EUSTON TOWER

Energy Statement

December 2024

British Land

ARUP

British Land Property Management Limited

Euston Tower

Energy Statement

Reference: EST-ARP-XX-XX-RP-M-00002

P05 | 11 December 2024

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

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1. Executive Summary

1.1 Purpose

This Energy Statement summarises the revisions made to the pending strategic application for Full Planning Permission (ref. 23/5240/P), submitted in December 2023 for the Proposed Development at Euston Tower (286 Euston Road, London). This document has been compiled in accordance with the guidance provided by the Greater London Authority (GLA) for energy assessments within the planning process. The purpose of this statement is to provide an overview of the energy considerations for the proposals for Euston Tower. It aims to demonstrate the Proposed Development's compliance with the GLA's and Camden Council's energy policies and objectives, the methods proposed to increase energy efficiency, and its contribution to sustainable development within the Greater London area.

The Applicant has undertaken extensive consultation during both the pre-application and determination stages of the Proposed Development and has sought to respond positively to the responses received. The scheme has been refined in response to feedback from Officers, local stakeholders and residents, including the Regents Park Conservation Area Advisory Committee and statutory consultees, including Historic England and The Greater London Authority.

1.2 Description of development

The Description of Development for the Proposed Development, in light of the 2024 Revisions, has been updated to the following:

"Redevelopment of Euston Tower comprising retention of parts of the existing building (including central core, basement and foundations) and erection of a new building incorporating these retained elements, to provide a 32-storey mixed-use building providing offices and research and development floorspace (Class E(g)) and office, retail, café and restaurant space (Class E) and Enterprise space (Class E/ F) at ground and first, and associated external terraces; public realm enhancements, including new landscaping and provision of new publicly accessible steps and ramp; short and long stay cycle storage; servicing; refuse storage; plant and other ancillary and associated work."

This is referred to throughout as the "Proposed Development".

1.3 Summary of Revisions

The principal components of the 2024 Revisions comprise:

- Land Uses
  - Publicly accessible space adjusted to L00 and L01 only.
- Massing
  - Tower
    - Tower massing adjusted to create a simpler, rectangular form.
    - Tower is rounded at the corners to help the tower appear slimmer in long distance views.
    - Breathing spines are pushed inwards to separate the tower into four quadrants.
  - Podium
    - Podium massing is adjusted along with tower massing to be rectilinear with rounded corners, creating an increase in ground floor open space along Hampstead Road.
    - Neighbourhood Innovation Lab entrance along Hampstead Road adjusted from triple height to double height.
    - Number of podium levels increased from four to six (L00-L05).
- Height
  - No change to tower height.
  - Podium height has increased by two levels.
- Tower
  - Façade design incorporates upstand into horizontal elements that wrap the rounded massing corners. Vertical elements span the tower top to bottom through which natural ventilation can occur.
  - Minor adjustment to vertical transportation strategy via level change for switch from mid- to high-rise lift banks.
  - Four double height amenities have been relocated relative to their previous quadrants/levels. All four double height amenities provide external terraces in various depths/heights, ensuring a wide range of amenity diversity.
  - Column grid adjusted to 9m bays and offset from façade by 2m. Megabracing strategy adjusted to Z arrangement.
  - The crown of the building has a double height amenity façade treatment such that the building is perceived the same from all angles. This is created by a combination of the façade treatment and the internal arrangement of central plant space at L30 and a "bathtub" of plant space at L31 that sets back from the tower façade.
- Podium
  - Escalator and stair layout of lobby space has been adjusted to be more space efficient.
  - Layout of public space in Neighbourhood Innovation Lab has been adjusted following feedback from public consultation.
- Public Realm
  - Main entrances to lobby space remain as per the submitted planning application in December 2023: on the southwest and southeast corners of the ground floor.
  - Main public entrance to Neighbourhood Innovation Lab remains at the northeast corner. Public entrance to restaurant space at L01 Regent's Place Plaza also remains on northwest corner.
  - Minor updates have been made to the design and location of planters and trees in the public realm
- Transport
  - End of trip facilities entrance and access has been adjusted to a bicycle stair and lift. External access remains from the southwest corner of the ground floor.

1.4 The Applicant

The applicant for this application is British Land Property Management Limited (hereafter, British Land)

1.5 Description of Existing Site

Euston Tower is an existing 36-storey tall building standing on the northern edge of central London, situated in the south-west of the London Borough of Camden.

Located on the corner of Euston and Hampstead Road, at the top of Tottenham Court Road the tower shares a busy intersection with The UCL Hospital campus and is directly opposite Warren Street Station. The current tower has a prominent presence, given its status as the tallest building in the borough aside from the nearby BT Tower, and as such acts as a physical landmark for London Euston, Euston Square and Warren Street stations as well as wayfinding for the wider neighbourhood.

Completed in 1970, Euston Tower was designed in the 'International Style'. Above a two-storey extruded glazed podium, the tower has a pinwheel plan clad in aluminium curtain walling with green reflective tinted glazing. It was designed as an office building to provide cellular office accommodation typical of the period and formed part of a wider masterplan known as The Euston Centre. It now stands on the eastern edge of the pedestrianised Regent's Place Campus. Since its completion, it has undergone a minor refurbishment with the addition of secondary glazing in the 1990s, but beyond this its external form and façade remain as originally constructed. These elements of the building are in a generally poor condition, due to a combination of wear in use and the quality of the original detailing. Gradually the existing tower has been vacated, and since 2021, with the exception of the retail floorspace at grade level, the building is vacant.

1.6 Results summary

The Proposed Development embodies an ambitious energy and carbon emissions reduction strategy. Through a combination of innovative and best practice energy reduction measures, the proposed mixed-use development achieves an **overall reduction in regulated carbon dioxide emissions of 16%** over Part L 2021.

1.6.1 Compliance with GLA requirements

- It is acknowledged that the current predicted on site reduction falls short of the GLA's 35% on-site carbon reduction over Part L 2021, which has been raised and highlighted in pre-application meetings with the GLA's energy officers. Feedback from these meetings stated the requirement for the limitations to be set out in detail, with clear reasons why compliance is not possible. These key points are detailed later in this section.

- The 'Note to accompany GLA Energy Assessment Guidance 2022' acknowledges that non-residential developments may find it more challenging to achieve significant on-site carbon reductions beyond Part L 2021 to meet both the energy efficiency target and the minimum 35% improvement. The note highlights that applicants are still expected to follow the energy hierarchy to maximise carbon savings.

- This Energy Statement for the Proposed Development is provided to demonstrate that the Energy Hierarchy has been followed in accordance with relevant planning requirements. Factors specific to the Proposed Development that prevent meeting this target are summarised in the following section.

1.6.2 Specific limitations of the Proposed Development:

Be Lean:

- Numerous façade options were explored as part of the design process informing the previous planning submission, with detailed analysis of embodied carbon, constructability and thermal performance aspects. The curtain wall façade system chosen balances each of these factors and delivers a well-rounded solution. However, the achievable overall U-value of this system is higher than that of the notional building façade performance, which relates to solid wall and glazed elements, and forms the baseline to which the Proposed Development is compared. Other façade types that may have delivered marginally improved thermal performance were investigated but deemed to not be feasible. A precast panel façade with punched window openings was studied but was found to impose significantly increased and unacceptable structural loads on the existing building foundations, which are to be retained and reused. A façade system implementing Ultra High Performance Concrete (UHPC) panels was also investigated but was not taken forwards as the installation methodology, requiring the sealing of external joints from the outside using scaffolding or abseiling, would have introduced installation health and safety risks that were deemed unacceptable. A detailed summary of the reasoning behind the façade strategy chosen is included in Section 5.3.1.

- Percentage glazing has been limited in many areas to be as low as feasibly possible whilst facilitating occupant satisfaction and connectivity through outward views. Overheating analysis and energy modelling has then informed the setting of g-value limits to minimise solar heat gain. However, there is also a balance to be made in providing glazing that allows sufficient natural light transmittance, reducing the operating hours of artificial lighting. The g-value targets for glazing within the Proposed Development aims to balance these factors.

Be Clean:

- Connections into local existing or planned heat networks were investigated but found to be unfeasible currently as there are no functioning heat networks or networks planned to be delivered within suitable timescales within the locality of the site.

Be Green:

- Prior to the previous submission, an assessment of different LZC technologies was undertaken but many were found to be unfeasible for application to the Proposed Development. In terms of power generating technologies, only PV was deemed suitable for inclusion within the scheme.

- System efficiencies have been maximised as far as possible. High efficiency simultaneous ASHPs have been implemented, using waste heat to produce domestic hot water through the use of WSHPs. However, as the Part L 2021 notional building also implements heat pumps with relatively high efficiencies, meaning that the demonstrable improvement of the Proposed Development over such a high performing baseline is reduced. Other solutions that could facilitate higher overall efficiencies, such as the integration of a ground source heat pump system, were investigated during the initial design process but were found to be unfeasible within the constraints of the site.

  A system utilising boreholes through the new structural slab within the footprint of the basement, meaning the existing slab is not greatly disturbed, would only allow for approximately 30 boreholes, allowing an estimated system capacity of less than 175kW, which is not deemed significant enough to make a material difference to the overall energy performance of the Proposed Development.

  A more significant GSHP installation could be achieved if significant parts of the existing structure within the basement were to be removed. It is estimated that if around 60, 200m deep boreholes were installed, necessitating the removal of much of the existing basement structure, the overall peak capacity of the system could be increased to around 360kW. However, it is estimated that it would take over 1150 years for the carbon savings gained from the increased system efficiencies to pay back the embodied carbon associated with removing the existing structure

  For these reasons, it has not been deemed possible to include a GSHP installation within the Proposed Development. This reasoning is covered in more detail in Section 8.4.1.

- The amount of usable area for PV is severely restricted as a result of the building's tower form and requirement for significant urban greening. Constraints are illustrated in more detail in Figure 11 and Figure 12 but, in summary, the level 31 roof level accommodates ASHPs, air-cooled chillers, lab exhaust fans and other central mechanical and electrical plant which cannot be situated anywhere else and require unobstructed free area above, making the area occupied by these items unusable for PV installation. The only space available to accommodate these requirements is above the Level 31 enclosures for the stair pressurisation equipment, stair core and lift machinery. To comply with urban greening requirements, the Green Roof Code recommends at least 750mm of spacing between arrays "to ensure there is no negative impact on either the green roof or PV performance", imposing a limitation on PV install density. Façade mounted PVs were considered but ultimately discounted due to fire concerns. Consideration was also given to transparent PV technology, but this technology is not yet suitable to be implemented as vision glazing for a building of this type. As such, maximising the carbon offset from on-site electricity generation is challenging.

In line with the requirements of the London Plan, energy consumption and carbon dioxide emissions have been assessed at each stage of the energy hierarchy, with overall savings and resulting off-set payment calculated.

In line with the requirements of the London Plan and the Camden Local Plan, the shortfall in carbon emissions below net-zero on-site is proposed as a financial contribution, via off-set payment.

Results and calculated offset payments are shown in Figure 1 and listed in Table 2.

The energy performance data is calculated following the Approved Document Part L2 2021 compliance method and based on inputs and assumptions as outlined in this document. The predictive energy assessment is calculated following GLA 'Be Seen' guidance using CIBSE TM54 methodology.

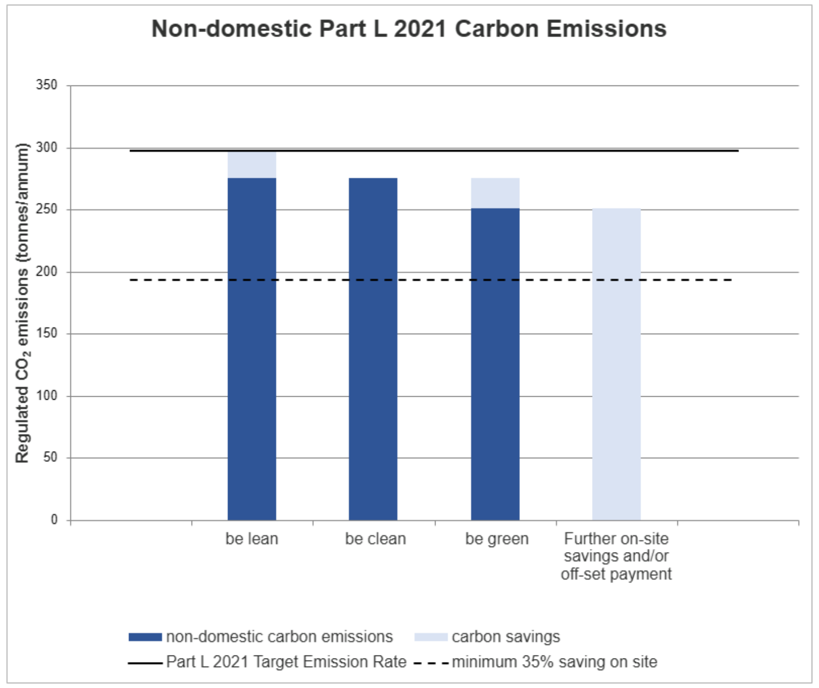


Figure 1: Regulated CO2 emissions savings from each stage of the Energy Hierarchy: non-domestic

	Total regulated emissions (Tonnes CO2 / year)	CO2 savings (Tonnes CO2 / year)	Percentage savings (%)
Baseline: Part L 2021	297.8		
Be lean: Savings from energy demand reduction	275.1	22.7	8%
Be clean: Savings from heat network	275.1	0.0	0%
Be green: Savings from renewable energy	251.2	23.9	8%
Cumulative on-site savings	-	**46.5**	**16%**
Annual savings from off-set payment	-	251.2	-
Cumulative savings for off-set payment (t CO2)	7.537		
Cash in-lieu contribution (£)	£716,023		

Table 1: Total Proposed Development regulated carbon emissions results, savings, off-set calculation and cash in-lieu contribution.

1.7 Energy strategy summary

This section sets out the key measures and CO_2 reductions identified for each stage of the energy hierarchy.

1.7.1 Be Lean

- Optimised glazing percentages to maximise daylight penetration but minimise overheating. g-value limits specified for glazing elements aims to limit excessive solar gain on to the floor plate.
- Façade elements that project horizontally and vertically adjacent to glazing are optimised to provide solar shading during peak scenarios but also allows for beneficial solar gain during winter months.
- An underfloor ventilation system avoids the need for active cooling for large periods of the year through free cooling provided by largely un-tempered fresh air supplied by the on-floor AHUs, with cooling done by the high efficiency heat exchanger. The underfloor system also avoids the need for additional high-level mechanical services, significantly reducing embodied carbon.
- A high-performance curtain wall façade has been specified to reduce space heating demand in winter and minimise the risk of summertime overheating. Embodied carbon has been considered in the analysis of the façade to provide a solution that reduces operational carbon but is also expected to be a lower embodied carbon solution when compared to other façade types, resulting in a better performance from a whole life carbon perspective.

1.7.2 Be Clean

- The development follows the GLA heating hierarchy first considering district systems followed by zero emissions or local heat sources. There are no proposed district heat networks in the local area for connection on day one, therefore on-site, low carbon generation of heat using ASHPs is proposed.
- The development is designed to avoid all on-site emissions, using an all-electric heating and cooling strategy, therefore no gas boilers or CHP are included in the scheme.
- Although not currently planned to connect, the scheme will be enabled for future connections into any local heat networks which can provide sufficient capacity to support the operation of the Proposed Development.

1.7.3 Be Green

- Heating and cooling will be provided to the development by central heating and cooling plant consisting of air-cooled chillers and simultaneous air source heat pumps (ASHPs) to maximise the ability to share heat between spaces within the building.
- Simultaneous heating and cooling heat pumps can utilise free cooling to maximise efficiency through mid-seasons.
- The installation of PV panels is included within the scheme to contribute to the reduction of operational carbon emissions. Approximately $100m^2$ is planned to be included spread across appropriate areas at Level 31 roof level.

