CO_2/annum)
Baseline	34.5	12.2
Be Lean	31.5	12.2
Be Clean	26.1	12.2

Table 17. Carbon Dioxide Emissions after Be Clean stage of the Energy Hierarchy for non-domestic buildings

Scenario	Regulated CO_2 savings (Tonnes CO_2/annum)	CO_2 reduction (%)
Savings from 'Be Lean'	3.0	9%
Savings from 'Be Clean'	5.4	16%

Table 18. Regulated Carbon Dioxide savings from Be Clean stage of the Energy Hierarchy for non-domestic buildings

BE Green

Use Renewable Energy

10. Be Green: Use Renewable Energy

10.1. Overview

Renewable energy is defined as energy derived from energy flows that occur naturally and repeatedly in the environment. It may be contrasted with energy sources that can be depleted such as fossil fuels or uranium-238-based nuclear power. It therefore follows that the commonly used phrase "equipment to generate renewable energy" is an oxymoron since renewable energy cannot be "generated" – the true function of the technology is to harness a natural energy flow.

Renewable energy technologies, with a couple of exceptions, all utilise energy from the sun – either directly or indirectly, the exceptions being true geothermal, which uses heat from the earth's core, and tidal / marine current electricity generation which uses the gravitational forces between the earth and the moon, (although some marine currents are also greatly affected by solar energy). Insofar as this report is only concerned with practical options for on-site renewable energy, these options are not considered further. The remaining range of "solar" technologies are however vast, and some would not even appear to be solar on superficial inspection. They can be summarised as follows:

- Solar thermal – direct heating of water for space heating or domestic hot water
- Photovoltaic – direct generation of electricity from sunlight
- Hydroelectricity – use of solar (water cycle) driven water flows to generate electricity
- Wind turbines – use of solar driven air movement to generate electricity
- Heat pumps – extraction of solar heat from the earth, atmosphere or water bodies
- Bio-fuels – combustion of solid or liquid biofuels to produce heat or electricity

The technologies, and their potential application to this site are discussed in more detail in the following sections. However, one further pertinent point must be made. The reason for adopting renewable energy technologies is to reduce greenhouse gas emissions – mainly carbon dioxide, and none of the technologies are wholly "zero carbon". This is because when the whole life cycle is considered, some energy must be put into every system to manufacture and maintain the equipment (which has a finite life) or to operate the equipment, and generally at present this energy is derived from non-renewable sources. Examples include the energy needed to refine and process the silicon used to manufacture photovoltaic panels, the diesel fuel used to transport wood pellets to the development and to power the wood processing machinery, and where applicable to biofuels, the energy used to manufacture the fertilizers needed to maintain soil fertility.

Finally, due to the dynamic and innovative nature of the renewable energy technology industry even apparently similar products can differ in vital practical details which means that detailed design of installations must be undertaken by experts, often working closely with the product manufacturers, as virtually no two products are identical or interchangeable.

The following section contains an overview of the technologies selected for this development. For more detailed analyses of all listed technologies, and the reasons for their exclusion, please see Appendix A.

10.2. Heat Pumps

Heat pumps collect low temperature heat and "concentrate" it to a usable temperature. A typical heat pump serving a heat network will typically deliver 2-3 kWh of useful energy for every 1 kWh of input energy. A heat pump operating in this way can therefore be deemed to have delivered 1-2 kWh of low carbon energy.

There are two common types of heat pump – ground source and air source. Water source heat pumps are also available, but rarely applicable, as they require a local large body of water. In urban locations such as this, ground source heat pumps are also rarely viable, due to the complexity of drilling boreholes to collect heat. These are typically up to 100m deep and should be spaced at least 6m apart to avoid over-cooling the ground. A typical borehole can deliver a maximum output of 4kW of heat; therefore, a significantly large area is required in order to be considered feasible.

Air source heat pumps collect heat from the ambient air using air-heat-exchanger units.

Whilst heat pumps can provide good levels of performance, they have practical limitations. Firstly, to be effective, the units must be located externally, which can impact acoustically as well as on visual amenity and space. In addition, as heat pumps collect heat from the air, their efficiency is intrinsically linked to air temperature. Therefore, when the demand for heat is at its peak, the efficiency of the system is at its lowest. Furthermore, as the system relies on grid-produced electricity to operate, its real carbon emissions will be heavily linked to the variable carbon intensity of the national grid.

