Energy Statement

The Tech Hub
Haymarket Media Group

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APPENDICES

1 EXECUTIVE SUMMARY

This Energy Statement has been developed to detail the influence of the 'Tech Hub' office building on the site wide energy strategy approach for the proposed mixed-use development on Richmond upon Thames College Campus, located within the London borough of Richmond upon Thames.

Detailed in the outline planning consent: U07956 Climate Change Adaptation - 35% CO_2, it is stated that the development should achieve 35% carbon emissions reduction over part L 2013 with 20% of this reduction coming from low carbon decentralized heat and energy networks or renewable energy sources.

Based on the energy strategy contained herein, the proposed 'Tech Hub' is aspiring to deliver 40% carbon dioxide emissions reduction on its regulated load over Part L 2013 (based on the approach, information, analysis and contents reported in this document), with 18% of those savings coming from the low and zero carbon technologies. The following details these measures:

- LEAN – energy efficiency measures delivering up to a 22.5% improvement.
- GREEN – VRF systems and PV delivering up to 18% CO_2 reduction.

Figure 1 below shows the carbon savings for each step in the GLAs suggested hierarchy for carbon savings. The site total regulated energy savings have been modelled at 40%

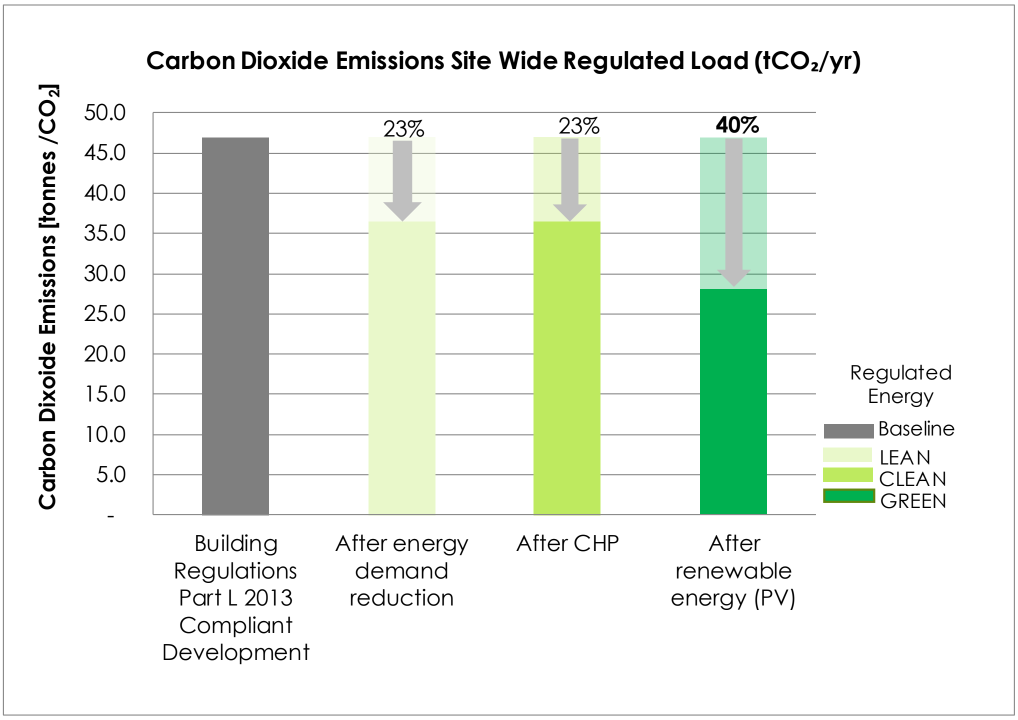


Figure 1: Regulated load carbon emission reduction according to the energy hierarchy

Table 1: Summary of total carbon dioxide emissions for each stage of the hierarchy

	Carbon Dioxide Emissions (tCO_2/yr)		
	Regulated	Unregulated	Total
Building Regulations Part L 2013 Compliant Development and Existing Building (TER)	47.0	37.3	84.3
Be Lean - Local Gas Boilers	36.4	37.3	73.7
Be Clean	36.4	37.3	73.7
Be Green – Heat Pumps and PV	28.0	37.3	65.3

Table 2: Summary of carbon dioxide emissions savings for each stage of the hierarchy

Savings from:	Regulated carbon dioxide savings	
	Tonnes CO_2 per annum	(%)
Be Lean - Local Gas Boilers	10.6	22.5%
Be Clean	0.0	0.0%
Be Green – Heat Pumps and PV	8.4	17.9%
Total cumulative savings	**19.0**	**40%**

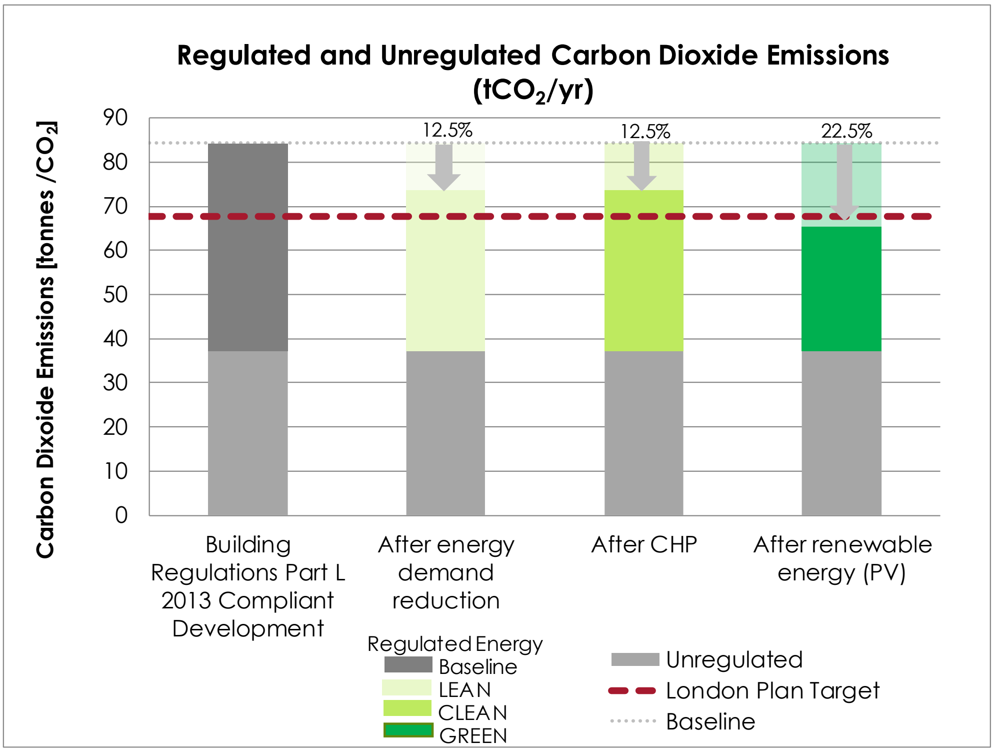


Figure 2: Overall site regulated and unregulated load carbon emission reduction according to the energy hierarchy

2 INTRODUCTION

Hurley Palmer Flatt has been instructed to provide an Energy Statement for the proposed Tech Hub development, located within the London borough of Richmond upon Thames. The report details the assessment process and the estimated CO_2 savings achieved through integration of passive design, energy efficiency measures and Low and Zero Carbon (LZC) technology. It also sets out how the Greater London Authority (GLA) London Plan and Richmond Council policies on energy and CO_2 emissions have been addressed.

The approach taken for the energy assessment is in line with GLA London Plan planning policies for energy as follows:

- Calculate baseline CO_2 emissions;
- Integrate measures to reduce energy demand and ensure efficient use of energy;
- Connect to a heat distribution network where possible
- Integrate renewable energy technology; and
- Calculate total CO_2 savings and final development CO_2 emissions.