1.7.4 Be Seen

- The GLA's 'Be Seen' spreadsheet with performance indicators including contextual data, building energy use and carbon emissions for the Proposed Development will be separately submitted.
- The energy performance of the Proposed Development has been assessed using a CIBSE TM54 compliant methodology to provide an assessment of regulated and non-regulated energy consumption.
- A comprehensive NABERS Design for Performance assessment will be carried out during RIBA Stage 3.

2. Context

2.1 Regulatory changes

With the 2021 update to the Building Regulations Approved Document Part L – Conservation of fuel and power: Buildings other than dwellings, herafter abbreviated to Part L 2021, there have been significant improvements made to the notional building to which the Proposed Development is compared, and that forms the baseline comparison on which the GLA requirement of 35% reduction in on-site carbon emissions is to be demonstrated.

These improvements to the parameters of the notional building aim to drive proposed buildings to achieve a 27% reduction in carbon emissions compared to requirements in Part L 2013. However, this baseline improvement has not seen a change in the GLA requirements for a 35% reduction in on-site carbon emissions, meaning that this target is now very difficult to meet, especially on a scheme such as the Proposed Development that has a number of specific challenges, which are discussed further in paragraph 1.2 below.

The GLA acknowledge how these regulatory changes have made it more challenging to meet their targets in the document, 'Note to accompany GLA Energy Assessment Guidance 2022' which states that "*Initially, non-residential developments may find it more challenging to achieve significant on-site carbon reductions beyond Part L 2021 to meet both the energy efficiency target and the minimum 35 per cent improvement. This is because the new Part L baseline now includes low carbon heating for non-residential developments but not for residential developments. However, planning applicants will still be expected to follow the energy hierarchy to maximise carbon savings before offsetting is considered.*"

A summary of the main notional building changes between each version of the Building Regulations Part L is provided below to demonstrate the significant improvements made on the 2013 version.

	 Building Regulations Approved Document Part L2a (2013)	 Building Regulations Approved Document Part L Volume 2 (2021)
GLA requirement for on-site carbon reduction over Part L	35%	35%
Notional Building Fabric Parameters		
Roofs (W/m²K)	0.18	0.15
Exposed walls (W/m²K)	0.26	0.18
Exposed floors & ground floors (W/m²K)	0.22	0.15
Windows (W/m²K)	1.6	1.4
Air tightness (m³/hr/m²)	5.0	3
Notional Building System Parameters		
Space heating source	Gas boiler	Electric heat pump
Space heating source efficiency	81.9%	264%
Domestic hot water source	Gas heater	Electric heat pump
Domestic hot water source efficiency	86.4%	286%

Table 2: Comparison of the main notional building changes between each version of the Building Regulations Part L

The previous parameters of the Part L 2013 notional building meant that the GLA's required 35% on-site carbon reduction was considerably more achievable when this was used as the baseline comparison. For reference, during the pre-application meeting with the GLA held 20/09/23, initial results, relating to a slightly different building geometry, were shown to be exceeding the Part L 2013 baseline by around 36%. Based on the current geometry of the Proposed Development and correlating with the performance against the Part L 2021 baseline as is demonstrated in this document, it is identified that the performance against the Part L 2013 baseline would be even more than the 36% previously highlighted in those discussions.

2.2 Main challenges specific to the Proposed Development

2.2.1 Building form

As the building ascends, the exterior surface area increases disproportionately to the interior volume, leading to a higher proportion of exposed walls versus internal floor area. This larger surface area results in increased heat transfer, demanding more energy for heating or cooling systems to maintain acceptable internal conditions.

Whilst the notional building does also assume this form, it should be noted that this is a constraint, especially when the notional building façade thermal performance is considered as is explained below.

2.2.2 Curtain wall façade

The notional building as per Approved Document Part L 2021 assumes relatively high thermal performance of fabric constructions. The notional building assumes a wall area of 60% of the overall façade area and applies a U-value of 0.18 W/m²K to these solid elements, it also assumes a window area of 40% of the overall façade area and applies a U-value of 1.4 W/m²K to these glazed elements. This results in a notional building average façade U-value of 1.04 W/m²K.

Analysis during the design of the Proposed Development has proven that a façade system implementing walls and windows, in the manner in which they are applied in the notional building, is not possible, owing to a range of constraints including constructability and increased structural loading on existing foundations. These factors are explained in more detail in Section 5.3.1. For these reasons a unitised curtain wall façade has been implemented within the Proposed Development.

Table 4.1 of Approvement Document Part L 2021 states a limiting U-value of 1.6 W/m²K for curtain walling elements, and the U-value of the system implemented within the Proposed Development significantly improves on this, delivering an average façade U-value of 1.24 W/m²K. However, as the notional building baseline result is based on the better performing window and wall U-values previously detailed, demonstrating an improvement on this with the less well performing curtain wall system required for the Proposed Development is very difficult meaning demonstrable improvement in the Be Lean section of the GLA Energy Hierarchy is challenging to achieve.

The proposed façade construction has been determined through detailed analysis to ensure a balance is provided between delivering high thermal performance to reduce operational energy demand, and the increased embodied carbon that arises from a higher performing façade. A sensitivity analysis has been undertaken which has found that the additional embodied carbon and complexity of the facade required to improve on this target does not correlate with significant energy and carbon reduction. Furthermore, as mentioned, buildability and construction worker health and safety has been a key consideration for the proposed façade, where a more complex higher performing façade would introduce additional risks in this regard.

2.2.3 Site constraints from the retention of existing structure

The retention of existing structure has been a key driver for the overall design of the Proposed Development to achieve embodied carbon savings. While this retention has a positive impact to the Proposed Development overall, it does introduce some limitations on opportunity for betterment of the notional building energy performance.

The Part L 2021 notional building implements relatively high-efficiency heat pumps, making it challenging to demonstrate improvement over such a high-performing baseline. Additional solutions, such as integrating a ground source heat pump (GSHP) system, provide opportunity to further exceed the notional efficiencies, but were deemed unfeasible within the site's constraints. Two scenarios were considered: firstly, implementing a borehole system within the new basement slab area only; and secondly, removing large portions of the existing structure to facilitate the installation of a larger borehole system. In the first scenario, under 175kW is available, insufficient for significant improvement on the overall energy performance. In the second scenario, there is potential to increase capacity up to 360kW, but the carbon payback associated with offsetting the removal of the existing materials would be over 1150 years. Thus, the energy performance benefits typically achieved with a GSHP installation are not available to the Proposed Development. This study is discussed in greater detail in Section 8.4.1.

3. Planning Context

This Energy Statement has been prepared in response to the planning policies and guidance contained in the following documents:

- The National Planning Policy Framework (Ministry of Housing, Communities & Local Government, 2023)
- The London Plan (GLA, March 2021), Chapter 9: Sustainable Infrastructure
- GLA Energy Assessment Guidance (GLA, June 2022)
- Camden Local Plan (2017)
- Camden Planning Guidance Energy Efficiency and Adaptation (2021)
- Part L 2021 and the Energy Assessment Guidance 2022 – cover note

3.1 National planning policy framework (2023)

The National Planning Policy Framework sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally prepared plans for housing and other development can be produced.

This Energy Statement responds to the following paragraph:

Paragraph 157 states that in determining planning applications, local planning authorities should expect new development to:

a) comply with any development plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and

b) take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

3.2 London Plan (2021)

The London Plan is an integrated policy framework that sets out an economic, environmental, transport and social framework for the development of Greater London from 2019 to 2041.

This Energy Statement responds to the following policies:

- SI 2 – Minimising greenhouse gas emissions
- SI 3 – Energy infrastructure
- SI 4 – Managing heat risk.

The overarching principle for new development is to develop a low carbon energy solution in accordance with the Mayor's energy hierarchy, which meets or exceeds the overall carbon emissions targets defined in Policy SI 2.

Policy SI 2 states that major developments should be net-zero carbon. By following the energy hierarchy, carbon must be reduced by a minimum of 35% beyond Building Regulations. Non-residential developments should aim to achieve 15% through energy efficiency measures alone.

The energy hierarchy is as follows:

- Be lean: use less energy
- Be clean: supply energy efficiently
- Be green: use renewable energy
- Be seen: monitor, verify and report on energy performance.

Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on site, any shortfall should be provided through a cash in lieu contribution to the relevant borough's carbon offset fund or off-site generation.

Policy SI 3 outlines the new heating hierarchy, which is considered in the development of the energy strategy.

The heating hierarchy is as follows:

1. Connect to local existing or planned heat networks
2. Use zero-emission or local secondary heat sources (in conjunction with heat pump, if required)
3. Use low-emission combined heat and power (CHP) (only where there is a case for CHP to enable the delivery of an area-wide heat network, meet the development's electricity demand and provide demand response to the local electricity network)
4. Use ultra-low NOx gas boilers.

Policy SI 4 outlines the cooling hierarchy, which requires major development proposals to demonstrate how they will reduce the potential for internal overheating and reliance on air conditioning systems in accordance with the following:

1. Reduce the amount of heat entering a building through orientation, shading, high albedo materials, fenestration, insulation and the provision of green infrastructure
2. Minimise internal heat generation through energy efficient design
3. Manage the heat within the building through exposed internal thermal mass and high ceilings
4. Provide passive ventilation
5. Provide mechanical ventilation
6. Provide active cooling systems.

3.3 Camden Local Plan (2017)

The Camden Local Plan was adopted on 3 July 2017, replacing the Core Strategy and Camden Development Policies as the basis for planning decisions and future development in Camden.

This Energy Statement responds to the following policies under 'Section 8: Sustainability and climate change':

- Policy CC1: 'Climate change mitigation'
- Policy CC2: 'Adapting to climate change'.

The energy strategy for the Proposed Development proposes a low carbon energy solution which has been developed in accordance with the energy hierarchy, cooling hierarchy and decentralised energy hierarchy referenced in CC1 and CC2. The strategy reduces on site carbon emissions as far as possible, with the remaining shortfall against the targets defined in CC1 to be secured as a financial cash-in-lieu contribution.

Policy CC1 requires all development to minimise the effects of climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation. This includes requiring all major development to demonstrate how London Plan targets for carbon dioxide emissions have been met. Policy CC1 also requires that major developments will be required to install appropriate monitoring equipment so that the Council can monitor the effectiveness of renewable and low carbon technologies.

Policy CC1: (Paragraph 8.8): All developments involving five or more dwellings and/or more than 500 sqm of (gross internal) any floorspace will be required to submit an energy statement demonstrating how the energy hierarchy (see London Plan Section 3.2) has been applied to make the fullest contribution to CO_2 reduction.

Policy CC1 (Section 8.11): The Council will expect developments of five or more dwellings and/or more than 500 sqm of any gross internal floorspace to achieve a 20% reduction in carbon dioxide emissions from on-site renewable energy generation (which can include sources of site related decentralised renewable energy), unless it can be demonstrated that such provision is not feasible. This is in line with stage three of the energy hierarchy 'Be green'. The 20% reduction should be calculated from the regulated CO2 emissions of the development after all proposed energy efficiency measures and any CO2 reduction from non-renewable decentralised energy (e.g. CHP) have been incorporated.

Policy CC1 (Section 8.12): All major developments will also be expected to demonstrate how relevant London Plan targets for CO2 reduction, including targets for renewable energy, have been met (see London Plan Section 3.2).

Where it is demonstrated that the required London Plan reductions in carbon dioxide emissions cannot be met on site, the Council will require a financial contribution to an agreed borough wide programme to provide for local low carbon projects.

Policy CC1 (Section 8.25): The Council will require all new developments to assess the feasibility of connecting to an existing decentralised energy network, or where this is not possible establishing a new network. Developments will be required to follow the steps below, in the order listed, to ensure that energy from an efficient source is used where possible:

- Connect immediately
- Connect in immediate future
- Provide a site wide low carbon network.

Policy CC2 (Section 8.41): All new developments will be expected to submit a statement demonstrating how the London Plan's 'cooling hierarchy' (see London Plan Section 3.2) has informed the building design.

Policy CC2 (Section 8.49): The council will expect the application of a BREEAM assessment to non-residential developments 500 sqm or more. We (the council) will expect these to achieve a BREEAM rating of excellent and will encourage zero carbon from 2019.

3.4 GLA Energy Assessment Guidance (June 2022)

This guidance document explains how to prepare an energy assessment to accompany strategic planning applications referred to the Mayor as set out in the London Plan Policy SI 2.

The purpose of an energy assessment is to demonstrate that the proposed climate change mitigation measures comply with London Plan energy policies, including the energy hierarchy. It also ensures energy remains an integral part of the development's design and evolution.

Section 1.7 identifies that each application is considered on its merits, taking into account the individual characteristics of the development. It further identifies that energy assessments should:

- be submitted at the planning application stage, not submitted post planning in response to a condition
- report estimated site-wide regulated CO2 emissions and reductions (broken down for the residential4 and non-residential elements of the development), expressed in tonnes per annum, after each stage of the energy hierarchy, using the GLA's carbon emissions reporting spreadsheet
- demonstrate how the net zero-carbon target for major residential and non-residential development will be met, with at least a 35 per cent on-site carbon reduction beyond Part L 2021 (to be met separately for residential and non-residential elements of the development), and provide the value of the offset payment which will be paid into the relevant borough's carbon offset fund to make up any shortfall to achieve net zero-carbon, where required
- commit that energy efficiency measures alone will reduce regulated CO2 emissions for residential uses by 10 per cent below those of a development compliant with Part L 2021 of the Building Regulations, and by 15 per cent for non-residential uses
- demonstrate that the cooling hierarchy has been followed and include information demonstrating that the risk of overheating has been mitigated through the incorporation of passive design measures
- demonstrate that connection to existing or planned district heating networks has been prioritised and provide correspondence to support this
- commit to a communal heat network to allow connection to existing or planned district heating networks identified in the area
- minimise the number of energy centres and provide a single point of connection to the District Heating Network (DHN)
- investigate and commit to suitable low carbon and/or renewable heating plant for installation within the energy centre if connection can't be made to an area wide network
- investigate and commit to maximising the installation of renewable technologies (including the potential for storage) on site
- report the Energy Use Intensity (EUI) and the space heating demand of the development using the GLA's carbon emissions reporting spreadsheet
- align with related documents and assessments that are submitted as part of the planning application, e.g. 'be seen' planning stage submissions, Whole Life-Cycle Carbon Assessments, Air Quality Assessments, Sustainability Statements.

3.5 Camden Planning Guidance – Energy Efficiency and Adaptation (January 2021)

The document states that "all development in Camden is expected to reduce carbon emissions by following the energy hierarchy in accordance with Local Plan policy CC1."

Section 6 – Energy statements, states that:

- Energy statements are required for all developments involving 5 or more dwellings and/or more than 500sqm of any (gross internal) floorspace.
- Energy statements should demonstrate how a development has been designed following the steps in the energy hierarchy.

Section 7 of the document refers to the following key points related to energy reduction:

- All development in Camden is expected to reduce carbon dioxide emissions through the application of the energy hierarchy.
- All new build major development to demonstrate compliance with London Plan targets for carbon dioxide emissions.

3.6 Part L 2021 and the Energy Assessment Guidance 2022

This document describes how the update in Building Regulations Part L and Part O should be captured within energy assessments, as well as the impact on on-site carbon reduction targets against a significantly improved baseline. It includes the following guidance:

- Initially, non-residential developments may find it more challenging to achieve significant on-site carbon reductions beyond Part L 2021 to meet both the energy efficiency target and the minimum 35 per cent improvement. This is because the new Part L baseline now includes low carbon heating for non-residential developments but not for residential developments. However, planning applicants will still be expected to follow the energy hierarchy to maximise carbon savings before offsetting is considered.

4. Energy Assessment Methodology

4.1 The Energy Hierarchy

The performance of the Proposed Development has been assessed following the procedure as set out by *"Energy Assessment Guidance - Greater London Authority guidance on preparing energy assessments as part of planning applications (June 2022)",* against the policies and supporting information within the London Plan (March 2021). This process follows the Mayor's energy hierarchy as detailed in Section 3.2.