The introduction of SAP10 carbon emission factors has, in most cases, resulted in heat pumps being the only viable option to reduce carbon emissions in line with London Plan target requirements. The challenge for the design team is how to incorporate this technology where it can operate at its most efficient capacity, and it is anticipated that these will need to be at roof level in most cases.

The proposal for this development is to locate ASHP's on one of the roofs. the ASHP's on the roof will provide all DHW and heating requirements to the apartments and DHW to the commercial units. provision for secondary VRF systems will be provided at the lower levels for each shell and core commercial unit heating and cooling.

The VRF system supplying heating will be reverse cycle so it is capable of providing the mechanical cooling required in each commercial unit also in an adjacent conditioned zone but crucially, as it is part of a VRF system, it will be able to recover heat within the refrigerant network whenever possible to maximise efficiency.

Element	Specification
Heating	Air Source Heat Pumps (ASHP) using a Variable Refrigerant flow (VRF) SCOP=2.8
Hot Water	Air Source Heat Pumps (ASHP) SCOP=2.8

Table 19. Heat pump Efficiency figures

10.3. Solar Photovoltaics (PV)

Photovoltaic panels are conceptually straightforward. The panels produce "zero carbon" electricity that is used in place of grid electricity, and the carbon dioxide emissions saved are the emissions that would have occurred had the electricity been produced by a power station feeding the grid.

Photovoltaic panels have certain siting constraints. To produce the maximum output, they should face due south, although south-east to south-west is certainly acceptable, and even east or west will be acceptable if the angle of inclination is no more than 20º. When not in direct sunlight but shaded by obstacles such as adjacent buildings or trees, the output of the affected panel is significantly reduced. As groups of panels are connected electrically in "series" a reduced output from one panel will reduce the output from all the panels in the group. This means that it is particularly important to avoid shading. However, photovoltaic panels have many advantages. They are clean, silent, reliable, low maintenance, and are easy to install. They also have a very long life – up to 40 years – which is at least double that typically quoted for other technologies.

In addition, and unlike most solar thermal panels, and most other renewable energy technologies, photovoltaic panels are "zero carbon" in use. They simply produce electricity when exposed to sunlight. However, the situation is rather different when the carbon dioxide emissions are determined using a "whole life cycle analysis" approach that includes the energy and other greenhouse gas emissions associated with panel.

This development proposal is well suited to photovoltaic panel technology and there is available roof space.

The system inverter will convert DC output to AC, bringing power into phase with the mains electricity supply. If there is any surplus electricity produced, this can be exported to the grid to be utilised by others.

It is calculated that a series of PV arrays can be installed on the roof of the development, totalling 222kWp. This maximises the amount of roof space available. Figure 9 on the next page shows the location of the proposed arrays.

Note that the specifics of the PV design, shall be evaluated fully during detailed design by a suitably qualified specialist.

Element	Specification
Array Size	222kWp; 549 Panels (Based on 405W panels)
Orientation and Tilt	South Facing - 0-15° pitch