2.1 Project Background

Haymarket Media Group is a global specialist media company involved in brand development and publications. The architectural brief for the technical hub is to provide a spaciously bright, flexible open plan space to allow Haymarket staff to work collaboratively within one dynamic space and support its work with the extended campus. Due to the nature of their work there will be high end IT facilities suitable for mobile working and other support areas such as break out lounge areas, recreational games area, kitchen/tea facilities and meeting rooms. The new building is within the existing Richmond Education and Enterprise Campus on the north west corner position. Externally the brief will include 10 car parking spaces (one for disabled use), a service area to the rear and new landscaping. The sports building and residential developments have achieved Reserved Matters planning consent. There is also a new secondary free school and special needs school which were handed over to the schools in June 2018.

The proposed office site is in the north-west corner of the campus adjacent to the A316 arterial road and neighbouring the Stoop, home to Harlequins.

Figure 3: Image of Haymarket Tech Hub

Figure 4: Development Site Location

The calculations in this Energy Statement are based on the drawings issued by TP Bennet on 10th June 2019

Table 3: Schedule of areas based on NIA

Zone	Net Internal Area (NIA) m^2
Total Floor Area	1,414

3 PLANNING POLICY AND BUILDING REGULATION TARGETS

The development has been designed to meet sustainability and energy targets which are driven through:

1. UK Building Regulations
   a. Part L2A – Conservation of fuel and power in new buildings other than dwellings
2. Greater London Authority (GLA) London Plan and relevant SPG's/SPD's;
3. London Borough of Richmond Upon Thames Core strategy
4. Decision Notice for outline planning

3.1 Building Regulation Part L Summary

The development will comply with building regulation Part L 2013 (Conservation of fuel and power in buildings).

a. Part L2A – Conservation of fuel and power in new buildings other than dwellings

Criterion 1 – Achieving the TER
Criterion 1 of L2A 2013 requires the calculated CO_2 Building Emission Rate (BER) to not exceed the Target CO_2 Emission Rate (TER) of the notional building, which is determined by Part L and NCM guidelines.

Criterion 2 – Limits on Design Flexibility
The performance of the individual fabric elements and fixed building services of the building should achieve reasonable overall standards of efficiency as per the requirements of Part L.

Criterion 3 – Limiting the Effects of Solar Gains in Summer
The purpose of Criterion 3 is to demonstrate the building has appropriate control measures to limit solar gain so as to reduce the need for, or capacity of, installed air conditioning systems.

Criterion 4 - Building performance consistent with the BER
This criterion is the responsibility of the Contractor

Criterion 5 - Provisions for energy efficient operation of the building
This criterion is the responsibility of the Contractor

3.2 Greater London Authority (GLA) London Plan

The Greater London Authority (GLA) has set out guidance relating to sustainable design within the London Plan (Spatial Development Strategy for Greater London). The current adopted London plan is dated March 2016, however in January 2019 policy 5.2 has been updated.

Policy 5.2 Minimising carbon dioxide emissions

Current Planning decisions

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

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

B. The Mayor will work with boroughs and developers to ensure that major developments meet the following targets for carbon dioxide emissions reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) outlined in the national Building Regulations leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019.

Non-Domestic Buildings: - Year Improvement on 2013 Building Regulations

- 2010 – 2013 | 25 per cent
- 2013 – 2016 | 35 per cent
- 2016 – 2019 | As per building regulations requirements
- 2019 – 2031 | Zero carbon

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

D. As a minimum, energy assessments should include the following details:

1) calculation of the energy demand and carbon dioxide emissions covered by the Building Regulations and, separately, the energy demand and carbon dioxide emissions from any other part of the development, including plant or equipment, that are not covered by the Building Regulations (see paragraph 5.22) at each stage of the energy hierarchy

2) proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings and services

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

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

E. The carbon dioxide reduction targets should be met on-site. Where it is clearly demonstrated that the specific targets cannot be fully achieved on-site, any shortfall may be provided off-site or through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere.

UPDATES January 2019.
The latest version of the guidance contains a number of updates, including:

- From January 2019, planning applicants are encouraged to use updated (SAP 10) carbon emission factors to assess the expected carbon performance of a new development. Applicants should continue to use the current Building Regulations methodology for estimating energy performance against Part L 2013 requirements (as outlined in Section 6) but with the outputs manually converted for the SAP 10 emission factors. A spreadsheet (version 1.1) has been developed for this purpose which should be submitted alongside an energy assessment. It should be noted that the use of the SAP 10 emission factors in this context is for demonstrating performance against planning policy targets and, as such, is separate to Building Regulation compliance. Applications should therefore ensure that compliance with Building Regulations is maintained.

- Updated information requirements for applicants proposing to install heat pumps and CHP, including clarification on when CHP is appropriate.
- An appendix containing the existing emission limits for heating and energy plant has been added.

Policy 5.6 Decentralised energy in development proposals
Planning decisions

A. 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.

B. 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

C. 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
Strategic

A. The Mayor seeks to increase the proportion of energy generated from renewable sources and expects that the projections for installed renewable energy capacity outlined in the Climate Change Mitigation and Energy Strategy and in supplementary planning guidance will be achieved in London.

Planning decisions

B. 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
Strategic

A. The Mayor seeks to reduce the impact of the urban heat island effect in London and encourages the design of places and spaces to avoid overheating and excessive heat generation, and to reduce overheating due to the impacts of climate change and the urban heat island effect on an area wide basis.

Planning decisions

B. 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).

C. 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. Further details and guidance regarding overheating and cooling are outlined in the London Climate Change Adaptation Strategy.

3.3 Richmond Council Core Strategy

This document sets the strategic policies to be adopted by developments seeking planning permission in the Borough. Policies relating to energy and sustainability are summarised below:

8.1.2 CP2 Reducing Carbon Emissions

2.A The Borough will reduce its carbon dioxide emissions by requiring measures that minimise energy consumption in new development and promoting these measures in existing development, particularly in its own buildings.

2.B The Council will require the evaluation, development and use of decentralised energy in appropriate development.

2.C The Council will increase the use of renewable energy by requiring all new development to Achieve a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation unless it can be demonstrated that such provision in not feasible, and by promoting its use in existing development.

3.4 Site Wide outline planning decisions - 15/3038/OUT (August 2016)

U07956 Climate Change Adaptation - 35% CO_2

The development as a whole shall incorporate climate change adaptation measures, including passive design features and demand reduction measures and the use of low and zero carbon technologies to ensure that a 35% reduction in regulated carbon emissions is achieved when compared to a building regulations 2013 compliant development. Features to include low-energy lighting, mechanical ventilation with heat recovery, high levels of insulation, low water use sanitary-ware and fittings, in accordance with details to be submitted to and approved in writing by the Local Planning Authority and retained in situ thereafter.

a. In respect of each Development Zone, unless otherwise agreed by the planning authority; each development zone shall incorporate efficient design, demand reduction and low carbon and renewable technologies to achieve a minimum 35% reduction in line with the development wide target and at least a 20% contribution to total energy demand within that Development Zone through low carbon decentralized heat and energy networks, or renewable energy sources. Where this is not the case the energy strategy should identify the Development Zone in which the shortfall will be made up and the target for that Development Zone be adjusted accordingly in accordance with detail to be submitted to and agreed in writing by the Local Planning Authority.

4 ENERGY HIERARCHY AND OVERHEATING

4.1 Carbon emission factors

The carbon emission factors are based upon the Part L 2013 published figures:

Table 4: Carbon Emissions Factors

Gas	0.216	$kgCO_2/kWh$
Grid Supplied Electricity	0.519	$kgCO_2/kWh$
Grid Displaced Electricity	0.519	$kgCO_2/kWh$

4.2 Establishing CO_2 Emissions

Table 5 Regulated carbon dioxide savings from each stage of the energy hierarchy for non-domestic buildings

Regulated non-domestic carbon dioxide savings	(Tonnes CO_2 per annum)	(%)
Be lean: Savings from energy demand reduction	10.6	22.5%
Be clean: Savings from heat network	0.0	0.0%
Be green: Savings from renewable energy	8.4	17.9%
Cumulative on-site savings	**19.0**	**40%**

The development exceeds the 35% reduction target and so there is no shortfall in regulated carbon dioxide savings.