- Be lean: use less energy and manage demand during operation
- Be clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly
- Be green: maximise opportunities for renewable energy by producing, storing and using renewable energy on-site
- Be seen: monitor, verify and report on energy performance.

This approach to assessment aligns with the requirements of Camden Local Plan, and its supporting planning guidance.

Each of these priorities is individually assessed to evaluate the performance of the design and the predicted carbon emissions relevant to each stage. A Predictive Energy Assessment using the TM54 methodology is also undertaken in fulfilment of the 'Be Seen' requirements.

4.2 Regulated energy and emissions

Regulated emissions are those from heating, cooling, lighting, hot water, fans, pumps and controls. These are fixed building services which are directly influenced by the building design and are the reported emissions used for assessment of the buildings' performance for policy compliance. These are determined based on generic building usage profiles to allow for like-for-like comparison, but these may not be realistic for any given building.

Building Regulations approved compliance software (IES Virtual Environment) has been used to establish the regulated CO_2 emissions after each stage of the energy reduction hierarchy as well as to determine the baseline emissions benchmark from which improvements are measured.

An energy model has been created for the below areas of the Proposed Development and images of the model are included in Figure 2 and Figure 3.

The Proposed Development is assessed as a new building, under Approved Document L of the Building Regulations.

The Building Regulation UK Part L BRUKL report for the building model is appended to this document.

The carbon emissions reported in this Energy Statement use Part L 2021 emissions factors.

4.3 Unregulated energy and emissions

Unregulated emissions are defined as those resulting from non-regulated energy sources such as small power (computers, audio equipment and other electrical appliances). An allowance for unregulated emission is made using the standard National Calculation Methodology profiles and domestic benchmarks to capture their effect on regulated emissions but are not included in the emissions reduction targets.

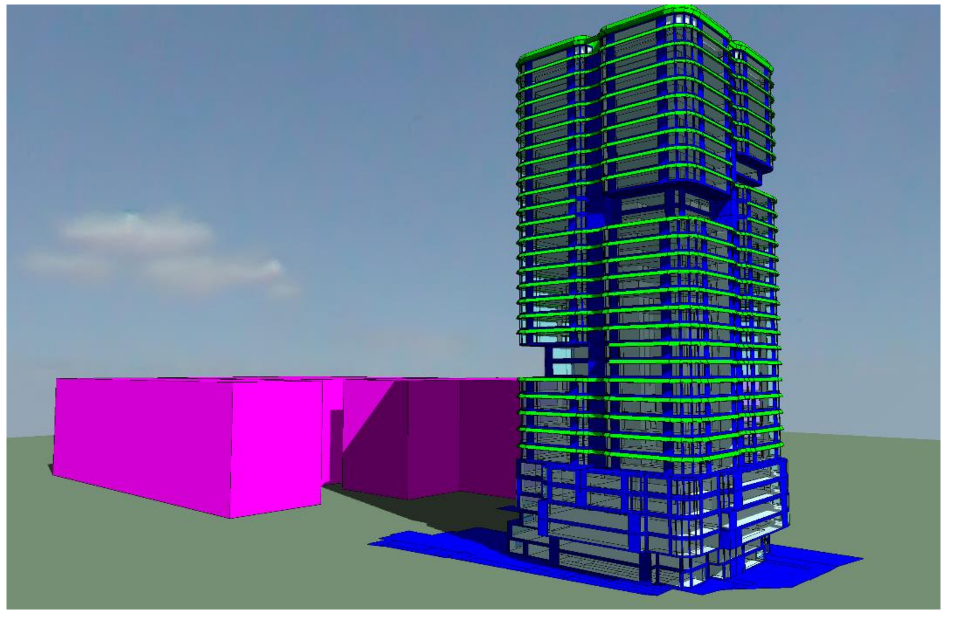


Figure 2: Image of the IES model of Euston Tower

Figure 3: Image of the IES model of Euston Tower from above

4.4 Results

The baseline results for regulated and unregulated carbon dioxide emissions are included in Table 3 below. In accordance with GLA guidance, the baseline for this element is derived from a notional building generated by the Part L 2021 compliance software based on the proposed building geometry. These results are used throughout the energy hierarchy to establish the reductions achieved for each of the stages

Stage in energy hierarchy	Carbon dioxide emission (Tonnes CO_2 per annum)		Notes
	Regulated	Unregulated	
Baseline	297.8	48.7	Unregulated emissions assessed using Part L NCM profiles

Table 3: Baseline building carbon emissions

5. Demand Reduction (Be Lean)

The first stage of the Energy Hierarchy approach focuses on demand reduction through adopting energy efficiency principles. Energy and therefore, carbon emissions, can be reduced through architectural and building fabric interventions (passive design) and energy efficient services (active design).

5.1 Be Lean results

Stage in energy hierarchy	Regulated emissions (Tonnes CO_2 / year)	CO_2 savings (Tonnes CO_2 / year)	Percentage savings (%)
Baseline	297.8		
Be Lean	275.1	22.7	8%

Table 4: Carbon dioxide emissions from the Be Lean stage of the energy hierarchy

5.2 Passive design overview

Optimising passive design is the most effective means of ensuring the Proposed Development is inherently low in energy demand. There are a range of energy efficiency measures that have been investigated throughout the design process and are included for the design of the Proposed Development at this stage:

- A high-performance curtain wall façade has been specified to reduce space heating demand in winter and minimise the risk of summertime overheating. Factors such as embodied carbon, constructability and thermal performance have been considered in the analysis of the façade to provide a solution that balances all considerations.
- Optimised glazing percentages to maximise daylight penetration but minimising overheating. G-value limits specified for glazing elements aims to limit excessive solar gain on to the floor plate.
- Façade elements that project horizontally and vertically adjacent to glazing are optimised to provide solar shading during peak scenarios but also allows for beneficial solar gain during winter months.

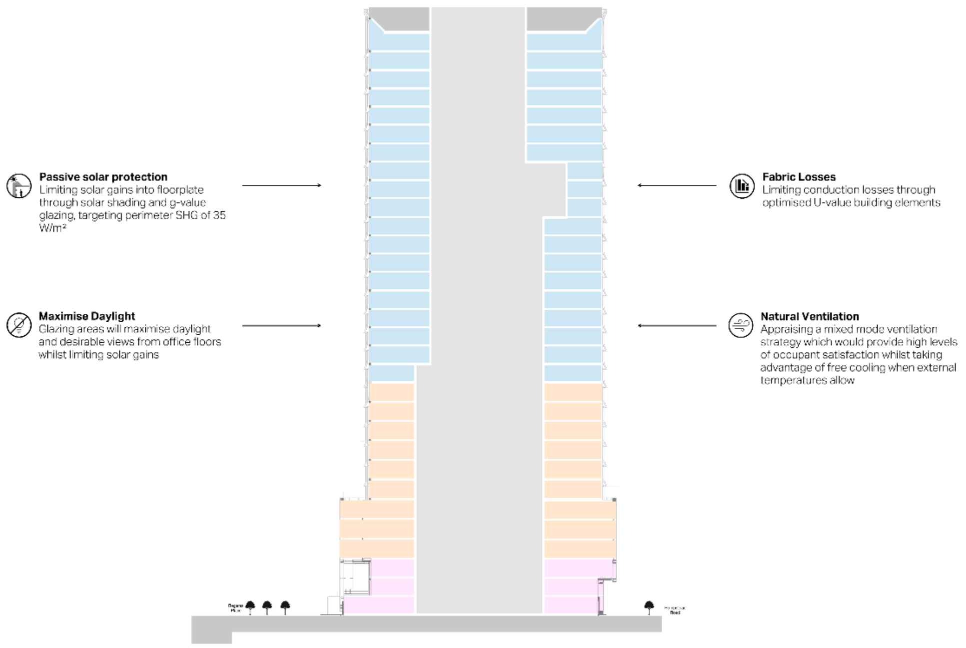


Figure 4: Overview of passive strategies employed within the Proposed Development

5.3 Passive design analysis

Following the London Plan and BREEAM guidance, the Proposed Development has been assessed early in the design process so that effective passive design measures can be successfully integrated into the overall design.

5.3.1 Approach to optimised envelope design

Thermal performance targets were set early in the design process to ensure the building envelope performs as well as possible. Working to a target average U-value of 1.24W/m^2.K across solid and glazed elements of the curtain wall, including thermal bridging, the design team developed a façade system that could deliver the required thermal performance. This target was based on other project experience and performance and aims to provide a balance between delivering high thermal performance to reduce operational energy demand and the increased embodied carbon arising from a higher performing façade. Sensitivity analysis has been undertaken which has found that the additional embodied carbon and complexity of the facade required to improve on this target does not correlate with significant energy and carbon reduction.

Other façade types that may have delivered marginally improved thermal performance were investigated prior to the initial planning submission, but deemed to not be feasible for the Proposed Development. For example, a precast panel façade with punched window openings was studied but was found to impose significantly increased and unacceptable structural loads on the existing building foundations, which are to be retained and reused. A façade system implementing Ultra High Performance Concrete (UHPC) panels was also investigated, but was not taken forward, as the installation methodology, requiring the sealing of external joints from the outside using scaffolding or abseiling, would have introduced installation health and safety risks that were deemed unacceptable.

The architectural intent, combined with various constructability considerations and an overall assessment of embodied carbon of different façade types meant that a unitised curtain wall system was deemed the most appropriate for the majority of the building façade.

Figure 5: Example of curtain wall façade panels showing solid elements and shadow gaps around glazing for natural ventilation

The façade design also allows for the potential incorporation of openable panels within the solid elements between the glazing which may be part of a proposed mixed-mode strategy for certain areas of the building. Figure 6 shows how an openable panel may look from the floor. At present, the results of the energy analysis do not rely on any benefit claimed from a natural ventilation system. Further analysis in the next design stage will explore the feasibility and operability of such a system, with expected ventilation levels delivered and the estimated energy savings achievable through reducing mechanical ventilation assessed if appropriate.

Figure 6: How the openable panels may look from the floorplate

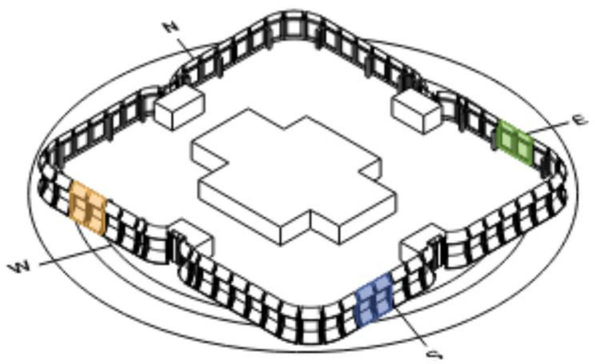
5.3.2 Approach to optimised solar gain targets

City offices are predominantly cooling-led buildings and optimising the façade to reduce solar gains as far as possible, whilst also providing good levels of daylight, is a key factor in reducing the overall operational energy performance of the building.

Industry net zero carbon energy targets from the UKGBC and supplementary guidance within the LETI Climate Emergency Design Guide have been used to establish targets for the Proposed Development. Based on limiting values suggested by LETI, and the peak incident solar gain on the façade, a peak solar gain limit of 35 W/m2 was set for the Office Building.

To investigate the effects of various solar control measures a number of investigations were undertaken to look at the effects of varying the g-value of the glazing and of varying the projection of the solid façade elements to quantify the benefit of the shading they provide.

The West and South façades were found to receive the worst solar gain. Figure 7 below shows the model used and results from the investigation into the shading elements.



Heatgain Study
g_value: 0.3

West			
Peak solar gains	All Year	72
	Summer	65
Exceedance Hours	All Hours	456
	During Summer	180

South		
Peak solar gains	All Year	76
	Summer	55
Exceedance Hours	All Hours	656
	During Summer	135

East		
Peak solar gains	All Year	58
	Summer	58
Exceedance Hours	All Hours	174
	During Summer	104

Figure 7: Solar gain modelling of shading elements

From this analysis it was found that a G-value of 0.3 was found to be appropriate in limiting peak solar gain to acceptable levels. As the shading elements include complex geometry, the effects of the shading elements were carefully correlated with reduced g-values in a detailed study comparing the solar heat gain onto the floorplate, with the resulting g-values then applied within the whole building energy model to reduce simulation run time whilst providing results that estimate the reduction in direct solar gain.

There are a number of amenity spaces throughout the Tower where the glazing is more extensive with limited framing, visually appearing double height. These areas are generally aligned with an external terrace, so that glazing is set back from the edge of the Tower and shaded by the projecting story above. Planting is proposed along each terrace which will provide additional shading, as will the structural columns and bracing that continues through the terrace, as indicated in Figure 8 below:

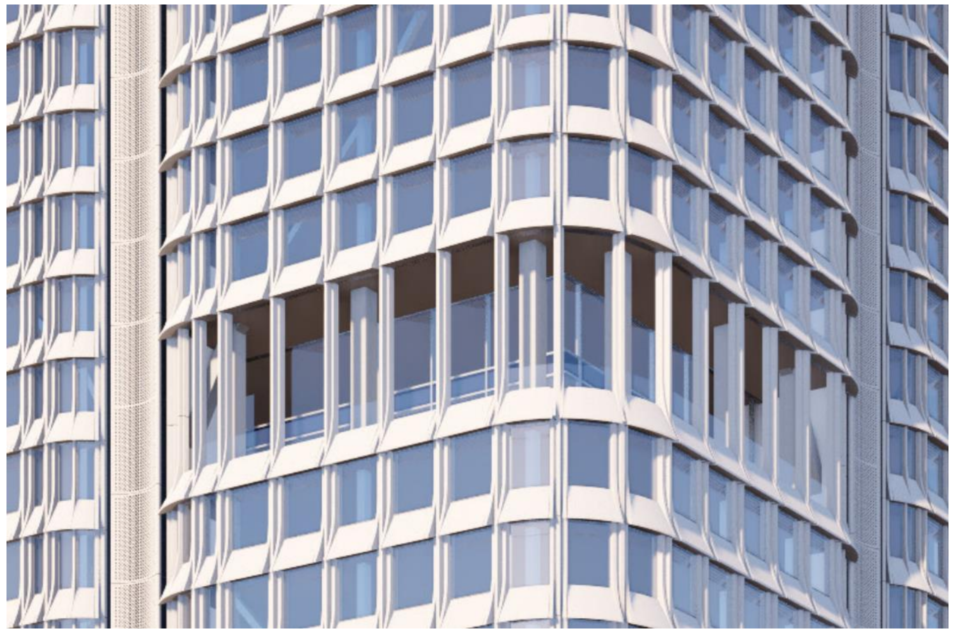


Figure 8: Example of amenity space glazing adjacent to a terrace area showing shading provided by the projecting storey above, and the structure.

Analysis of the modelling showed that with the shading elements in these amenity spaces, the solar heat gain was sometimes exceeding acceptable levels. As the architectural intent in these areas relies on the good daylighting and internal experience provided by the large, glazed areas, an external blind integrated into a Closed Cavity Façade (CCF) has been proposed in this area to limit the direct solar gain into amenity spaces.

5.3.3 Adaptation to climate change

By employing effective passive design measures, particularly those relating to solar control, the design is well placed to cope with anticipated increases in summertime temperatures. The building infrastructure is designed with future elevated summer temperatures in mind and predicted future weather data has been used in the modelling of the Proposed Development.

5.3.4 Envelope airtightness

Specific air-tightness targets have been set which are improvements on the Building Regulations Part L requirements. Best practice construction techniques will be employed, and airtightness tests will be made on completion to ensure that the finished construction achieves the design values.

5.3.5 Thermal mass

The intent within most spaces of the Proposed Development is that soffits remain exposed. This reduces the embodied carbon associated with ceiling installations and allows the thermal mass of the exposed soffits to be implemented as part of the strategy to reduce the maximum cooling demand by absorbing excess heat during peak periods, enhancing energy efficiency and increasing occupant comfort.