Table 20. PV specification modelled

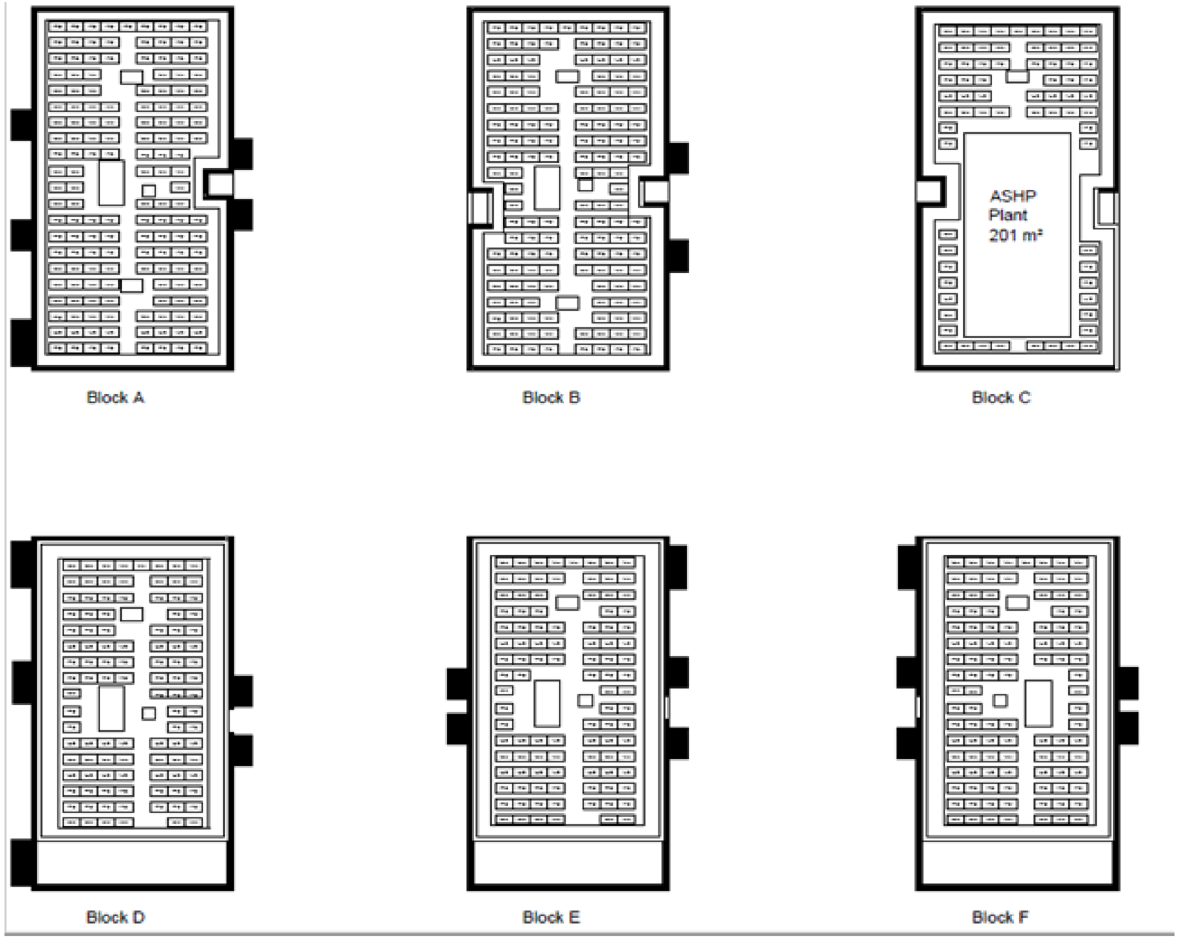

Figure 12.Proposed PV array to be confirmed at detailed design

10.4. Results Summary – Be Green

Scenario	Regulated CO_2 emissions (Tonnes CO_2/annum)	Unregulated CO_2 emissions (Tonnes CO_2/annum)
Baseline	417.4	249.4
Be Lean	360.7	249.4
Be Clean	360.7	249.4
Be Green	126.7	249.4

Table 21. Carbon Dioxide Emissions after Be Green stage of the Energy Hierarchy for domestic buildings

Scenario	Regulated CO_2 savings (Tonnes CO_2/annum)	CO_2 reduction (%)
Savings from 'Be Lean'	56.7	14%
Savings from 'Be Clean'	0	0%
Savings from 'Be Green'	234.0	56%
Cumulative on-site savings	**290.7**	**70%**
Remaining emissions to offset	3,801	-

Table 22. Regulated Carbon Dioxide savings from Be Green stage of the Energy Hierarchy for domestic buildings