4.3 Calculating Regulated CO_2 Emissions for refurbishments

The strategy considers a baseline, which has been defined for the commercial (non-residential) building on the site, as follows:

Commercial (non-residential) areas within the development have been modelled using Integrated Environmental Solutions (IES), Virtual Environment software 2014. This software creates a dynamic thermal model of the building, using ApacheSIM to calculate the building's loads, energy consumption and resulting CO_2 emissions. This software calculates the Building CO_2 Emissions Rate (BER) and Notional Target Emission Rate (TER) using the Building Regulations 2013 methodology based on the National Calculation Methodology (NCM).

4.3.1 Energy Models

IES calculates regulated energy consumption i.e. energy uses considered under Part L 2013, for example heating, cooling, domestic hot water (DHW), and electricity for lighting, pumps and fans. Unregulated energy consumption includes all energy not considered under Part L 2013, for example, gas for catering, small power, lifts and external lighting. An IES model was created for all non-residential spaces to dynamically simulate these areas and estimate the energy consumption and associated carbon emissions.

An estimation of energy consumption has been calculated using the results from IES to provide a total development carbon footprint.

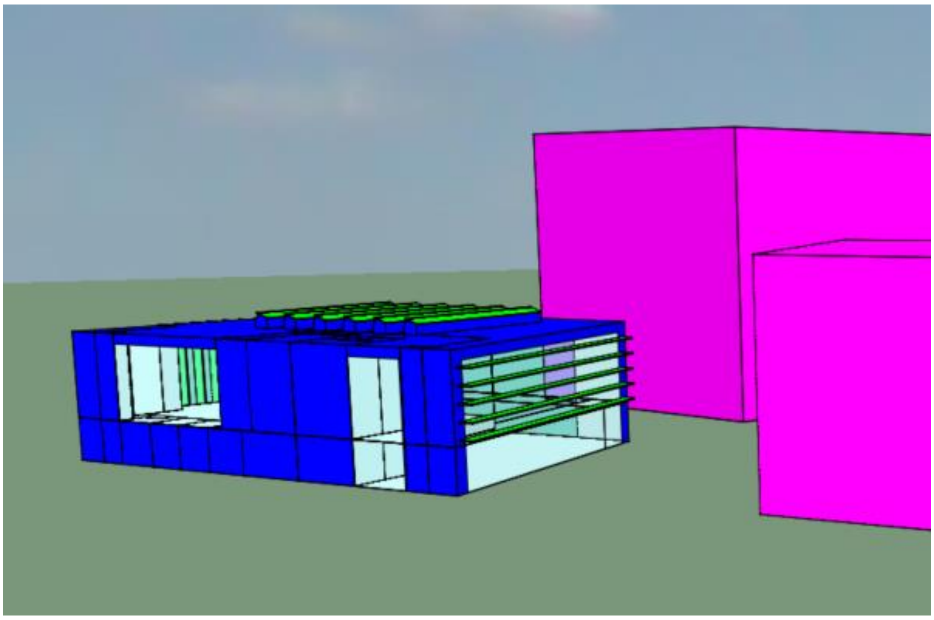


Figure 5: IES model of development

4.4 Baseline Energy Consumption and CO_2 Emissions

The tables below demonstrate the CO_2 emissions for The Tech Hub

Table 6: CO_2 Emissions for the Baseline Scheme Overall Non-Domestic

BASELINE WED14041 Haymarket - The Tech Hub	Carbon dioxide emissions [tCO2/yr]		Carbon dioxide emissions [% of total]	
	Regulated	Unregulated	Regulated	Unregulated
Baseline	47.0	37	56%	44%

The baseline CO_2 emissions are **47 tCO_2** (regulated energy uses).

4.5 Demand Reduction (BE LEAN)

A key element of the energy strategy has been to maximise the energy efficiency of the building through passive design and efficient servicing. The measures included within the design are described in detail below.

4.5.1 Form and Façade

The building has been designed to optimize daylight and sight lines. In doing so careful consideration has been paid to the potential for overheating and glazing g-values and u-values as well as external shading has been carefully assessed to mitigate this.

4.5.2 Optimise Criteria

The design team has looked for opportunities within the design to reduce the heating and cooling loads within the building. Examples of where this has had an impact on the design include the following:

- Optimisation of the lighting strategy has meant that sizable heat loads are removed from the building, negating the requirement for excessive cooling;

- Maximising fabric performance will reduce the space heating loads in winter and cooling loads in summer.

4.5.3 Building Fabric and Passive Design

The following table shows the u-values and air permeability of the existing building and the proposed design

Table 7: Target Fabric and Glazing Specifications

Element		Target and proposed Fabric Targets			
		Notional / Existing Building Values		Proposed Building u-value Targets	
External Wall	u-value	0.26	W/m².K	0.24	W/m².K
Ground Floor	u-value	0.22	W/m².K	0.14	W/m².K
Roof	u-value	0.18	W/m².K	0.17	W/m².K
Doors	u-value	2.2	W/m².K	2.20	W/m².K
Windows	u-value	1.6	W/m².K	1.55	W/m².K
	g-value	0.4		0.30	

4.5.4 Energy Efficient Building Services

The following energy efficiency measures within the building services are proposed for the development:

- Highly efficient lighting to be specified with luminous efficacy of 110 lm/W for all office areas.
- Lighting to all other areas of the buildings will be highly efficient and incorporate occupancy sensors where applicable.
- Heating and cooling will be provided through VRF heat pumps.

Whilst these are the design standards currently targeted, their achievability will be reviewed through detailed design stages to ensure the overall CO_2 reduction targets are maintained, and to consider any design changes.

4.5.5 Be Lean Energy Consumption and CO_2 Emissions

The IES models have been run to calculate the resulting energy consumption and CO_2 emissions considering the passive design and energy efficiency measures detailed within the previous section.

Referring to the baseline scheme, the resulting CO_2 savings for the energy efficient scheme are detailed in the table below:

Table 8 CO_2 savings for the Site-wide Be Lean

'Be LEAN' WED14041 Haymarket - The Tech Hub	Carbon Dioxide Emissions (tCO_2/yr)		
	Regulated	Unregulated	Total
Emissions after demand reduction (tCO_2/yr)	36.4	37	73.7
Savings (tCO_2/yr)	10.6	0	10.6
Savings (%)	22.5%	0.0%	12.5%

The above table demonstrates that there is up to a **13.3% reduction in regulated CO_2** emissions over the existing building for the development, which reduces to a 7.4% reduction when unregulated emissions are considered.

4.6 Cooling and Overheating

Supplementary Planning Guidance encourages developers to undertake dynamic modelling to assess the risk of overheating in their development. Such an assessment is generally an expectation of the GLA regarding Policy 5.9 'Overheating and Cooling' under climate change adaptation, as stated in GLA's energy planning guidance document dated March 2016.

Minimising internal heat generation through energy efficient design:	Minimal infrastructure will be in place in the building
Reducing the amount of heat entering the building in summer	Optimizing g-values and u-values as well as shading to reduce the amount of solar gains entering the building in the summer
Use of thermal mass and high ceilings to manage the heat within the building:	The building has a concrete construction with high ceilings which will allow the heat to rise and the space to remain cool in the summer
Passive Ventilation	This is an office building next to a road and so mechanical cooling is in place due to noise and pollution considerations.
Mechanical Ventilation	Cooling is anticipated to be done through an efficient VRF system.