5.3.6 Summary of specified envelope thermal performance

Element		Proposed Performance
Curtain wall*		1.24 $W/m^2.K$ average
Roof		0.12
Floor		0.15
Solar gain target**		35 W/m^2 (averaged over a 4.5m perimeter area)
Glazing	Tower	58% - shaded by projecting façade elements
	Amenity Spaces	86% - extensively overshaded by floor above and structure, incl. external blinds
	Podium	62% - average figure across all facades
g-value		0.30
Airtightness		3 $m^3/hr/m^2$ @ 50Pa

* Total thermal performance including glazing, opaque areas and all thermal bridging

**Target value, sometimes exceeded but outside of peak cooling season.

5.4 Active design overview

The building services systems have been carefully considered to ensure that they are as efficient as possible in operation. A summary of some of the active design measures employed on the Proposed Development are provided in Figure 9 below.

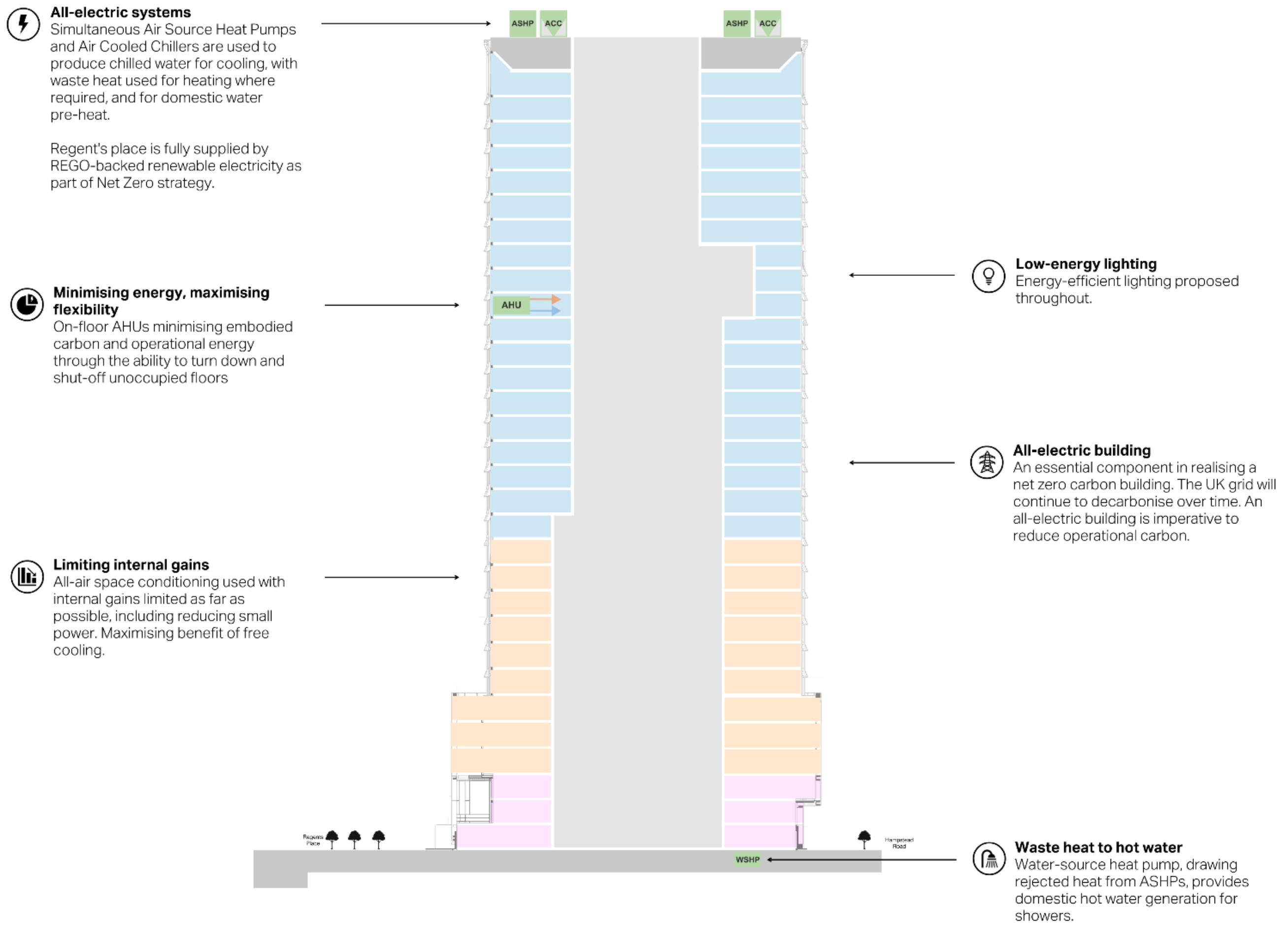


Figure 9: Overview of the proposed energy sharing strategy highlighting main heating and cooling equipment.

5.4.1 Ventilation strategy

Decentralised ventilation systems are proposed in many areas of the Proposed Development to minimise fan energy and provide accurate demand control, ensuring that systems turn down to minimum levels of operation during periods of low use and off, when not required. The strategy in placing air handling equipment close to the areas they serve minimises long duct runs, which also presents an embodied carbon saving.

A 'full fresh air' underfloor air distribution (UFAD) system is proposed to satisfy the internal space conditioning requirements and provide excellent internal air quality. This strategy uses a pressurised floor plenum to provide supply air, negating the need for high level distribution ductwork within Office spaces, which presents a significant embodied carbon saving as well as improved visual perception across the floorplate.

The system facilitates the exploitation of free cooling, providing significant energy savings during the winter and mid-seasons. Air handling units will be fitted with high-efficiency heat recovery devices in all cases to ensure highly efficient operation.

To offset the minimised conduction heat gains and losses through the façade, active trench units with low-energy fans are proposed in all office spaces and in certain areas of the podium.

During the detailed system modelling required as part of the NABERS process, to be undertaken in the next design stage, this will be further investigated and quantified.

5.4.2 Lighting

Low energy LED lighting will be used across the Proposed Development which will make a significant contribution to reducing the carbon emissions arising from the operation of the building. Internal lux levels will be specified to suit the expected tasks conducted in the various spaces of the building. The lowest possible lux levels will be used as the basis of design to reduce lighting energy consumption as far as possible. Lighting power densities of 6 W/m^2 and 10 W/m^2 have been allowed in office areas and lab-enabled areas, respectively, based on BCO guidance and client requirements.

5.4.3 Smart sensing and control

The Proposed Development will utilise sensing and control to effectively modulate building services systems to match the user demand, thereby improving user experience and satisfaction whilst minimising energy consumption. During future design stages, the following potential opportunities, among others, will be explored and implemented, subject to an assessment of feasibility and viability.

- Variable speed systems to ensure low energy consumption during periods of low load. Pump configurations and smart control systems will be explored using detailed energy modelling in the next design stages.
- The control methodologies of the natural ventilation openings in office areas will be further developed and refined. There are numerous project precedents for different types of system, and the project team will investigate possible options, to provide the best balance between occupant satisfaction and energy reduction.

5.4.4 Thermal storage, heat recovery and energy sharing

Simultaneous heating/cooling ASHPs form an integrated energy system that will serve the whole of the Proposed Development. These will recycle waste heat from the cooling system and use it to provide space and water heating. Peak cooling loads in the Office Building will be topped up by air-cooled chillers. These can provide higher efficiency cooling than ASHPs, especially when there is no simultaneous heating load. Thermal storage is a key part of maximising the operation of this system and allowing the equipment to work at optimal efficiency.

Detailed operational energy modelling during the Stage 3 design will develop the sizing of the thermal energy stores and inform the optimum capacity of the heating and cooling generation systems.

6. Cooling and Overheating

Avoiding operational energy consumption arising from active cooling has been a key driver of the design. As outlined in Section 5.2, a number of passive measures have been included within the Proposed Development to reduce the cooling requirements as much as is feasibly possible.

6.1 Cooling hierarchy

To minimise the operational carbon emissions of active cooling systems as well as reduce the embodied carbon impact of the system installations, the cooling hierarchy outlined in the London Plan has been implemented within the designs of the Proposed Development. The requirement for cooling, the extent fo the areas where it is applied and the overall system cooling capacity have all been minimised, as described below.

1. **Reduce the amount of heat entering a building through orientation, shading, high albedo materials, fenestration, insulation and the provision of green infrastructure**

   The passive design measures described in Section 5.2 substantially reduce solar gain, conduction and infiltration gains.

2. **Minimise internal heat generation through energy efficient design**

   Mechanical systems will be designed to minimise unwanted heat generation such as those from pipework, fans and pumps through proper insulation and specification of high efficiency equipment. Lighting systems will be highly efficient LED systems, controlled to minimise lighting energy during daylight hours.

3. **Manage the heat within the building through exposed internal thermal mass and high ceilings**

   Many spaces throughout the Proposed Development are enabled for an exposed soffit approach. This reduces the embodied carbon associated with suspended ceilings and allows the thermal mass of the exposed soffit to absorb excess heat and reduce peak cooling demand. This available thermal mass coupled with the openable panels may allow for night-purge ventilation to be investigated in the future, cooling the thermal mass during unoccupied hours, providing additional cooling to the floorplate if required during the day.

4. **Provide passive ventilation**

   To enhance occupant satisfaction and wellbeing, openable, solid panels are planned to be integrated within the façade design of the Office spaces of the Proposed Development. These panels will allow for additional natural ventilation to be supplied to perimeter zones of the floorplate. As there is still significant design development to undertake, no operational energy or carbon savings have been claimed from this addition. Further analysis in later design stages will confirm the expected ventilation levels delivered and the estimated energy savings achievable through reducing mechanical ventilation levels, if appropriate.

5. **Provide mechanical ventilation**

   Mechanical ventilation provided to each space is covered in detail by the Ventilation Statement. In general, across the Lab-enabled and Office spaces, which occupy the majority of the floor area of the Proposed Development, an all-air underfloor displacement ventilation solution is proposed, using on-floor AHUs. This strategy optimises the potential for using free-cooling from outside fresh air, supplied into the spaces through the underfloor system, avoiding the need for active cooling. Avoiding the use of high-level ductwork also reduces the overall embodied carbon of the installation.

6. **Provide active cooling systems**

   The central mechanical cooling system will be highly efficient and will comprise simultaneous heating and cooling ASHPs and Air-Cooled Chillers. The simultaneous ASHP units will allow for waste heat rejected from spaces being cooled to be reused in heating other spaces and in the production of domestic hot water.

6.2 Overheating assessment

An overheating assessment has been completed to ensure that heat gains are minimised within the building and to ensure that adequate means of maintaining comfort conditions are provided.

The assessment has been undertaken in line with CIBSE TM52: The Limits of Thermal Comfort, which is applicable to non-domestic buildings.

Each space in the building is assessed against the following criteria:

1. Hours exceedance: The space must not exceed the threshold comfort temperature by >1°C for more than 3% of occupied hours
2. Daily Weighted Exceedance: A daily limit of temperature rise and duration, allowing longer periods of a low temperature rise and shorter periods of high temperature rise.
3. Upper Limit Temperature: Sets a maximum daily temperature for each space.

In accordance with GLA and BREEAM guidance, the overheating risk for these areas has been undertaken following CIBSE TM52 and tested against the following weather profiles to determine current and future climate resilience.

- Design Summer Year 1 for the 2020s: current design year
- Design Summer Year 2 for the 2020s: a year with a very intense single warm spell
- Design Summer Year 3 for the 2020s: a year with a prolonged period of sustained warmth

In accordance with CIBSE TM52, if more than 3% of a building's occupied hours are above an operative temperature of 26°C, the building is determined to be at risk of overheating.

The GLA's guidance does not expect the building to pass with the more onerous weather files, DSY2 and DSY3.

All areas analysed showed that less than 3% of a building's occupied hours are above an operative temperature of 26°C, therefore the building is not considered to be at risk of overheating.

The building was also analysed under DSY2 and DSY3, and all areas analysed showed that less than 3% of a building's occupied hours are above an operative temperature of 26°C.

Refer to Appendix 0 Overheating Assessment for further information and results.

7. Heating Infrastructure (Be Clean)

7.1 District Heat Networks

The London Heat Map shows the planned Euston Road heat network within the vicinity of the Proposed Development with the indicative route marked in purple within Figure 10 below.

It is understood that although the planned network is indicated, there has not been any active progress in procuring this network in recent years. Camden's Borough Wide Heat Demand and Heat Source Mapping (2015) report does pick up on a focus area around the Euston station development, but it is understood that this network is not currently available for connection and there is no reasonable prospect of delivery within suitable timescales.

For this reason, the Proposed Development will be provided with high efficiency ASHPs to generate heat, rather than rely on a connection into a district heat network.

As the Proposed Development progresses there may be further clarity on planned heat networks within the area. As such, the requirements for a future network connection have been considered and provided for. Sleeves through the basement walls will be provided to allow pipework to pass through and connect into a future district heating network. Suitable space in the basement area will be allocated for the installation of heat exchangers as may be required in the future for heat network connection.

The indicative route shown on the London Heat Map shows the district heating main running along Euston Road and Hampstead Road, and it is proposed that the pipework sleeves be allowed in the East side of the basement for a connection into a future main along Hampstead Road. The final location and detailing of these connections will be decided in future design stages.

Figure 10: Image from the London Heat Map showing the proposed Euston Road heat network

7.2 Combined Heat and Power

The combined production of electricity and usable heat is known as Combined Heat and Power (CHP). In a CHP system, steam or hot water, which would otherwise be rejected when electricity alone is produced, is used for space or process heating. The London Plan and GLA Energy Assessment Guidance (2022) limits the use of CHP to 'only where there is a case for CHP to enable the delivery of an area-wide heat network'. As there are no area-wide heat networks planned within the vicinity of the Proposed Development, CHP is not proposed to be included as part of the energy strategy for the Proposed Development.

The Proposed Development adopts an all-electric heat-pump heating and cooling strategy with no on-site flue emissions in normal operation arising from heating and cooling equipment.

8. Renewable Energy (Be Green)

8.1 Be Green results

The table below shows the emissions reduction for the Be Green stage of the energy hierarchy.

Stage in energy hierarchy	Regulated emissions (Tonnes CO_2 / year)	CO_2 savings (Tonnes CO_2 / year)	Percentage savings (%)
Baseline	*297.8*		
Be Lean	*275.1*	*22.7*	*8%*
Be Clean	*275.1*	*0.0*	*0%*
Be Green	251.2	23.9	8%

Table 5: Carbon dioxide emissions savings from the Be Green stage of the energy hierarchy

8.2 LZC feasibility study

Following the GLA and BREEAM guidance, an initial review of potential Low and Zero Carbon technologies was undertaken at an early stage, the summary of which is included below:

Possible Technology	Assessment of feasibility	Notes
Heat generating technologies		
Solar thermal panels	Unfeasible	Roof space is insufficient for a significant installation that would be required to meet the domestic hot water demands of the building. Roof space is prioritised for ASHPs, Air Cooled Chillers and PV. Other roof / terrace areas are used for planting to improve the urban greening factor and sustainability targets.
Biomass boilers	Unfeasible	Fuel delivery would be disruptive to traffic and emissions arising from these deliveries and also the products of combustion would be detrimental to local air quality.
Air Source Heat Pumps	Feasible	The Proposed Development is well suited to the application of air source heat pump technology. Refer to Section 8.4.2 for further information.
Ground Source Heat Pumps	Unfeasible	Both open and closed loop ground source heat pump systems have been investigated but are not deemed feasible in the Proposed Development due to the disruption this would cause to the existing basement slab which is to be retained. The footprint of the development does also not allow sufficient separation between open loop abstraction and recharge boreholes. Refer to Section 8.4.1 for further information.
Hydrogen Boilers	Unfeasible	Immature technology with uncertainties around future hydrogen fuel supply. Heat pump technology is mature and available now and as such presents a more feasible approach.
Power generating technologies		
Wind turbines	Unfeasible	Limited performance in an urban setting with turbulent wind movement.
Photovoltaic panels	Feasible	The Level 31 roof level is suitable for PV installation, but with limited space available. Further areas for PV will be reassessed at each design stage if additional space is released. Refer to Section 8.3 for further information.
Hydrogen fuel cells	Unfeasible	Immature technology with uncertainties around future hydrogen fuel supply.