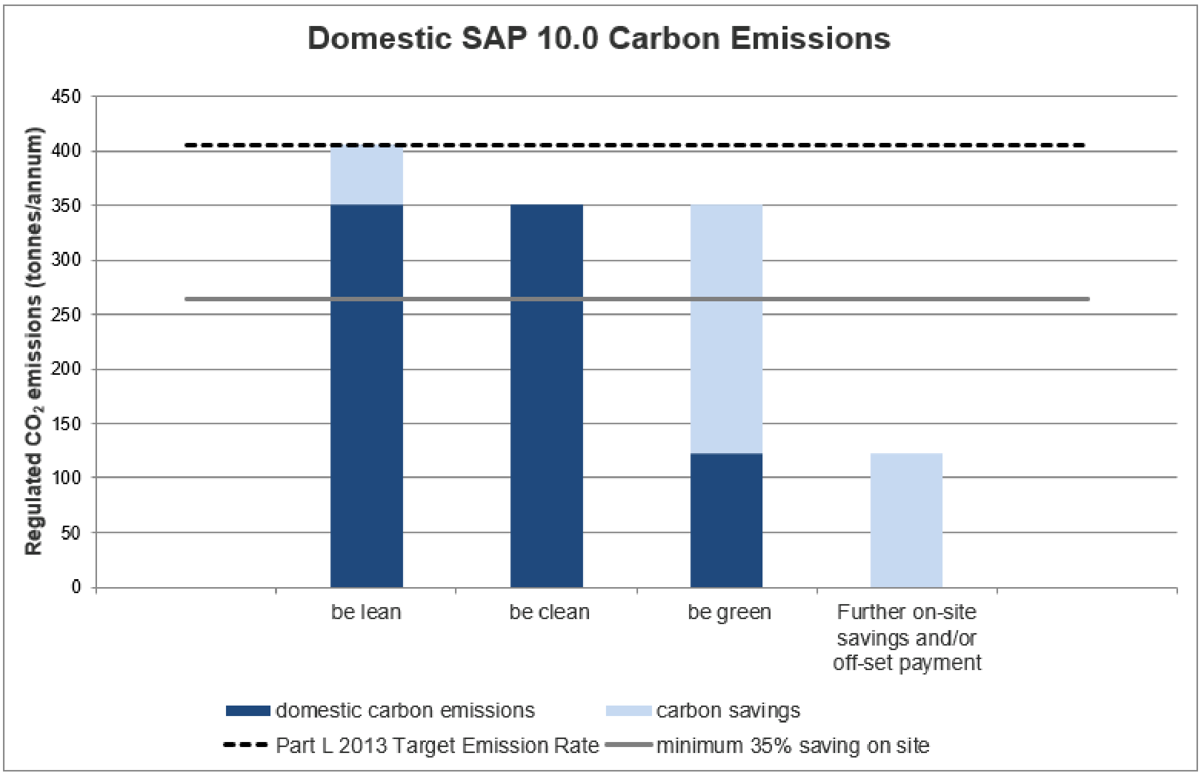

Figure 13.Domestic CO_2 savings through the Energy Hierarchy

Scenario	Regulated CO_2 emissions (Tonnes CO_2/annum)	Unregulated CO_2 emissions (Tonnes CO_2/annum)
Baseline	34.5	12.2
Be Lean	31.5	12.2
Be Clean	26.1	12.2
Be Green	23.2	12.2

Table 23. Carbon Dioxide Emissions after Be Green stage of the Energy Hierarchy for non-domestic buildings

Scenario	Regulated CO_2 savings (Tonnes CO_2/annum)	CO_2 reduction (%)
Savings from 'Be Lean'	3.0	9%
Savings from 'Be Clean'	5.4	16%
Savings from 'Be Green'	3.0	9%
Cumulative on-site savings	**11.4**	**33%**
Remaining emissions to offset	23.2	-

Table 24. Regulated Carbon Dioxide savings from Be Green stage of the Energy Hierarchy for non-domestic buildings