Table 9 Reporting template for cooling demand

	Area weighted average non-domestic cooling demand (MJ/m^2)	Total area weighted non-domestic cooling demand (MJ/year)
Actual	126.8 (whole building)	212,821
Notional	205.3 (Whole Building)	344,575

All spaces but one pass Criterion 3 as shown in the BRUKL in appendix A, the first-floor office space does not pass criterion 3 by 64%.

4.6.1 Connection to an area wide heat network

The district heating network in Richmond does not currently reach this building and so connection to a district heat network was not included in the design.

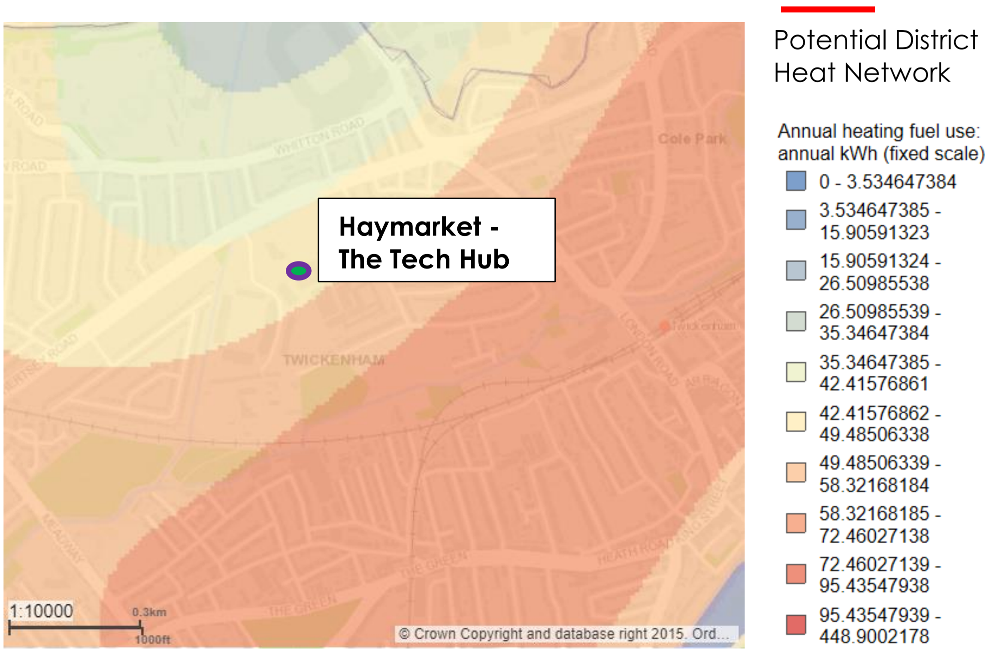


Figure 6: Heat Network Map from https://www.london.gov.uk/what-we-do/environment/energy/london-heat-map/view-london-heat-map

4.6.2 Communal Heating System

The proposed development is a small single development and so it will not be possible to connect to a site wide communal heating system.

4.6.3 Individual Heating System

The development is proposing to use VRF heating throughout the development. This takes advantage of the lower carbon emissions of the electric grid as well as the efficiency of the heat pumps coefficient of performance (COP).

4.6.4 'Be Clean' Energy Consumption and CO_2 Emissions

There are no savings associated with the 'Be Clean' level of the hierarchy, the savings from the heat pumps will be captured under the GREEN energy savings.

4.7 Renewable Energy (BE GREEN)

All Low or Zero Carbon (LZC) technologies identified within both the London Plan and BREEAM credit guidance have been assessed. Where technologies are not considered appropriate to the site and energy demand of the development, justification for their exclusion has been provided.

The following localised green technologies have been considered as viable for the site:

- VRF units
- Photovoltaics

The following localised green technologies have been considered as non-viable for the site:

- Bio fuel combined heat and power (CHP) local in the building
- Biomass (CHP) local in the building
- Fuel Cells
- Biofuel community heating scheme local in the building
- Wind turbines

4.7.1 Feasibility of Renewable Technologies

An initial assessment has been carried out to determine which technologies are technically feasible on the site. For technologies which are identified as feasible, the following factors have been considered to determine which technologies are appropriate in terms of economic and local planning feasibility:

- Energy generated from each LZC energy source per year
- Payback
- Land Use
- Local Planning Criteria
- Noise
- Life cycle cost/lifecycle impact of the potential specification in terms of carbon emissions
- Any available grants

4.7.2 Solar Panels

The roofs are sloped and predominantly face south and west, this being the case solar panels have been deemed viable for this development

The table below summarises the desktop study undertaken to determine the feasibility of solar photovoltaic panels at the site:

Table 18: Key considerations of solar technology

Technology	Criteria	Requirement Met?
Photovoltaic panels		
Roof orientation	Are available roofs facing south-west to south-east (through south), or flat?	✓
Roof space	Is there enough un-shaded roof area?	✓
Electrical demand	Is there electrical demand on site?	✓

PVs are expected to be installed on this project which anticipates a 9.5 kWp capacity installed on the roofs of the building.

Roof space is limited on this development and so solar thermal technology has been deemed not viable for this project as it would conflict with the PV technology for roof space.

Technology	Criteria	Requirement Met?
Solar Thermal		
Roof orientation	Are available roofs facing south-west to south-east (through south), or flat?	✓
Roof space	Is there enough un-shaded roof area?	✓
Hot water demand	Is there year-round hot water demand?	✓
Heating system	Would a solar thermal collector be compatible with the proposed heating system?	✓
Hot water storage	Is there space for a hot water storage vessel?	✓
Conflicts with other systems?	Will solar thermal conflict with other systems (e.g. PV) which are higher up the energy hierarchy?	X

4.7.3 Heat Pumps

The table below summarises the desktop study undertaken to determine the feasibility of heat pumps at the site:

Table 19: Key considerations of heat pump technology

Technology	Criteria	Requirement Met?
Heat distribution system	Is it possible to have a low-grade distribution system e.g. under floor heating?	✓
Heat distribution system	Is it compatible with the proposed cooling system?	✓
Ground-source Heat Pump		
Ground conditions	Has a basic ground study concluded that the site is suitable for GSHP?	-
Horizontal piping	Is there a large area of open land where horizontal piping could be installed?	X
Vertical piping	Is the ground suitable for vertical piping? Can underground obstacles be avoided?	X
Plant room	Is there space allowed for a GSHP and associated auxiliary equipment?	X
Water-source Heat Pump (River or Lake)		
Resource	Is there an available water source close to the site?	X
Access	Can the available water source be accessed?	X
Air Source Heat Pump		

Roof space	Is there available roof space for air-source heat pumps?	✓
Electrical Capacity	Is there sufficient electrical capacity for air-sourced heat pumps	✓

4.7.4 Wind Turbines

The table below summarises the desktop study undertaken to determine the feasibility of either roof mounted or standalone wind turbines at the site:

Table 10: Key considerations of wind technology

Technology	Criteria	Requirement Met?
Stand-alone Wind Turbine		
Wind speed	Is average wind speed greater than 6m/s at hub height?	-
Clear air flow to turbine	Is the area free from obstructions that could cause turbulence?	X
Open land around proposed site	Is there sufficient open land for a turbine to be installed?	X
Distance to nearest property	Are surrounding properties far away enough to avoid noise disturbance?	X

4.7.5 Biofuel Community Heating Scheme

Wood chips / pellets would require many deliveries and storage, not compatible with a city centre location. Liquid biofuel requires less storage space and has been considered in further detail by the design team.

The biodiesel is typically tested against EN14214 and supplied as pure Biodiesel at B100. Certain suppliers have plans to supply liquid biodiesel to sites around London via tanker. The tanker is anticipated to be sized to hold between 3,000 and 5,000 litres per delivery. Once delivered, the fuel would be pumped to a holding tank onsite, so the location of this tank would need to be accommodated which is not possible within this concentrated site.