Table 6: Summary of LZC technology feasibility review

8.3 Photovoltaic panels used on the Site

The Level 31 roof level of the proposed development fulfils a number of functions, it:

- Provides plant areas for equipment that require high volumes of outside air for efficient operation, namely the ASHPs and Air-Cooled Chillers.
- Houses the Building Maintenance Unit (BMU) and the track it operates upon, to facilitate a safe access method for façade access and maintenance.
- Provides space for on-site electricity generation using photovoltaic panels.

An assessment of the available space has been undertaken and it is proposed that 63no. panels could be installed at Level 31 roof level as shown below in at Figure 11 and Figure 12.

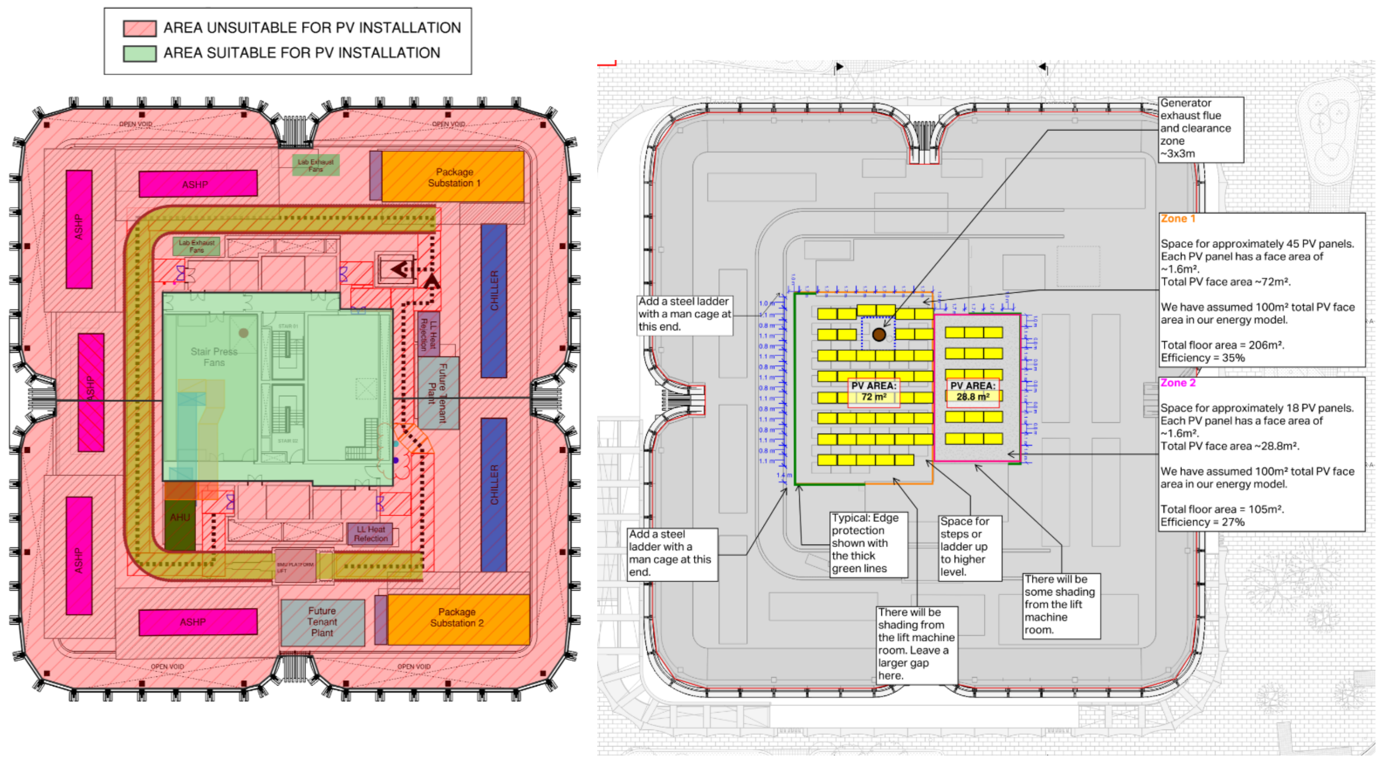


Figure 11: Areas available for installation of PV at Level 31 roof level

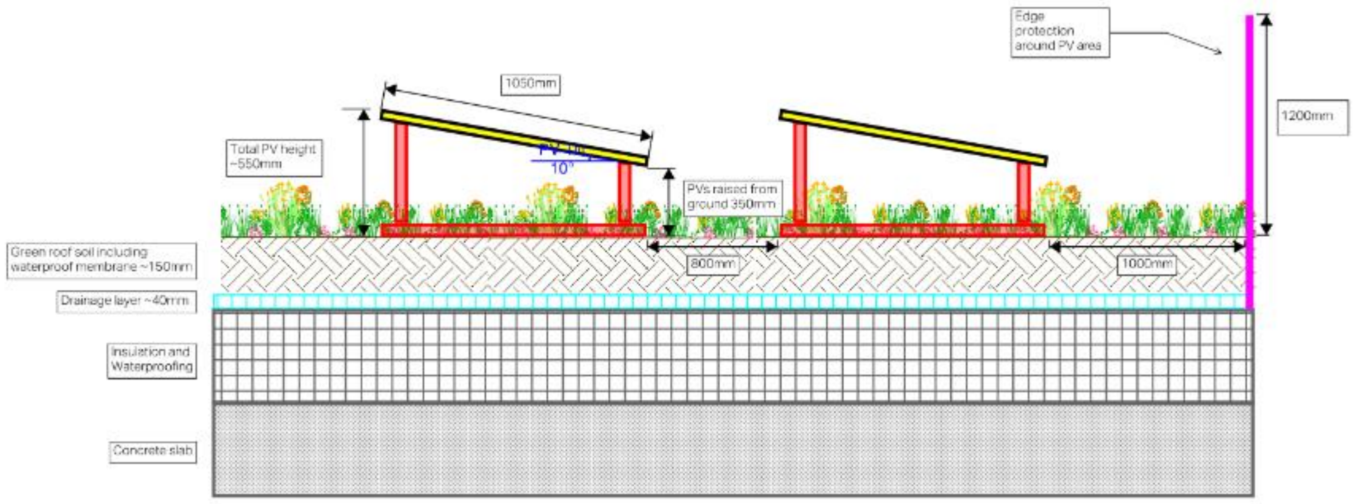


Figure 12: PV section indicating green roof constraints

The table below outlines the parameters of the PV installation.

Item	Info
Total installed capacity (kWp)	23.31 kWp
Annual electricity generation (MWh/annum)	19.88 MWh/annum

Table 7: Summary of PV installation output

8.4 Heat pump systems

The use of electrically powered heat pumps within the Proposed Development will take advantage of the future decarbonisation of the national electricity grid. As the grid decarbonises, the Proposed Development will emit less operational carbon, feasibly becoming fully net zero carbon if the grid becomes sufficiently decarbonised.

8.4.1 Ground Source Heat Pumps

The use of a Ground Source Heat Pump (GSHP) system was evaluated as part of the LZC technology feasibility assessment. As domestic water heating loads are likely to be consistent through the year, it was proposed that a GSHP system could be used to provide this, whilst possibly allowing the discharge of excess heat from the buildings cooling systems to 'recharge' the ground heat source. During the study It was found that:

- Installing a pipe network within the new structural piles planned would not yield sufficient heat for it to be feasible.
- Allowing boreholes through the new structural slab within the footprint of the basement would allow for approximately 30 boreholes, allowing an estimated system capacity of less than 175kW, which again does not provide sufficient yield to be viable.
- An open loop system would require 2no. injection wells and 1no. abstraction well located approximately 100m apart. This separation distance would not be able to be accommodated within the redline boundary of the Proposed Development.
- The installation of boreholes (both open-loop and closed-loop) would require extensive excavation through the existing basement slab, which would have an impact on the structural capacity of the slab, likely requiring removal or reinforcement, carrying an embodied carbon penalty. The routing of distribution pipework connecting the boreholes to the GSHP equipment would also require extensive excavation of the existing slab which would also impact the structural capacity of the slab.
- It is expected that a more significant GSHP installation with a higher capacity could be achieved if large parts of the existing structure within the basement were to be removed to allow the installation of a greater number of boreholes and connecting pipework. It is estimated that if around 60, 200m deep boreholes were installed, necessitating the removal of much of the existing basement structure, the overall peak capacity of the system could be increased to around 360kW. However, it is estimated that it would take over 1150 years for the carbon savings gained from the increased system efficiencies to pay back the embodied carbon associated with removing the existing structure

In all cases, there is a recognition that the area surrounding and below Euston Tower is heavily congested with utilities and London Underground assets and this would require significant coordination and consenting from these stakeholders. For the possible yield of the system, the energy saving potential and the impact on the retained structural slab, it was not deemed feasible to include a GSHP installation within the Proposed Development.

Two different types of heat pump are included within the current strategy and are detailed in the following sections.

8.4.2 Air Source Heat Pumps

Simultaneous Air Source Heat Pumps (ASHP) will be installed at Level 31 roof level. The ASHPs are sized to meet the space heating and domestic hot water generation requirements of the Proposed Development.

Simultaneous heat pumps will recover heat from the cooling system and deliver it to the heating system, thereby providing heating and cooling at the same time. The simultaneous heat pumps will operate as air-source heat pumps/air-cooled chillers when the heating and cooling demand do not align.

Table 8 shows the rated performance of the simultaneous heat pump in its three modes of operation.

Since the performance of the system varies depending on the mode of operation and ambient temperature, annual demand profiles are required to calculate the overall system performance. Using the demand profiles and efficiencies stated in Table 8, the overall annual performance of the system can be calculated. This calculation is shown within Appendix A.4 and provides the heating and cooling SEER and SCOP assigned within the energy modelling.

8.4.3 Water Source Heat Pumps

The domestic hot water (DHW) required will be largely produced by Water Source Heat Pumps (WSHP), located in the basement level, recovering heat rejected by the ASHPs and providing DHW at acceptable temperatures. WSHP's are required to boost the temperature received from the ASHP's as these units alone cannot produce the temperatures required for domestic hot water. The main demand for DHW arises in the basement showers. For this reason, the WSHPs are located within the basement, to minimise distribution pipework and the heat losses caused by long pipe runs.

The expected performance of the Air Source and Water Source heat pumps proposed are shown in Table 8 below.

Table 8 Heat pump performance data

Parameter	Efficiency metric	Varies with ambient temperature
Cooling only, EER	2.87*	✓
Cooling, SEER	4.20***	×
Simultaneous heating & cooling, TER	7.47	×
Heating only, COP	2.57**	✓
Heating, SCOP	3.55***	×
DHW Heat Pump, COP	5.0	×
DHW System, SCOP	3.49	×

**at cooling design ambient, 35°C*
***at heating design ambient, -4°C*
****refer to Appendix A.4 for calculations*

9. Flexibility and peak energy demand

The operational carbon emissions from an all-electric building depend on the dynamic variation of the carbon intensity of the electrical grid. As the electrical grid continues to decarbonise, this variation of carbon intensity and power availability and cost will increase due to the fluctuations in supply from renewable energy sources.

The Proposed Development's heating and cooling strategy uses thermal energy storage linked to electric heat pumps. This is an efficient approach to load-shedding, maximising the use of infrastructure that is already in place within an all-electric heating strategy to further reduce the operational carbon footprint of the Proposed Development.

Thermal energy storage provides the following benefits:

- Reduces the peak electrical capacity required for the all-electric energy centre
- Acts as demand side energy storage, allowing the energy network to benefit from off-peak low carbon electrical energy and off-peak tariff, and then release it as thermal energy during peaks.

	Electrical	Heat	Details
Estimated peak demand	7,600 kVA	2,954 kW	Connected electrical load, and peak diversified thermal load
Available capacity	Mains supply – 7,600 kVA Backup supply – 3,200 kVA	N/A	Local electrical capacity advised by utility consultant
Flexibility Potential	0 kW	739 kW	Thermal storage can provide approx. 25% of hourly peak load. On-site electrical storage or generation is not proposed
Revised peak demand	7,600 kVA	2,585 kW	Additional thermal capacity included for resilience and ability to be responsive when electrical grid incentivises use.
Percentage flexibility predicted (%)	0%	12.5%	Calculations from flexibility potential as a proportion of peak demand

Table 9: Summary of peak demand, capacity, and flexibility potential

Flexibility achieved through	Yes / No	Details
Electrical energy storage (kWh)	No	None planned within scheme
Heat energy storage (kWh) capacity	Yes	25,500 L thermal heat storage has been provided within the Proposed Development with the final size to be determined as the design progresses dependent on the eventual system volumes which are not yet known.
Renewable energy generation	Yes	PV installation is planned at Level 31 roof level
Gateway to enable automated demand response	Yes	To be provided to thermal energy system via Building Management System, and car park charging through dynamic load management system.
Smart systems integration	Yes	Landlord systems will be designed to be open-protocol where appropriate with gateways that gets useful data out, while providing appropriate level of data security.

Table 10: Summary of interventions for achieving flexibility

10. Monitoring and Reporting (Be Seen)

The effectiveness of the energy strategy for the Proposed Development will be assessed based on its real-world performance in operation. The London Plan requires the reporting of energy usage data within the 'Be Seen' requirements, which aims to reduce the energy performance gap often previously identified between the design and actual performance of the building in operation.

Building Management Systems (BMS) will be implemented within the Proposed Development. These systems will oversee and monitor the performance of building systems and services, offering insights into equipment and system efficiency as well as overall energy consumption. The BMS will be enabled to continuously monitor and analyse the actual energy performance post-construction.

10.1 Predictive energy assessment

To comply with the requirements described in the 'Be Seen' guidance for planning stage, the building energy consumption (kWh/m^2) has been estimated using the CIBSE TM54 analysis process to accompany the Building Regulations Part L compliant methodology. The CIBSE TM54 methodology provides an assessment of both regulated and unregulated energy consumption.

The TM54 modelling process uses a range of scenarios with different inputs, decided by the design team, including occupancy density and profiles, space uses, and equipment gains to model upper and lower energy consumption bounds for the Proposed Development. The process is summarised in further detail in Appendix A.1.

The carbon emissions reported in this assessment are used for the contribution of operational carbon performance for Module B6 of the separate Whole Life-Cycle Carbon Assessment

To further improve the estimations of operational energy demand and carbon emissions during operation a comprehensive NABERS Design for Performance (DfP) assessment will be carried out during the next design stage. This will be used to inform the refinement of the energy strategy and aid in ensuring that equipment and systems are appropriately sized, specified and controlled to optimise performance.

The GLA's 'Be Seen' reporting spreadsheet with performance indicators including contextual data, building energy use and carbon emissions for the Proposed Development with be submitted separately.

10.2 Be Seen results

Different low-end, high-end and mid-range scenarios were tested alongside the baseline cases, representing the design intent of the Proposed Development at this stage. Each was tested to give an indication of the range of variation in a building's performance due to various uncertainties.

- Baseline cases: these scenarios represent the current design intent most accurately. A scenario where the building is fully occupied by office tenants was chosen to compare against the current design intent where the building is also partially occupied by lab tenants on all lab enabled floors. These scenarios use the current design estimates and allowances.
- Medium Office/Lab: the best estimate of the energy use based on the occupancy estimates from the prospective occupants using less energy intensive assumptions for the building's power allowances.
- Low-end scenario: generated by considering the uncertainties on low ends of the baseline for key parameters.

Table 11 compares the absolute energy consumption and Energy Use Intensity (EUI) of the Proposed Development represented by the Baseline Office/Lab scenario with the alternative scenarios selected for CIBSE TM54 analysis.