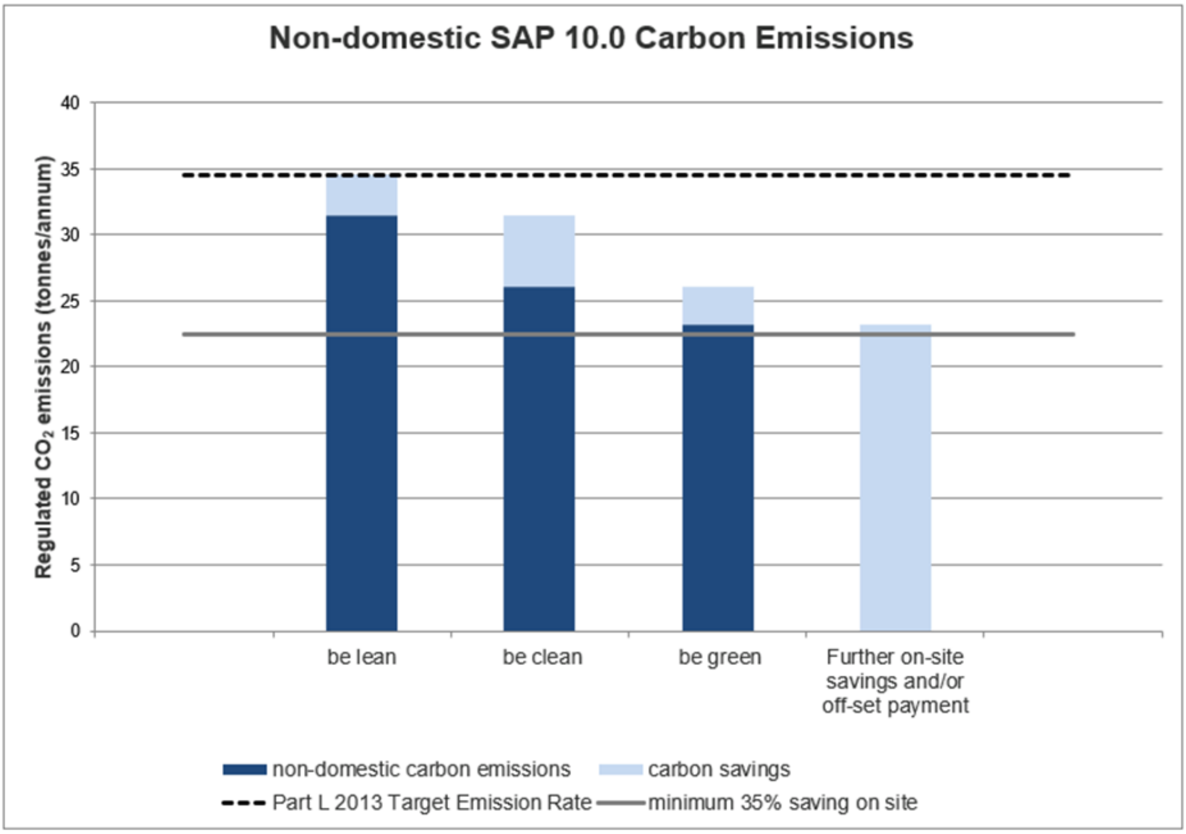

Figure 14. Non-domestic CO_2 savings through the Energy Hierarchy

11. Carbon Offset

If the net zero-carbon target cannot be met on site and the GLA is satisfied that onsite savings have been maximised, then the remaining emissions are offset via a financial contribution to the relevant Borough's carbon offset fund.

Contributions to the carbon offset fund are to be spent within the vicinity of the named development and used for retrofitting existing buildings, decentralised energy networks, renewable energy or any other programme that achieves a calculable reduction in carbon emissions.

In accordance with The Hillingdon planning policy, the offset fee is calculated as £95/tonne for a period of 30 years. The offset fee required can therefore be calculated as per the below:

Scenario	Regulated CO_2 savings (Tonnes CO_2/annum)	CO_2 reduction (%)
Savings from 'Be Lean'	56.7	14%
Savings from 'Be Clean'	0	0%
Savings from 'Be Green'	234.0	56%
Cumulative on-site savings	**290.7**	**70%**
Remaining emissions to offset	126.7	-
	Tonnes (Co_2)	
Cumulative savings for offset payment (for 30 years)	**3,801**	-
Cash in-lieu contribution*	**£228,088**	-

**Carbon price is based on GLA recommended price of £60 per tonne of carbon dioxide*

Table 25. Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for domestic buildings showing the carbon offset payment

Scenario	Regulated CO_2 savings (Tonnes CO_2/annum)	CO_2 reduction (%)
Savings from 'Be Lean'	3.0	9%
Savings from 'Be Clean'	5.4	16%
Savings from 'Be Green'	3.0	9%
Cumulative on-site savings	**11.4**	**33%**
Remaining emissions to offset	23.2	-
	Tonnes (Co_2)	
Cumulative savings for offset payment (for 30 years)	**695**	-
Cash in-lieu contribution*	**£41,684**	-

Table 26. Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for domestic buildings showing the carbon offset payment

It should be noted however that the exact amount will change dependent on detailed design, and specific products specified for construction, as such it is the case that this payment be recalculated post-construction, and true figures calculated from the 'As Built' emissions.

12. Conclusions

This Energy Statement has outlined the proposed preliminary specification for the development and the resulting savings implemented at each stage of the energy hierarchy. The baseline has been created by establishing the current Regulatory minimum standard and adjusting the figures to reflect the latest draft CO_2 emission factors as desired by the GLA.

The possibility of connecting to an existing District Heat Network and been found to be feasible. The opportunity for on-site heat networks has been evaluated and found to be technically viable for LTHW production. Therefore, an ASHP system shall be implemented, with provision made to allow for connection to a future district heating scheme if one becomes available.