The table below summarises the desktop study undertaken to determine the feasibility of a biofuel heating scheme at the site:

Table 11: Key considerations of biofuel technology

Technology	Criteria	Requirement Met?
Woody Biomass		
Heat demand	Is there a year-round heat demand?	X
Supply chain	Is there an established supply chain in the local area?	-
Delivery logistics	Is the site accessible for deliveries? Is there sufficient space for a supply vehicle to access a biomass storage tank?	X

Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	X
Plant room	Is there sufficient space for a biofuel boiler and associated auxiliary equipment?	X
Flue	Can the flue be designed to meet planning authority requirements?	-
Liquid Biofuel		
Heat demand	Is there a year-round heat demand?	X
Supply chain	Is there an established supply chain in the local area? And can the required quantities of biofuel be guaranteed?	-
Security of supply	Is the future supply of biofuel guaranteed?	-
Delivery logistics	Is the site accessible for deliveries? Is there sufficient space for a supply vehicle to access a biofuel storage tank?	X
Storage	Is there sufficient space for fuel storage to allow a reasonable number of deliveries?	X
Running costs	Are the high running costs acceptable?	-

4.7.6 Biofuel Combined Heat and Power (CHP)

A CHP system has been analysed and is not recommended for the site as there is no constant hot water baseload demand.

The inclusion of a centralised heating plant will ensure that biofuel technology could be implemented in the future, if viability improves.

4.7.7 Fuel Cells

The primary fuel source for fuel cells is hydrogen. This can be obtained (using a reformer) from a wide range of fuel supplies including natural gas, coal gas, methanol, landfill gas and other fuels containing hydrogen.

Fuel cells produce zero emissions (at the point of use) when running on pure hydrogen. However most building applications to date have involved the use of carbon-based fuels (primarily natural gas) requiring the use of a reformer. A consequence of the reforming process is the emission of carbon dioxide, although emissions are still lower than conventional combustion processes due to the higher operating efficiency of the fuel cell.
The efficiencies of fuel-cell plants are in the range of 40 to 55% (electrical power generation) and waste heat is generated making it a co-generation energy source.

There is not currently a hydrogen network in London, although there is a very good natural gas infrastructure hence most fuel cells operate using natural gas. Analysis has shown that the carbon savings realised from gas fired CHP outweigh those from a hydrogen fuel cell that is powered by natural gas due to the conversion process from gas to hydrogen. The table below summarises the desktop study undertaken to determine the feasibility of fuel cell technology at the site:

Table 12: Key considerations of fuel cell technology

Technology	Criteria	Requirement Met?
Fuel Cells		
Fuel Supply	Is there a source of hydrogen available?	X
Fuel Supply	Is there an alternate fuel source available?	X
Plant room	Is there space allowed for a fuel cell and associated auxiliary equipment?	X

4.7.8 'Be Green' Energy Consumption and CO_2 Emissions

Table 13 CO_2 savings for the Site-wide Be GREEN

'Be GREEN' Haymarket The Tech Hub – Overall Site Wide	Carbon dioxide emissions (tCO_2/yr)		
	Regulated	Unregulated	Total
Emissions after demand reduction (tCO_2/yr)	28.0	37	65.3
Savings (tCO_2/yr)	19.0	0	19.0
Savings (%)	40%	0.0%	22.5%

The above table demonstrates that there is up to a **39% reduction in regulated CO_2** emissions over the existing building for the development, which provides a combined 21.8% reduction when unregulated emissions are considered.

4.8 Total Carbon Emission Savings

The total CO_2 savings achieved by the energy strategy are predicted as up to **18.3 tCO_2** when compared against the Part L 2013 baseline scenario. The tables below show the breakdown in predicted savings for each stage of the energy hierarchy. The combined savings equate to up to a predicted **39%** reduction in regulated CO_2 emissions over the baseline Part L 2013 compliant scheme.

Table 14: Summary of SITE WIDE regulated and unregulated CO_2 emissions savings

Overall	Carbon Dioxide Emissions (tCO_2/yr)		
	Regulated	Unregulated	Total
Building Regulations Part L 2013 Compliant Development (TER)	47.0	37.3	84.3
Be Lean - Local Gas Boilers	36.4	37.3	73.7
Be Clean	36.4	37.3	73.7
Be Green - PV and Heat Pumps	28.0	37.3	65.3

Table 15: Summary of SITE WIDE CO_2 emissions savings for each stage of the hierarchy

SITE WIDE Savings from:	Regulated carbon dioxide savings	
	Tonnes CO_2 per annum	(%)
Be Lean - Local Gas Boilers	10.6	22.5%
Be Clean	0.0	0.0%
Be Green - PV and Heat Pumps	8.4	17.9%
Total cumulative savings	**19.0**	**40%**

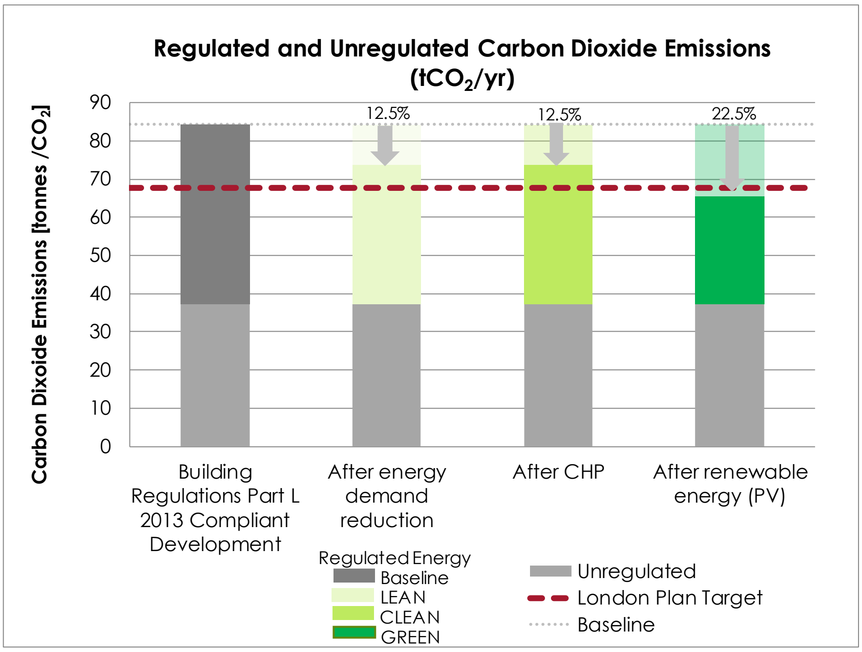


Figure 7: Summary of total carbon dioxide emissions for each stage of the hierarchy SITE WIDE

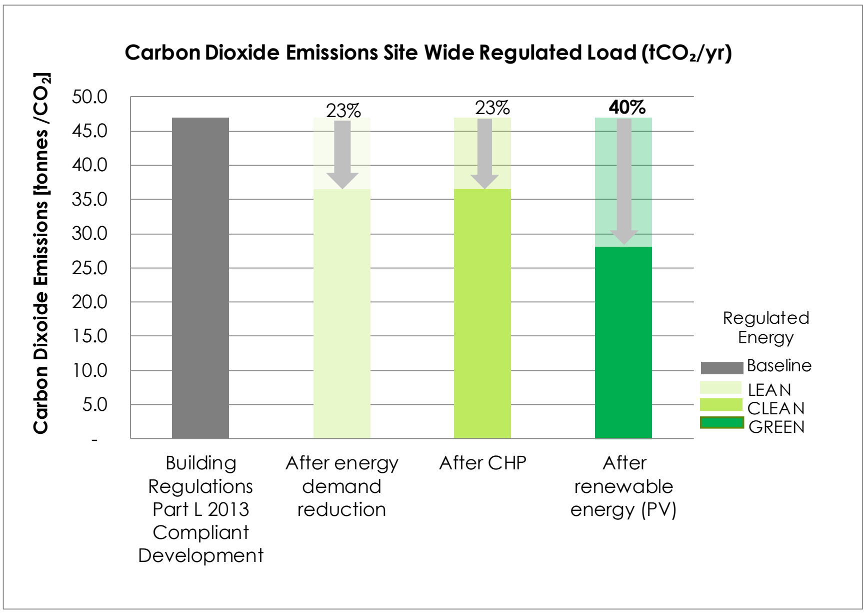


Figure 8: Regulated load carbon emission reduction according to the energy hierarchy