TM54 Result	Building Energy Consumption (MWh/Year)	Building Energy Intensity (kWh/m2)
Baseline Office/ Lab	**11,366**	**158.3**
Baseline Office	7,617	106.1
Medium Office/ Lab	10,687	148.8
Low End	6,669	92.9

Table 11 Summary of TM54 Results

For further information on the assumptions, methodology and results refer to Appendix A.1 Predictive Energy Assessment.

The results of the predictive energy assessments are presented in the graphs below.

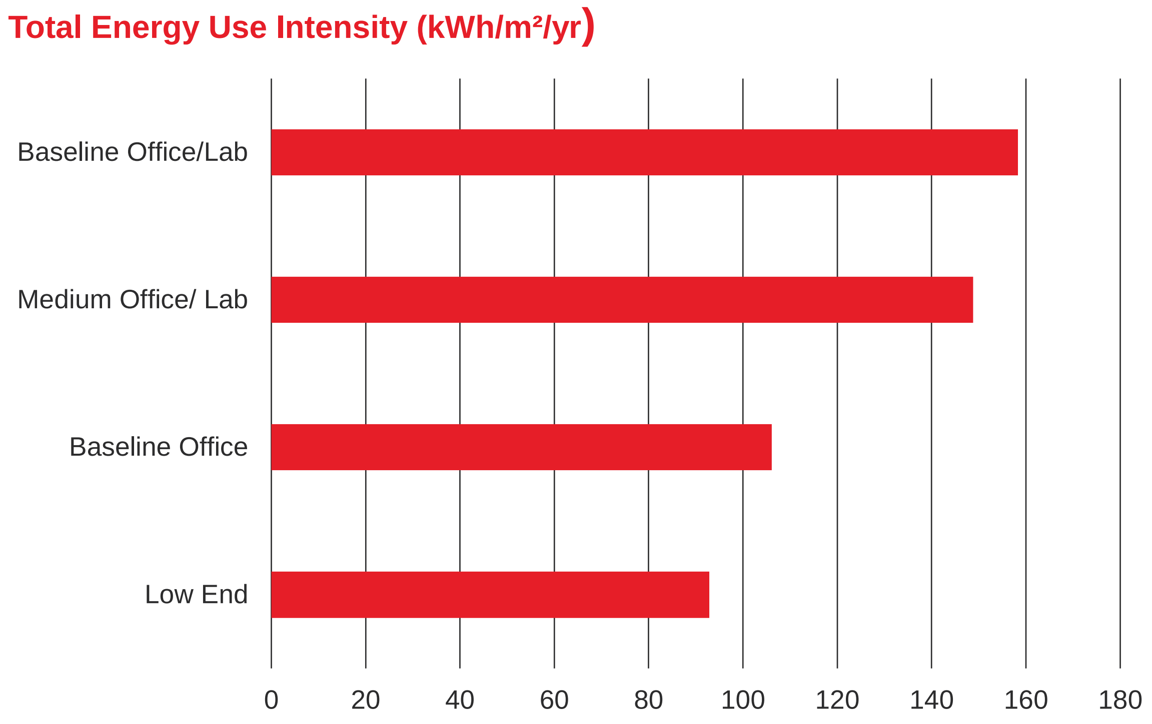


Figure 13: Energy Use Intensity per scenario for the Proposed Development

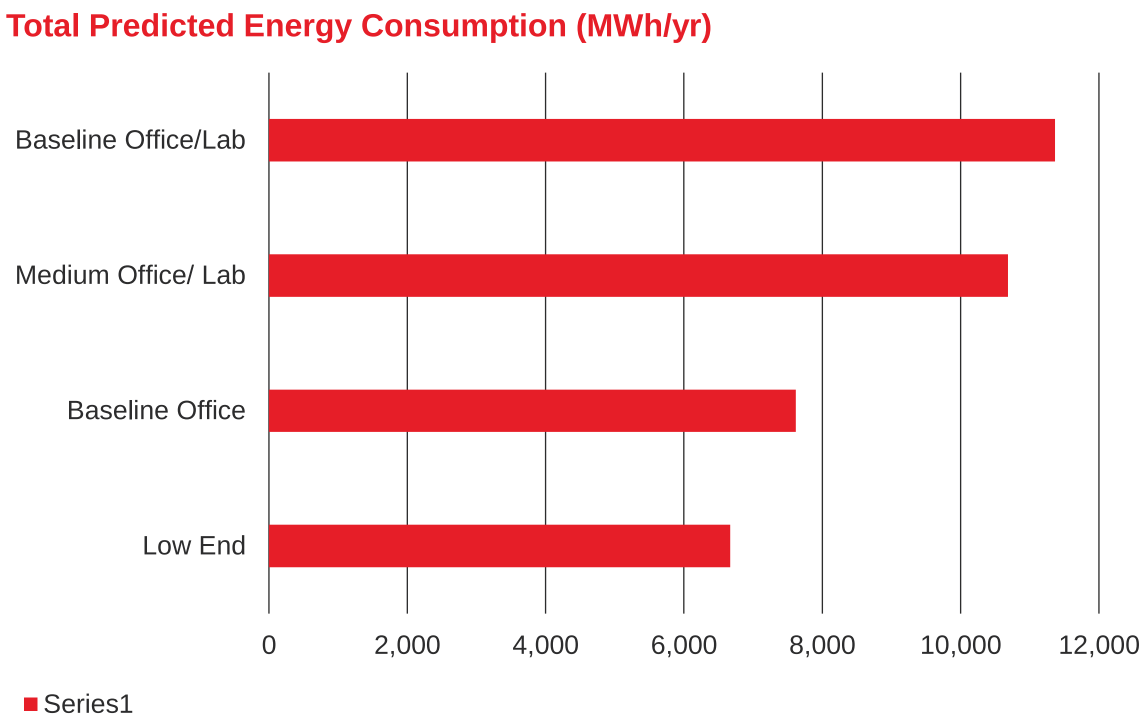


Figure 14 Predicted annual energy consumption per scenario for the Proposed Development

Building Type	EUI (kWh/m²/year) (excluding renewable energy)	Space heating demand (kWh/m²/year) (excluding renewable energy)	EUI value from Table 4 of the GLA Energy Assessment guidance (kWh/m²/year) (excluding renewable energy)	Space heating demand from Table 4 of the guidance (kWh/m²/year) (excluding renewable energy)	Operational energy use assessment	Notes (if expected performance differs from the Table 4 values in the guidance or other software used)
Office	158.28	8.41	55	15	CIBSE TM54	See appendix A.1

Table 12: Non-residential predicted energy use (as per GLA reporting spreadsheet)

Table 12 above presents the key information from the EUI & space heating demand tab of the GLA carbon emission reporting spreadsheet.

11. Conclusion

This Energy Strategy for the Proposed Development has followed the energy hierarchy principles set out in the London Plan (2021) and the Camden Local Plan (2017). The strategy is in line with Energy Hierarchy identified within the London Plan and the information provided to satisfy each requirement is summarised below.

Be lean: use less energy and manage demand during operation

The Proposed Development applies passive design principles including the specification of a high-performance building fabric and carefully considered glazing to reduce energy demand. Effective active systems are proposed to then meet this reduced demand as efficiently as possible. The reduction beyond Part L 2021 through energy efficiency measures is 8%.

Be clean: exploit local energy resources (such as secondary heat) and supply energy efficiently and cleanly

Connection into a district heat network has been considered and analysed with the future connection possibilities outlined. LZC technologies have also been appraised and assessed for feasibility.

Be green: maximise opportunities for renewable energy by producing, storing and using renewable energy on-site

The implementation of simultaneous ASHPs has been detailed and their integration with other building systems to share energy efficiently has been discussed. The inclusion of a PV installation at Level 31 roof level has been summarised. The reduction beyond Part L 2021 through renewable energy measures on-site is 8%.

Be seen: monitor, verify and report on energy performance.

Predictive energy assessments in accordance with CIBSE TM54 have been performed and submitted as part of this Energy Statement.

The proposed energy strategy has been demonstrated to achieve a **16%** on-site reduction in regulated carbon dioxide emissions beyond Part L 2021. The results and carbon offset contributions can be seen in the tables below.

	Total regulated emissions (Tonnes CO2 / year)	CO2 savings (Tonnes CO2 / year)	Percentage savings (%)
Baseline: Part L 2021	297.8		
Be lean: Savings from energy demand reduction	275.1	22.7	8%
Be clean: Savings from heat network	275.1	0.0	0%
Be green: Savings from renewable energy	251.2	23.9	8%
Cumulative on-site savings		**46.5**	**16%**

Table 13: Total Proposed Development regulated carbon emissions results and savings

11.1.1 Compliance with GLA requirements

It is acknowledged that the current predicted on site reduction falls short of the GLA's 35% on-site carbon reduction over Part L 2021, which has been raised and highlighted in pre-application meetings with the GLA's energy officers. Feedback from these meetings stated the requirement for the limitations to be set out in detail, with clear reasons why compliance is not possible for the Proposed Development. The key points in this regard are detailed later in this section.

The 'Note to accompany GLA Energy Assessment Guidance 2022' acknowledges that non-residential developments may find it more challenging to achieve significant on-site carbon reductions beyond Part L 2021 to meet both the energy efficiency target and the minimum 35% improvement.

The note acknowledges that the non-residential baseline also now includes low-carbon, electrically powered heat generation, with a relatively high efficiency meaning the demonstrable improvement from the inclusion of these measures in the Proposed Development is greatly reduced.

The new Part L baseline is also based on building fabric with much better thermal performance than Part L 2013, making it very difficult to demonstrate significant improvements in energy demand reduction.

The note highlights that applicants are still expected to follow the energy hierarchy to maximise carbon savings.

This Energy Statement for the Proposed Development is provided to demonstrate that the Energy Hierarchy has been followed in accordance with relevant planning requirements. Factors specific to the Proposed Development that prevent meeting this target are summarised in the following section.

11.1.2 Specific limitations of the Proposed Development:

Be Lean:

- Numerous façade options were explored as part of the design process informing the previous planning submission, with detailed analysis of embodied carbon, constructability and thermal performance aspects. The curtain wall façade system chosen balances each of these factors and delivers a well-rounded solution. However, the achievable overall U-value of this system is higher than that of the notional building façade performance, which relates to solid wall and glazed elements, and forms the baseline to which the Proposed Development is compared. Other façade types that may have delivered marginally improved thermal performance were investigated but deemed to not be feasible. A precast panel façade with punched window openings was studied but was found to impose significantly increased and unacceptable structural loads on the existing building foundations, which are to be retained and reused. A façade system implementing Ultra High Performance Concrete (UHPC) panels was also investigated but was not taken forwards as the installation methodology, requiring the sealing of external joints from the outside, using scaffolding or abseiling, would have introduced installation health and safety risks that were deemed unacceptable. A detailed summary of the reasoning behind the façade strategy chosen is included in Section 5.3.1.
- Percentage glazing has been limited in many areas to be as low as feasibly possible whilst facilitating occupant satisfaction and connectivity through outward views. Overheating analysis and energy modelling has then informed the setting of g-value limits to minimise solar heat gain. However, there is also a balance to be made in providing glazing that allows sufficient natural light transmittance, reducing the operating hours of artificial lighting. The g-value targets for glazing within the Proposed Development aims to balance these factors.

Be Clean:

- Connections into local existing or planned heat networks were investigated but found to be unfeasible currently as there are no functioning heat networks or networks planned to be delivered within suitable timescales within the locality of the site.

Be Green:

- Prior to initial submission of the pending application, an assessment of different LZC technologies was undertaken. Many were found to be unfeasible for implementation in the Proposed Development, and in terms of power generating technologies, only PV was deemed suitable for inclusion within the scheme. This is still the case for the Proposed Development following the latest revisions.

- System efficiencies have been maximised as far as possible. High efficiency simultaneous ASHPs have been implemented, using waste heat to produce domestic hot water through the use of WSHPs. However, as the Part L 2021 notional building also implements heat pumps with relatively high efficiencies, the demonstrable improvement of the Proposed Development over such a high performing baseline is reduced. Other solutions that could facilitate higher overall efficiencies, such as the integration of a ground source heat pump system, were investigated during the design process but were found to be unfeasible within the constraints of the site.

  A system utilising boreholes through the new structural slab within the footprint of the basement, meaning the existing slab is not greatly disturbed, would only allow for approximately 30 boreholes, allowing an estimated system capacity of less than 175kW, which is not significant enough to make a material difference to the overall energy performance of the Proposed Development.

  A more significant GSHP installation with a higher capacity could be achieved if large parts of the existing structure within the basement were to be removed to allow the installation of a greater number of boreholes and connecting pipework. In all cases, there is a recognition that the area surrounding and below Euston Tower is heavily congested with utilities and London Underground assets and this would require significant coordination and consenting from these stakeholders.

  For the possible yield of the system, the energy saving potential and the impact on the retained structural slab, a GSHP installation has not been included within the Proposed Development. This reasoning is covered in more detail in Section 8.4.1.

- The amount of usable area for PV is severely restricted, as a result of the buildings tower form and requirement for significant urban greening. The level 31 roof level accommodates multiple major plant items such as ASHPs and air-cooled chillers which cannot be situated anywhere else and require unobstructed free area above, leaving only a small portion above the rooftop enclosures available for PV. As such, maximising the carbon offset from on-site electricity generation is challenging.

11.2 Carbon off-setting

The carbon off-set has been calculated on the remaining regulated carbon emissions post Be Green stage. The carbon offsetting price of £95/tonne of CO2 has been used in line with recommendations from The London Plan. The resulting offset requirement and cash in-lieu contributions

Non-domestic building offset	
Cumulative shortfall in target CO_2 savings [tCO_2 over 30 years]	7,537
Cash in-lieu contribution [£]	716,023

A.1 Predictive Energy Assessment

Euston Tower

Predictive Energy Assessment

Contents

1. Executive Summary

This Predictive Energy Assessment is a supplemental report to the Energy Statement. This report describes the methodology used during the predicted energy assessment of the Proposed Development of Euston Tower, in line with the requirements of GLA ‘Be Seen’ guidance. For further details on policy and requirements, please refer to the main body of the Energy Statement.

The results from this assessment have formed the basis of the Whole Life Carbon Assessment submitted for planning, as well as the ‘Be Seen’ energy consumption that is reported in the main body of the Energy Statement.

2. Model Construction

2.1 Choice of modelling tool and approach

For this project, the DSM tool IES <Virtual Environment> was used to estimate the operational energy consumption of the building under expected conditions, using an hourly resolution over a year.

DSM tools provide a holistic estimate of energy use as they consider the variation of energy consumption over time by simulating the dynamic relationship between the building form, fabric, external weather, occupants, usage patterns. The HVAC plant can also be developed either as part of an existing dynamic simulation template (simple HVAC Modelling) or through separate HVAC modules specified at a component level (Detailed HVAC Modelling).

Since this project is at RIBA Stage 2, an initial operational energy model has been set up using the simple HVAC modelling approach. As the design progresses to stages 3 and onwards, a more detailed HVAC modelling methodology will be developed to inform the design process.

Dynamic simulation models require a range of different input parameters to be able to provide detailed outputs and accurate insights into building performance. Further information about the input data can be found in following sections.

2.2 Weather File

The Proposed Development is located on Euston Road, in the London Borough of Camden, therefore the London Test Reference Year (TRY05) weather data was used as a reference for the external ambient conditions the building will experience.

In this development cooling is anticipated to be the dominant load, therefore the overall energy use will be highly dependent on external conditions. The impact of the weather is included in the sensitivity analysis.

2.3 Model geometry

The building geometry and the context of the Proposed Development was modelled within IES using Stage 2 design drawings – snapshots of the 3D model geometry are shown in Figure 1

The entire Office Building was modelled to allow detailed energy analysis throughout the building. The Part L modelling described within the main body of the Energy Statement was based on a full building model.