Additional energy and CO_2 savings will then be achieved through the use of a photovoltaic array.

The measures implemented at the Be Green stage produce a CO_2 reduction of 67% against the baseline using the SAP10 carbon factors. This exceeds the minimum required 35%.

The remaining emissions shall be offset via a £269,772 contribution to The London Borough of Hillingdon carbon offset fund in order to contribute to sustainable improvements elsewhere in the Borough.

Therefore, the foregoing results show that the development proposals have been assessed in line with the applicable planning policies of the London Plan: London Plan Policy SI.2 Minimising greenhouse gas emissions; London Plan Policy SI.3 Energy Infrastructure; and London Plan Policy, in addition to the local policies of The Borough of Hillingdon.

Appendices

Appendix A - Renewable Technology Considerations

Solar Thermal Systems

Solar thermal panels use the sun's energy to contribute to the heat energy needed to provide space heating and/or domestic hot water. They are perhaps the oldest, and certainly the most obvious and easily understood type of renewable energy technology.

The panels consist of a roof-mounted solar heat collector which can be either a flat plat or tube system containing water, or a more complex evacuated tube system, which in some cases utilises "heat pipes". The systems also include provision to ensure that the water in the panel does not freeze in winter, and pumps to drive the "solar circuit". The principal disadvantage with solar thermal systems is that the heat cannot be stored for long periods, and unlike electricity cannot be exported when surplus is available.

In large schemes such as this, an array of panels would be connected to a storage vessel in the plant room. The amount of fossil fuel that can be saved is limited to the amount that would have been used if the solar heated water was not available. If surplus hot water is produced it will be wasted, so cannot be counted when determining the amount of renewable energy being delivered. Solar thermal systems also use electricity to power the pumps needed to circulate the heat exchange fluid through the solar panels, and the resulting carbon emissions from this electricity must be offset against the emissions saving from the heat collected.

It is considered unlikely that solar thermal technology will provide adequate heat to serve a development of this size. As such, other technology will need to be proposed alongside. This would need to be heat pump technology to ensure the carbon emissions are maximised. It was therefore considered more appropriate to use ASHP to provide all heat, and then the remaining roof space can be allocated to PV panel instead of solar thermal, which would generate electricity instead of heat, where excess energy can be exported in not utilised on site.

It is therefore established that a Solar Photovoltaic array would be a more viable use of this roof space, making solar thermal infeasible.

Micro-Hydroelectricity

The utilisation of "waterpower", together with "wind" is generally recognised as having facilitated the early stages of the Industrial Revolution in Europe. Water wheels were simple to manufacture and produced high torque without gears and simple gears could be used to increase speed. Waterpower was, unlike wind power, controllable, and subject to a sufficient water level in the "mill pond", was available on demand.

Waterpower was of course used to grind wheat to produce flour, but also powered many types of machinery including fans for blast furnaces, and hammer mills used to produce wrought iron. Today, large hydroelectric schemes are still very important energy sources in many countries, although in the UK only 0.8% of the electricity demand is produced in this way, mainly because there are very few suitable sites. The Government estimates that if all the rivers and streams in the UK could be harnessed the output would still only be 3% of the total demand, so while local schemes can be important, strategically, this is one of the less important technologies.

Micro-hydro is the term used for very small schemes, although it is applied to any scheme producing less than 1 MW. On-site micro-hydro is clearly totally dependent on the availability of a suitable river or stream that could be utilised in an environmentally acceptable way, and produce a worthwhile output, and such availability is so limited in typical urban sites as to make this a technology that is generally of no relevance.

The extraction of energy from flowing water will by definition reduce its velocity and change water levels and introducing such changes even to a canalised urban river can have both upstream and downstream impacts. And where the site has a natural ecology, the local impacts can be far greater and the necessary mitigation difficult to achieve. So, in conclusion, the most likely instance where a micro-hydro installation might be possible is one where an existing or historical site can be utilised, but these are very rare.

Micro-Hydro is not suitable for this development.

Wind Turbines

The general principles of operation of small-scale wind turbines are straightforward, and windmills are probably one of earliest ways that mankind harnessed natural energy flows and put them to practical use. However, while conceptually simple, wind turbines present complex challenges both on technical and planning terms and cannot be considered a simple option.