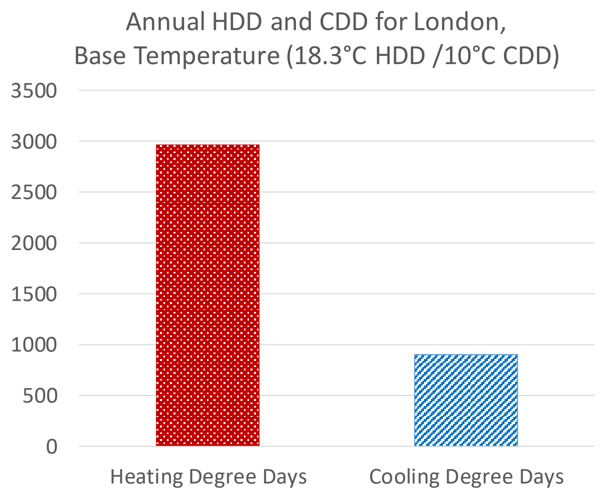
APPENDIX A
MODELLING INPUTS

MODELLING APPROACH

A dynamic thermal model has been created from architectural drawings received 10/06/19using the IES-VE software tool (version 2018.0.1.0) to represent the development and enable an evaluation of external and internal conditions for all spaces within the basement and grounds floors as well as the yard building.

Climate Conditions and Weather File

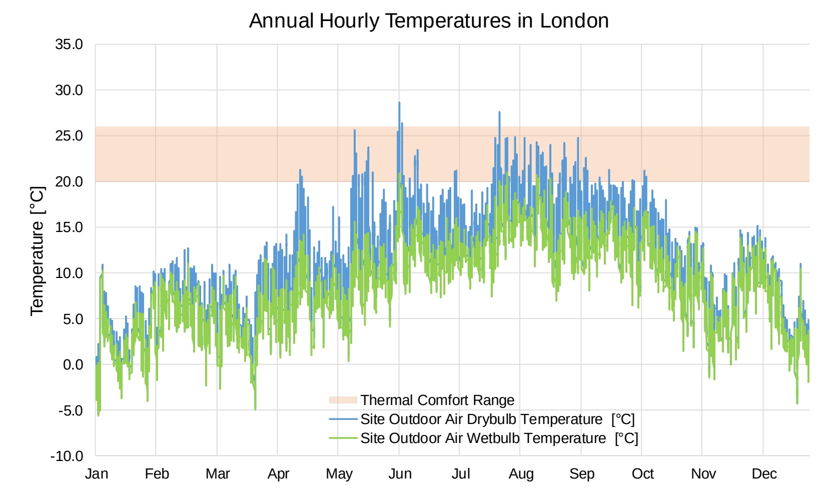
The Tech Hub building is in the Borough of Richmond, London. London has a moderate climate with the maximum temperature rarely rising above 26°C (Figure 9).



Heating Degree Days	2968	(base 18.3°C)
Cooling Degree Days	898	(base 10°C)

Thermal Comfort Range

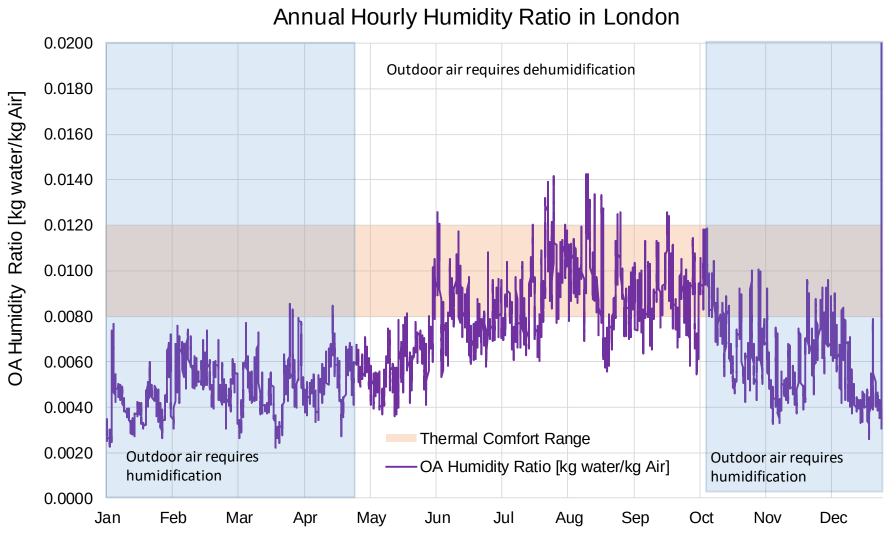
Low Temperature	20	°C	max Temperature	28.6 °C
High Temperature	26	°C	min Temperature	-5.40 °C
Humidity Ratio Summer	0.012	kg/kg	Relative humidity indoor range	40% - 60%
Humidity Ratio Winter	0.008	kg/kg		



Number of hours during the year the outdoor air is between 20 °C and 26 °C	384	4%
Number of hours during the year the outdoor air is between 18 °C and 28 °C	906	10%
Number of hours during the year the outdoor air is between 20°C and 26°C and humidty < 0.012	327	4%

Figure 9: Annual Dry bulb and wet bulb outdoor air temperatures for London

It is an ideal climate for passive cooling through window opening in the summer months when the temperature outside is low enough, with dehumidification rarely required.



Occupied Hours between Jan - April and Nov - Dec (WINTER) dehumidification is required	0	0%
Occupied Hours between May - Oct (SUMMER) dehumidification is required	94	4%
Occupied Hours between Jan - April and Nov - Dec (WINTER) Humidification is required	2235	95%
Occupied Hours between May - Oct (SUMMER) Humidification is required	1161	49%

Figure 10: Annual outdoor humidity levels for London

Geometry

The IES-VE model includes all spaces and adjacent spaces have been modelled to capture their thermal and shading effects.

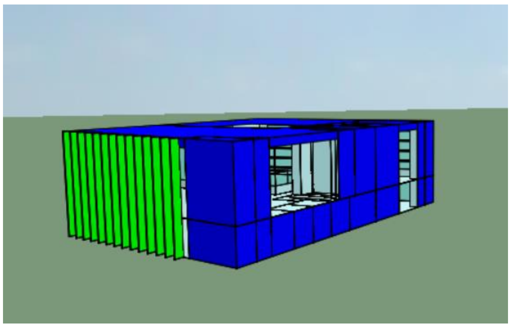


Figure 11: IES-VE model

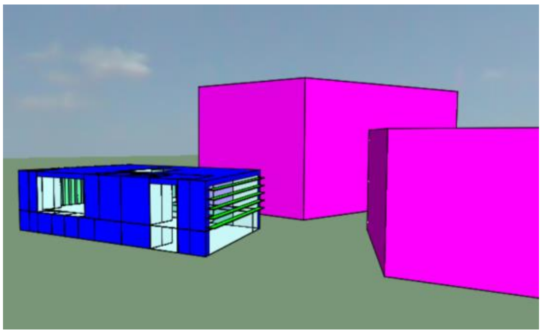


Figure 12: IES-VE model with surroundings

Constructions
The following constructions have been applied to the model.