Internal layouts were generated for different areas of the buildings according to their function as well as their different loads, solar gains, and usage patterns. The main office floor plate is divided into four perimeter zones (North East, North West, South East and South West) and two internal zones (North and South).

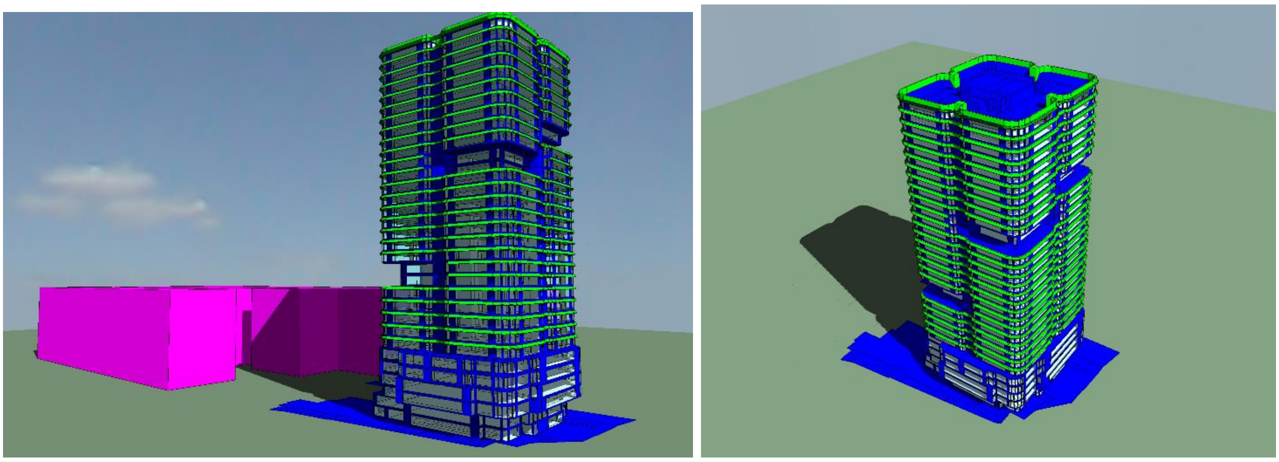


Figure 1 – Snapshots from 3D energy model

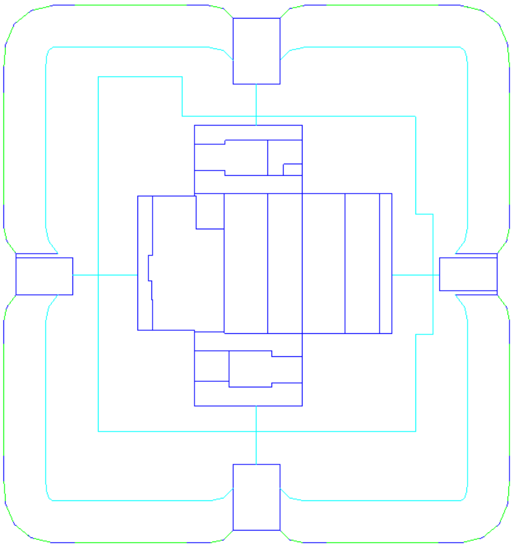


Figure 2 – Internal zones on a typical upper level in the office tower

2.4 Façade thermal performance

Façade performance is as described within the Be Lean chapter of the Energy Statement.

3. Scenario Methodology

3.1 Scenario testing: low-end, mid-range and high-end

Different low-end, high-end and mid-range scenarios were tested alongside the baseline cases, representing the design intent of the Proposed Development at this stage. Each was tested to give an indication of the range of variation in a building's performance due to various uncertainties.

- Baseline cases: these scenarios represent the current design intent most accurately. A scenario where the building is fully occupied by office tenants was chosen to compare against the current design intent where the building is also partially occupied by lab tenants. These scenarios use the current design estimates and allowances.
- Medium Office/Lab: the best estimate of the energy use based on the occupancy estimates from the prospective occupants using more less energy intensive assumptions for the building's power allowances.
- High-end and low-end scenarios: generated by considering the uncertainties on opposing ends from the baseline for key parameters.

The scenarios in Table 1 were to represent ranges in the variables that are least certain or have a have a high influence on performance.

Table 1 – Summary of test scenario inputs

	Low-end	Medium Office/Lab	Baseline Office	Baseline Office/Lab
Tenancy	All office	Office + Lab	All office	Office + Lab
Office occupancy density (m^2 per person)	1: 10	1:8	1:8	1:8
Lab occupancy density (m^2 per person)	-	1:20	-	1:12
Plant operation hours	Refer to Table 3 *Low*	Refer to Table 3 *Medium (Baseline)*	Refer to Table 3 *Medium (Baseline)*	Refer to Table 3 *Medium (Baseline)*
Office small power*	13.5 W/m^2 (BCO 2023)	13.5 W/m^2 (BCO 2023)	20 W/m^2 (BCO 2019)	20 W/m^2 (BCO 2019)
Lab small power	-	90 W/m^2	-	90 W/m^2
Lift energy controls	Incorporating ECO controls and regenerative braking	Standard	Standard	Standard
Weather file	London_TRY	London_TRY	London_TRY	London_TRY

*Includes tenant tea point allowances

4. Model Assumptions

4.1 Internal gains and associated energy uses

Internal heat gains are generated by the activity of occupants as metabolic heat, by electrical devices, or by thermal emission of artificial lighting.

The internal heat gains from occupants, equipment and processes within the building were included in the model to accurately calculate the energy use associated with heating, cooling and distribution systems.

4.1.1 Occupancy Factors

The occupancy density and pattern can have a significant impact on the building's energy use. Future occupiers are not known at this design stage, therefore different occupancy scenarios where defined and tested.

In different tested scenarios the design occupant densities were combined with the workstation density and real diversity or utilisation factors (the average proportion of staff that are in the office at any one time) as shown in Table 2.

Table 2 – Modelled occupancy factors

Parameters	Low	Medium (Baseline)
Design Occupant Density	10 m^2/person	8 m^2/person
Workstation Diversity	70%*	70%*
Occupant Diversity	70%*	70%*

*Based on NABERS DfP as referenced within CIBSE TM54 Guidance

4.1.2 Operating Hours

The building's operating profile is defined both by its operating hours and by the extent of the out-of-hours activity. The intended hours of operation of the plant and equipment are also needed to accurately calculate the energy performance of the building. Table 3 shows the operating hours assumptions that were tested.

Table 3 – Modelled operating hours

	Low	Medium (Baseline)
Occupancy, small power & lighting	**Mon – Fri:** 8am to 6pm **Sat:** 9am to 12pm **Sun:** None	**Mon – Fri:** 8am to 6pm **Sat:** 9am to 12pm **Sun:** None
Reception Plant, Basement Plant and Servers	**Mon-Fri:** 24/7 **Sat:** 24/7 **Sun:** 24/7	**Mon-Fri:** 24/7 **Sat:** 24/7 **Sun:** 24/7
Plant Operating Hours	**Mon – Fri:** 7am to 7pm **Sat:** 11am to 1pm **Sun:** None	**Mon – Fri:** 7am to 7pm **Sat:** 9am to 1pm **Sun:** None

4.2 Internal lighting gains and controls

The internal lighting and their control strategies have been modelled for all spaces within the building to estimate an accurate lighting energy use. Table (9) shows the lighting power breakdown that was implemented in each of the different building zones. For landlord areas, it has been assumed that the lighting operates on a time switch profile from 08.00 to 20.00.

Table 4 – Modelled lighting power

Building Zones	Lighting Power Density (W/m²)	Control Type
Office	5.5	PIR Sensor
Lab enabled	5.5	PIR Sensor
Public Facing	6	PIR Sensor
Circulation	6	PIR Sensor
Retail	6	PIR Sensor
Showers/ Changing	6	PIR Sensor
Cycle Store	6	PIR Sensor
Plantrooms	6	PIR Sensor
WC	6	PIR Sensor

4.3 Lifts and escalators

Estimation of the annual lift energy consumption is shown in Table 5 and has been based on the *BS EN ISO 25745-2:2015: Energy Performance of lifts, escalators and moving walks. Energy Calculations and classifications for lifts (elevators).*

Table 5 – Calculated lift energy consumption

Type	Number	Annual Energy Consumption (kWh)
General Lifts	13	282,985
Goods Lifts	5	147,117
Other Lifts -	4	53,405
Escalators	5	105,040

4.4 Catering

Estimation of catering consumption is shown in Table 5 and has been based on the *Restaurants, Clubs and Bars: Planning, Design and Investment for Food Service Facilities (Lawson 1995)* as references within *CIBSE TM50: Energy efficiency in commercial kitchens (2021)*

Table 6 – Calculated catering energy consumption

Catering Type	Meals Per Year	Annual Energy Consumption (kWh)
Coffee Shop/ Restaurant	198,616	170,810

4.5 Small power gains and profiles

Benchmarks from the British Council for Offices (BCO) guide to specification, key design criteria (BCO, 2023) and NABERS UK guidance (2020) among others were used to extract a range of small power loads.

The energy use from other equipment such as communal small power (e.g., printers), small catering equipment (e.g., fridges), local kitchen areas and tea points (e.g., microwaves) were also considered in the calculations and are accounted for within the values stated in Table 7. Lab enabled equipment loads have been derived from industry best practice guidance (BCO Science Guide 202 /BL Guide 2022).

It should be noted that out of hours consumption was allowed for, with equipment operating at 25% out of main office hours.

Table 7 – Modelled small power load

Small Power Load (W/m^2)	Low-end	Medium Office/Lab	Baseline Office	Baseline Office/Lab
Office Equipment Load	13.5	13.5	20	20
Lab Enabled Equipment Load	-	90	-	90

4.6 Server rooms

The building includes 10no. satellite equipment rooms containing servers with a rated power of **3.2 kW** on upper levels of the building. These rooms are equipped with local cooling, therefore their energy consumption was considered in the energy model.

IT and server rooms were assumed to run **24/7.**

4.7 Domestic hot water usage

The domestic hot water (DHW) demand and profile was established using benchmarks from CIBSE Guide G (2014) as shown in Table 8.

Table 8 – Modelled domestic hot water consumption

Building Zone	Daily demand (l/person)	Storage per 24-hour demand (l)	Recovery Period (hour)
Office (Open Plan)	4	4.5	2.0
Lab Enabled	4	4.5	2.0
Changing/Showers	3	3	2.0
Retail	Considered within general power allowance to retail spaces		

4.8 Mechanical ventilation

The majority of the building zones will be mechanically ventilated with a mechanical ventilation system providing the required fresh air to maintain adequate indoor air quality and thermal comfort. The following air-flow rates were used, in line with the proposed building specification.

Table 9 –Modelled ventilation rates

Building Zone	Air Supply Rate (L/s/person)
Office	3.65 ($l/s/m^2$)
Lab enabled	6 ACH
Public Facing	12

Circulation	0
Retail	12
Showers/ Changing	10 ACH
Cycle Store	0
Plantrooms	1 ACH
WC	5 ACH

4.9 Space heating: Setpoints, controls, generation, and distribution

The setpoint and setback temperatures for space heating shown in Table 10 are set consistently across the building zones with a sufficient dead band to avoid simultaneous heating and cooling. **Error! Reference source not found.** shows the annual heating load profile

Table 10 – Modelled internal temperatures (winter)

Building Zone	Setpoint Temperature	Setback Temperature
Office (Open Plan)	20 ºC ± 2 ºC	16 ºC ± 2 ºC
Lab enabled	20 ºC ± 2 ºC	16 ºC ± 2 ºC
Circulation	18 ºC ± 2 ºC	N/A

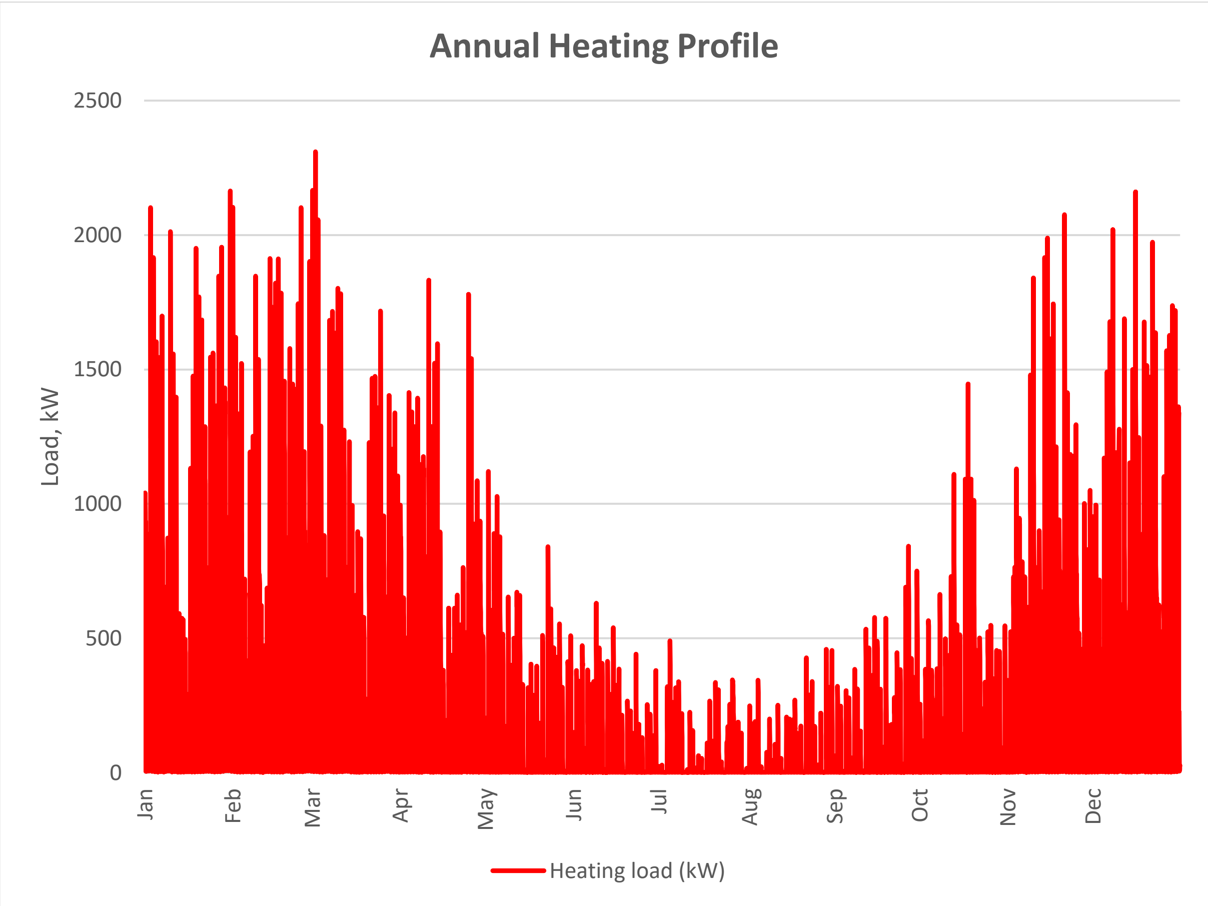


Figure 3 – Heating demand across the year

4.10 Space cooling: Setpoints, controls, generation, and distribution

The setpoint and setback temperatures for space cooling shown in Table 11 are set consistently across the building zones with a sufficient dead band to avoid simultaneous heating and cooling. Figure 4 shows the annual cooling load profile.