Considering in the first instance only the technical issues, it will first be necessary to establish whether a site has an adequate wind resource. Preliminary checks can be made using the DTI wind speed database and a site with a theoretical average wind speed of at least 5 m/s at 25m above ground level can be suitable. Other relevant issues are the amount of local wind shadowing and turbulence likely to be produced by nearby buildings and trees and whether the site is open in the direction of the prevailing wind. In practice, even on a promising site these issues mean that to have any confidence that a worthwhile amount of electricity could be generated and thereby validate an investment decision it is necessary to carry out extended wind speed measurements, typically over a full year.

In the normal absence of valid wind data at the beginning of a project some guidance is becoming available on the reduction in output typically seen on a sheltered urban site compared to manufacturer's wind-tunnel data. This can be illustrated by reference to the data for a 2.5kWe unit with a rotor diameter of 3.5m. In a rural environment with an average wind speed of 8 m/s, such a unit would produce 10,164 kWh/yr. and reduce carbon dioxide emissions by 5,773 kg. On an urban site where the wind speed is just 4.8 m/s it would produce only 392 kWh/yr. and reduce emissions by just 223 kg. A single turbine of this type would therefore reduce the emissions from the development by a negligible amount so would make no practical contribution to the emissions reduction target.

While this technical review indicates that wind turbines are very unlikely to be feasible, in addition, other issues must be considered. Clearly the overriding issue is the impact on the visual amenity of the site and surroundings and opinions are generally divided on the aesthetics of wind turbines.

So, while large wind turbines installed in "wind farms" in exposed locations and increasingly offshore, can and are providing a substantial amount of the UK's current renewable electricity, the use of micro wind turbines on small residential or commercial developments is of questionable value, and is frequently no more than a token gesture.

Biofuels

In the UK there are essentially two types of bio-fuels available at present. Biomass generally refers to either wood chips or wood pellets. Biodiesel (or plant oil) is a liquid biofuel (chemically modified vegetable oil) that can be used in place of heating oil or to run diesel engines. In the built environment, biodiesel is not a viable proposition at present due to fuel availability and cost, and it is questionable whether this should ever be the case since it is a valuable energy source which can be readily used for transport that cannot at present easily be powered by other biofuels. There are also real issues of the true carbon emissions associated with its production. There are a range of energy inputs associated with growing and processing the fuel, and while it is generally regarded as having a bio-fuel output to fossil fuel input ratio of around 4: 1, some studies suggest it can be 2: 1 or lower.

In contrast, biomass is readily available, requires minimal processing, and a proportion is sourced from the waste stream that would ultimately go to landfill where decomposition releases methane, a greenhouse gas 22 times more potent than CO_2. However, the delivery, storage and utilisation of biomass is far less convenient than gas or even oil. In terms of types of system, there are essentially two – a simple biomass boiler burning either wood chips, which are cheaper but more difficult to handle, or wood pellets.

Biomass heating systems generally need a lot of room to store the fuel, and suitable arrangements to enable it to be delivered to the plant rooms. They are also an extremely high-maintenance system when compared to alternative solutions. Furthermore, the burning of Biofuels has a negative impact on the surrounding air quality which is against the current drive to clean up the air in the city. In this instance, it is not considered a viable option.

Appendix B - CO_2 Emission Factors

CO_2 emission factors are variable and relate to the carbon intensity of the fuel that is supplied to the building. In the case of natural gas, this is fairly stable, and varies only marginally with regard to processing and delivery of the gas to site. In the case of electricity, this varies substantially, and can range by a factor of 10 over the course of a single day. This is due to peaks and troughs in demand, and the associated electricity production methods that are used in order to provide power to the national grid.

The current carbon emission factors are widely regarded as being wholly inaccurate and unfit for purpose

Due to this, the GLA have mandated that all referable planning submissions must instead use revised draft SAP10 carbon factors, that more closely reflect the real-world carbon intensity of the grid.

The below table details the revisions to the CO_2 emission factors, only fuels used within the site proposals have been listed here:

Fuel	Regulatory CO_2 emission factor ($kgCO_2/kWh$)	London Plan (GLA) CO_2 emission factor ($kgCO_2/kWh$)
Natural gas	**0.216**	**0.210**
Grid electricity	**0.519**	**0.233**

Appendix C – DER Worksheets

To follow in email submission

Appendix D – BRUKL Reports

To follow in email submission

Appendix E – GLA Spreadsheet

To follow in email submission