Element		Target and proposed Fabric Targets			
		Notional Building Values		Proposed Building u-value Targets	
External Wall	u-value	0.26	W/m².K	0.24	W/m².K
Ground Floor	u-value	0.22	W/m².K	0.14	W/m².K
Roof	u-value	0.18	W/m².K	0.17	W/m².K
Doors	u-value	2.2	W/m².K	2.2	W/m².K
Windows	u-value	1.6	W/m².K	1.55	W/m².K
	g-value	0.4		0.3	

Internal gains
Internal gains were set using NCM templates, in the existing building all lighting is set to T8 fluorescent bulbs and in the proposed building the following lighting has been applied:

Usage Type	Constant illuminance control* [Y/N]	Automatic Daylighting Control [Y/N]	Daylight Control Type (Switching/ Dimming)	Daylight Sensor Type (Standalone / Addressable)
Office	110	No	Y	Auto-On-Off (0.9)
Kitchenette	90	No	Y	Auto-On-Off (0.9)
Showers/Lockers	90	No	Y	Auto-On-Off (0.9)
L/V Comms	100	No	Y	Auto-On-Off (0.9)
Plant Room	100	Yes	Y	Auto-On-Off (0.9)
WC	100	No	Y	Auto-On-Off (0.9)
Circulation	100	No	Y	Auto-On-Off (0.9)

Heating and cooling strategy
The office areas will be ventilated using an AHU with heat recovery and VRF heat pumps for the heating and cooling. Full details below

Description	Units	Office ground Floor	Office first floor	Kitchenette
System Description				
Outdoor air delivery (Ventilation)		Rooftop AHU	Rooftop AHU	Rooftop AHU
Central Plant		Nuaire BOXER packaged supply and extract air handling unit with thermal wheel HR	Nuaire BOXER packaged supply and extract air handling unit with thermal wheel HR	Nuaire BOXER packaged supply and extract air handling unit with thermal wheel HR
Room Conditioning Heating		VRF Underfloor Air Conditioning	VRF Underfloor Air Conditioning	VRF Underfloor Air Conditioning
Room Conditioning Cooling		VRF Underfloor Air Conditioning	VRF Underfloor Air Conditioning	VRF Underfloor Air Conditioning
Plant Heating Details				
Heating system type (assumed system in model)	Description	VRF Underfloor Air Conditioning Daikin RYYQ16U	VRF Underfloor Air Conditioning	VRF Underfloor Air Conditioning
Heat Fuel Type	Elec/gas	Electricity	Electricity	Electricity
Heat generator seasonal efficiency	SCOP/%	4.1	4	4.1
Boiler installed on or after 1998?	Yes/No	N/A	N/A	N/A
Central Time Control?	Yes/No	Yes	Yes	Yes
Optimum start/stop control?	Yes/No	Yes	Yes	Yes
Local Time Control?	Yes/No	Yes	Yes	Yes
Local Temperature Control?	Yes/No	Yes	Yes	Yes
Weather Compensation Control?	Yes/No	No	No	No
Is there provision for metering?	Yes/No	Yes	Yes	Yes
Does the metering warn "out of range" values?	Yes/No	?	?	?
Pump	List	N/A	N/A	N/A
Plant Cooling Details				
Cooling system type (assumed system in model)	Description	VRF Underfloor Air Conditioning	VRF Underfloor Air Conditioning	VRF Underfloor Air Conditioning
Nominal EER	EER	3.64	3.64	3.64
Seasonal EER	SEER	6.3	6	6.3
Power	kW	11.2	11.2	11
Does it Qualify for ECA? (tax credits)	Yes/No			
Mixed mode? (CMM)	Description	N/A	N/A	
Ventilation / AHU				
Specific Fan power for AHU	W/l/s	1.2	1.2	1.2
Demand controlled ventilation?	List	Yes	Yes	Yes
Ductwork Leakage Classification	Type	Low Pressure Class A	Low Pressure Class A	Low Pressure Class A
AHU Leakage Classification	Type	L1	L1	L1
Heat recovery	Type	Thermal Wheel	Thermal Wheel	Thermal Wheel
	% efficiency	82%	82%	82%
8. DHW				
DHW system type	Description	Electric Vented Water Heater	Electric Vented Water Heater	Electric Vented Water Heater
DHW system delivery efficiency	%	38%	38%	38%
DHW Fuel Type	Elec/gas	Electricity	Electricity	Electricity
Is the system a storage system?	Yes/No	Yes	Yes	Yes
Storage Volume	litres	200	200	200
Insulation	Type	?	?	?
Does the system have secondary circulation?	Yes/No	No	No	No
10. Building Management				
Electric Power Factor of the building	Power Factor Control	0.95	0.95	0.95
Lighting systems have provision for metering?	Yes/No	Yes	Yes	Yes
Lighting systems metering warns of "out of range values?	Yes/No	Yes	Yes	Yes

Description	Units	Ground Floor Showers/Lockers	L/V Comms	Plant	Ground Floor WC	First Floor WC	Stairs
System Description							
Outdoor air delivery (Ventilation)		Dedicated	Dedicated	Dedicated	Dedicated	Dedicated	None
Central Plant		Dedicated extract fan	Dedicated extract fan	Dedicated extract fan	Dedicated extract fan	Dedicated extract fan	-
Room Conditioning Heating		-	-	-	-	-	-
Room Conditioning Cooling		-	-	-	-	-	-
Plant Heating Details							
Heating system type (assumed system in model)	Description						
Heat Fuel Type	Elec/gas						
Heat generator seasonal efficiency	SCOP/%						
Boiler installed on or after 1998?	Yes/No						
Central Time Control?	Yes/No						
Optimum start/stop control?	Yes/No	N/A	N/A	N/A	N/A	N/A	N/A
Local Time Control?	Yes/No						
Local Temperature Control?	Yes/No						
Weather Compensation Control?	Yes/No						
Is there provision for metering?	Yes/No						
Does the metering warn "out of range" values?	Yes/No						
Pump	List						
Plant Cooling Details							
Cooling system type (assumed system in model)	Description						
Nominal EER	EER						
Seasonal EER	SEER	N/A	N/A	N/A	N/A	N/A	N/A
Power	kW						
Does it Qualify for ECA? (tax credits)	Yes/No						
Mixed mode? (CMM)	Description						
Ventilation / AHU							
Specific Fan power for AHU	W/l/s	0.4			0.4	0.5	
Demand controlled ventilation?	List	Yes			Yes	Yes	
Ductwork Leakage Classification	Type	Low Pressure	N/A	N/A	Low Pressure	Low Pressure	N/A
AHU Leakage Classification	Type	L1			L1	L1	
Heat recovery	Type	N/A			N/A	N/A	
	% efficiency	N/A			N/A	N/A	
8. DHW							
DHW system type	Description	Electric Vented Water Heater			Electric Vented Water Heater	Electric Vented Water Heater	
DHW system delivery efficiency	%	38%			38%	38%	
DHW Fuel Type	Elec/gas	Electricity	N/A	N/A	Electricity	Electricity	N/A
Is the system a storage system?	Yes/No	Yes			Yes	Yes	
Storage Volume	litres	200			200	200	
Insulation	Type	?			?	?	
Does the system have secondary circulation?	Yes/No	No			No	No	
10. Building Management							
Electric Power Factor of the building	Power Factor Control	0.95			0.95	0.95	
Lighting systems have provision for metering?	Yes/No	Yes	N/A	N/A	Yes	Yes	N/A
Lighting systems metering warns of 'out of range' values?	Yes/No	Yes			Yes	Yes	

APPENDIX B
COMPLIANCE RESULTS BRUKL

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Haymarket Tech Hub - GREEN

As built

Date: Wed Jul 24 15:58:09 2019

Administrative information

Building Details

Address: Address 1, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.10

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.10

BRUKL compliance check version: v5.4.b.0

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	27.1
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	27.1
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	16.7
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 fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the 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	0.24	0.24	00000011:Surf[1]
Floor	0.25	0.24	0.24	00000011:Surf[0]
Roof	0.25	0.17	0.17	0000001D:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.56	1.6	RF000003:Surf[4]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = 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
$m^3/(h.m^2)$ at 50 Pa	10	3

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Rooftop AHU/VRF First Floor

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4	3.64	0	1.2	0.82
Standard value	2.5*	3.2	N/A	1.6^	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

2- Rooftop AHU/VRF Ground Floor

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	4.1	3.64	0	1.2	0.82
Standard value	2.5*	3.2	N/A	1.6^	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

"No HWS in project, or hot water is provided by HVAC system"

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

General lighting and display lighting	**Luminous efficacy [lm/W]**			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
00 - Accessible WC	-	100	-	39
00 - Circulation	-	100	-	24
00 - Comms Room	100	-	-	60
00 - L/V Room	100	-	-	61
00 - Plant Room	100	-	-	63
00 - Stairs	-	100	-	43
00 - Stairs	-	100	-	45
00 - WC	-	100	-	41
00 - WCs	-	100	-	136
01 - Accessible WC	-	100	-	47
01 - Kitchenette	-	90	-	289
01 - Open Office3 - Void	110	-	-	0
01 - Stairs	-	100	-	85
01 - Stairs	-	100	-	89
01 - WC	-	100	-	188
00 - Lockers	-	90	-	55
00 - Showers	-	90	-	22

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
00 - Open Office	110	-	-	4842
01 - Open Office	110	-	-	2984
Roof	-	-	-	0
Roof	-	-	-	0
Roof	-	-	-	0
Roof	-	-	-	0
Roof	-	-	-	0
Roof	-	-	-	0

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
01 - Kitchenette	NO (-14.6%)	NO
01 - Open Office3 - Void	NO (-44.3%)	NO
00 - Open Office	NO (-18.1%)	NO
01 - Open Office	YES (+49.4%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	1678.4	1678.4
External area [m²]	4020.5	4020.5
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	2174.55	1418.24
Average U-value [W/m²K]	0.54	0.35
Alpha value* [%]	10.14	10

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

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
100	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: 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	11	6.59
Cooling	2.84	6.39
Auxiliary	8.06	13.05
Lighting	9.14	23.68
Hot water	6.32	5.95
Equipment*	42.78	42.78
TOTAL**	**37.36**	**55.67**

* Energy used by equipment does not count towards the total for consumption or 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	4.22	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]	194.39	147.92
Primary energy* [kWh/m²]	145.05	175.1
Total emissions [kg/m²]	16.7	27.1

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

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	67.5	50.1	5.1	2.7	7.5	3.67	5.16	4.1	6.3
	Notional	0	0	0	0	0	0	0	----	----
[ST] Fan coil systems, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	331.9	76.7	25.7	4.3	7.7	3.58	4.91	4	6
	Notional	27.6	97.9	3	7.2	12.3	2.56	3.79	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	143	107.4	15.5	7.9	13.9	2.56	3.79	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.24	00000011:Surf[1]
Floor	0.2	0.24	00000011:Surf[0]
Roof	0.15	0.17	0000001D:Surf[0]
Windows, roof windows, and rooflights	1.5	1.55	00000022:Surf[2]
Personnel doors	1.5	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
$m^3/(h.m^2)$ at 50 Pa	5	3

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Haymarket Tech Hub - LEAN

As built

Date: Wed Jul 24 16:06:44 2019

Administrative information

Building Details

Address: Address 1, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.10

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.10

BRUKL compliance check version: v5.4.b.0

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	28
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	28
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	21.7
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 fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the 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	0.24	0.24	00000011:Surf[1]
Floor	0.25	0.24	0.24	00000011:Surf[0]
Roof	0.25	0.17	0.17	0000001D:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.56	1.6	RF000003:Surf[4]
Personnel doors	2.2	-	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = 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
$m^3/(h.m^2)$ at 50 Pa	10	3

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- Rooftop AHU/VRF First Floor

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	3.64	0	1.2	0.82
Standard value	0.91*	3.2	N/A	1.6^	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

2- Rooftop AHU/VRF Ground Floor

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	0.91	3.64	0	1.2	0.82
Standard value	0.91*	3.2	N/A	1.6^	0.65
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

"No HWS in project, or hot water is provided by HVAC system"

"No zones in project where local mechanical ventilation, exhaust, or terminal unit is applicable"

General lighting and display lighting	**Luminous efficacy [lm/W]**			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
00 - Accessible WC	-	100	-	39
00 - Circulation	-	100	-	24
00 - Comms Room	100	-	-	60
00 - L/V Room	100	-	-	61
00 - Plant Room	100	-	-	63
00 - Stairs	-	100	-	43
00 - Stairs	-	100	-	45
00 - WC	-	100	-	41
00 - WCs	-	100	-	136
01 - Accessible WC	-	100	-	47
01 - Kitchenette	-	90	-	289
01 - Open Office3 - Void	110	-	-	0
01 - Stairs	-	100	-	85
01 - Stairs	-	100	-	89
01 - WC	-	100	-	188
00 - Lockers	-	90	-	55
00 - Showers	-	90	-	22

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
00 - Open Office	110	-	-	4842
01 - Open Office	110	-	-	2984
Roof	120	-	-	0
Roof	120	-	-	0
Roof	120	-	-	0
Roof	120	-	-	0
Roof	120	-	-	0
Roof	120	-	-	0

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
01 - Kitchenette	NO (-14.6%)	NO
01 - Open Office3 - Void	NO (-44.3%)	NO
00 - Open Office	NO (-18.1%)	NO
01 - Open Office	YES (+49.4%)	NO
Roof	NO (-91.9%)	NO
Roof	NO (-92.2%)	NO
Roof	NO (-92.1%)	NO
Roof	NO (-92.2%)	NO
Roof	NO (-92.2%)	NO
Roof	NO (-92.1%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	1678.4	1678.4
External area [m²]	4020.5	4020.5
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	2174.55	1420.65
Average U-value [W/m²K]	0.54	0.35
Alpha value* [%]	10.14	10

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

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
100	**B1 Offices and Workshop businesses**
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Institutions: Hospitals and Care Homes
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: 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	48.67	19.57
Cooling	2.84	6.4
Auxiliary	8.06	13.06
Lighting	9.14	23.68
Hot water	6.67	5.95
Equipment*	42.78	42.78
TOTAL**	**75.37**	**68.67**

* Energy used by equipment does not count towards the total for consumption or 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	4.22	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]	194.39	148.12
Primary energy* [kWh/m²]	138.5	159.56
Total emissions [kg/m²]	21.7	28

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

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	67.5	50.1	23	2.7	7.5	0.82	5.16	0.91	6.3
	Notional	0	0	0	0	0	0	0	----	----
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	331.9	76.7	113.1	4.3	7.7	0.82	4.91	0.91	6
	Notional	27.6	98.1	8.9	7.2	12.3	0.86	3.79	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	143.1	107.7	46.1	7.9	13.9	0.86	3.79	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	U_{i-Typ}	U_{i-Min}	Surface where the minimum value occurs*
Wall	0.23	0.24	00000011:Surf[1]
Floor	0.2	0.24	00000011:Surf[0]
Roof	0.15	0.17	0000001D:Surf[0]
Windows, roof windows, and rooflights	1.5	1.55	00000022:Surf[2]
Personnel doors	1.5	-	No Personnel doors in building
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

U_{i-Typ} = Typical individual element U-values [W/(m²K)] U_{i-Min} = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
$m^3/(h.m^2)$ at 50 Pa	5	3