Table 11 – Modelled internal temperatures (summer)

Building Zone	Setpoint Temperature	Setback Temperature
Office (Open Plan)	24ºC ± 2 ºC	26ºC ± 2 ºC
Lab enabled	24 ºC ± 2 ºC	26ºC ± 2 ºC
Circulation	26 ºC ± 2 ºC	N/A

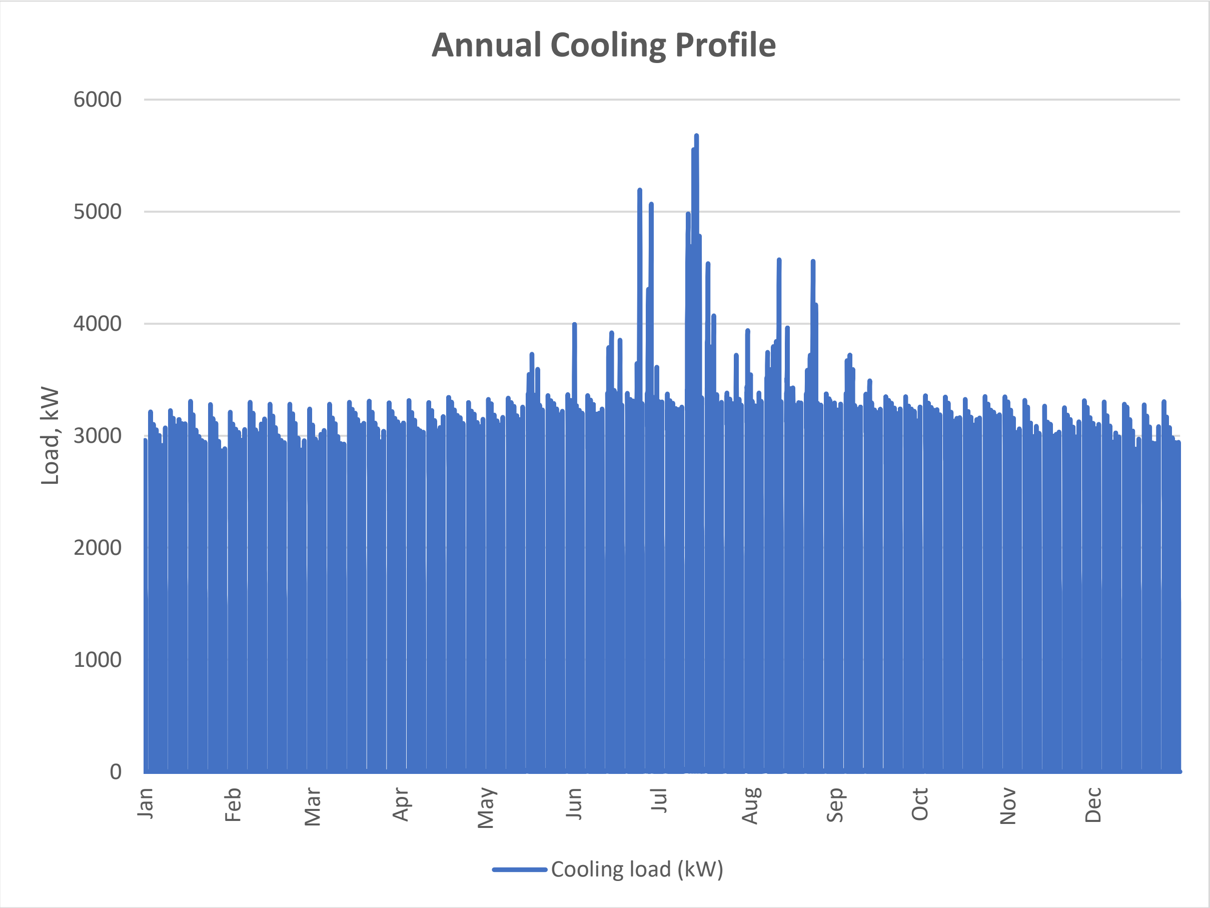


Figure 4 – Cooling profile across the year

5. Results and Conclusion

5.1 Baseline results

The results show that the most energy consumption is associated with ‘unregulated loads’ of equipment/ small power and therefore cooling, along with lifts and escalators (other). In this case, the equipment energy consumption is particularly high due to the requirement of the lab enabled spaces.

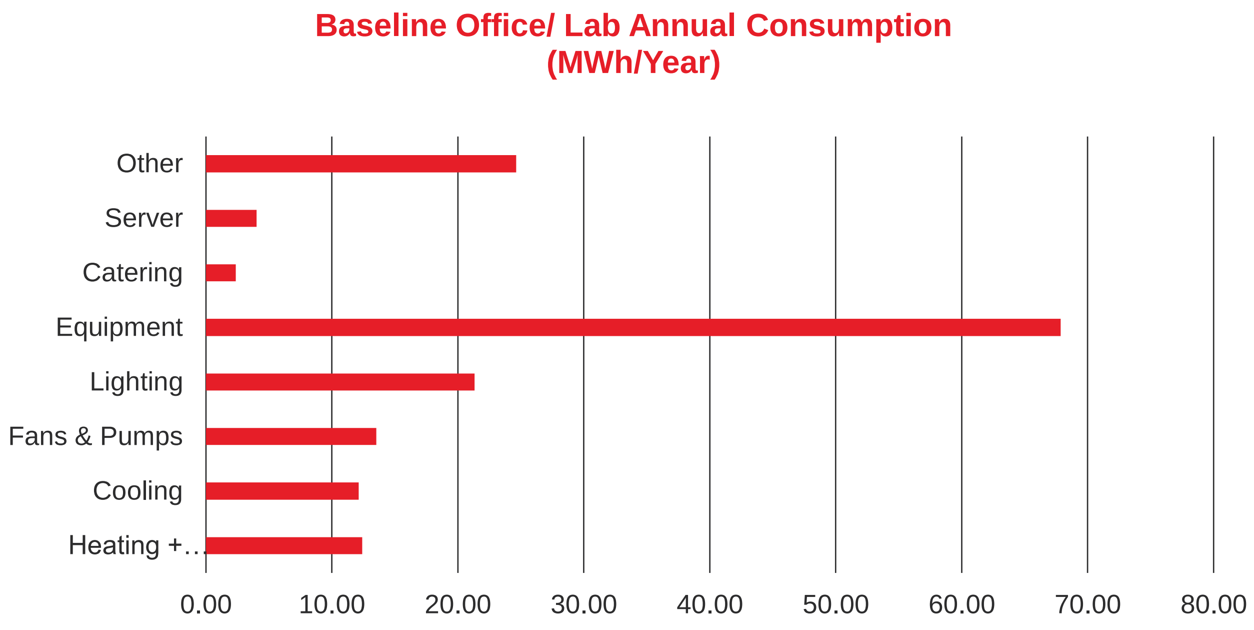


Figure 5 - Baseline energy consumption

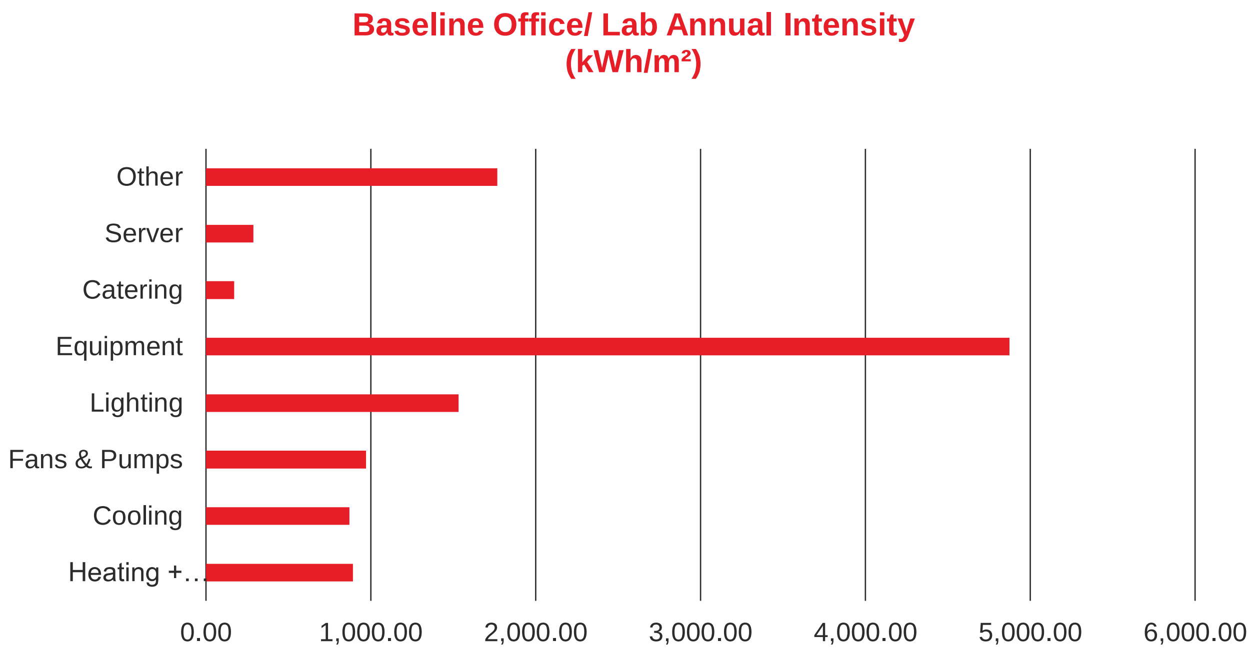


Figure 6 - Baseline energy intensity

Table 12 provides the split of regulated and unregulated energy use inline with the GLA requirement to provide consumption separately, which has been provided as an input into the Whole Life Carbon Assessment.

Table 12 - Regulated and Unregulated Energy Use

Baseline Office/Lab	Predicted Energy Consumption (MWh/yr)		
	Base Build	Tenant	Total
	8,685	4,680	13,365

5.2 Scenario testing results

The change from a lab-enabled spaces to all office scenario has the greatest reduction in energy consumption, mainly due to negating the heat loads associated with the lab equipment and therefore decreasing the cooling consumption. The medium scenario, which includes lab enabled spaces, also shows a significant reduction in energy consumption from equipment and cooling, due to reduced small power allowances. The changes in occupancy rates resulted in changes in lift energy. It is clear that the equipment is the leading energy consumer and therefore has the greatest impact on these scenarios.

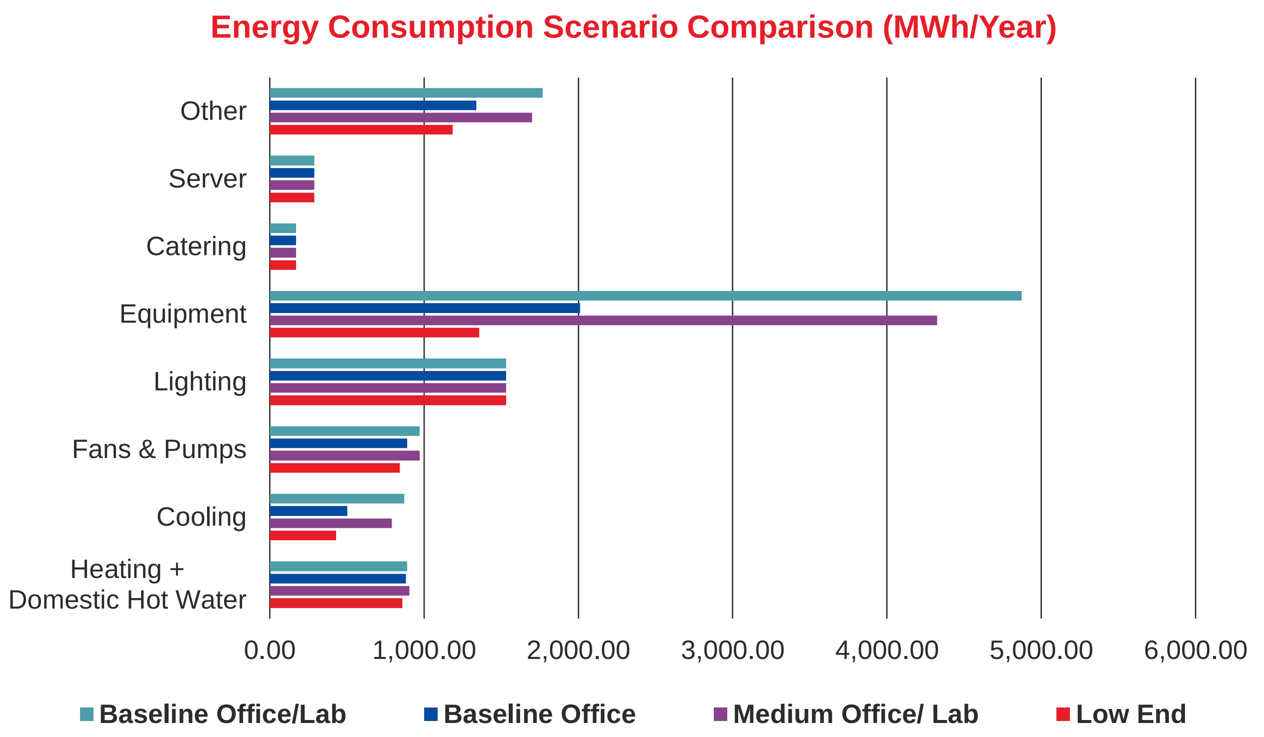


Figure 7 Total energy consumption by scenario

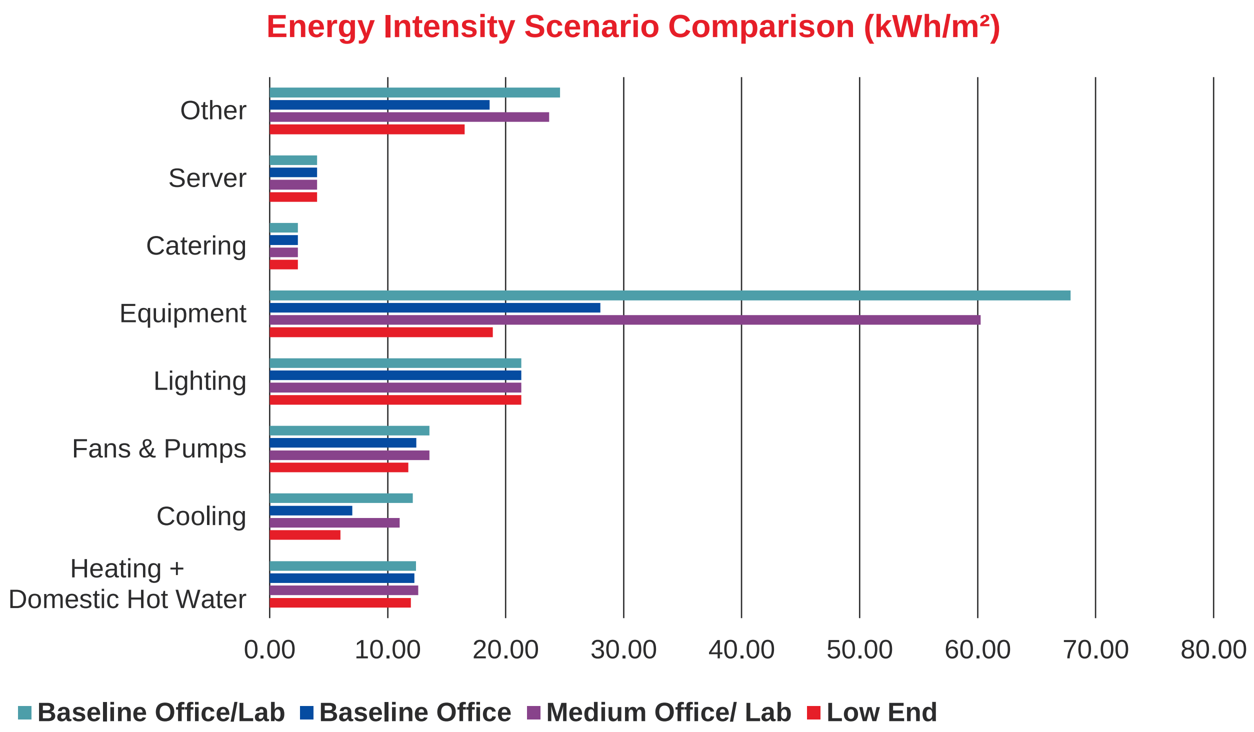


Figure 8 Total energy intensity by scenario

5.3 Be Seen results

The below figures show the absolute energy consumption of each scenario assessed for the Proposed Development as well as the relative energy use intensity.

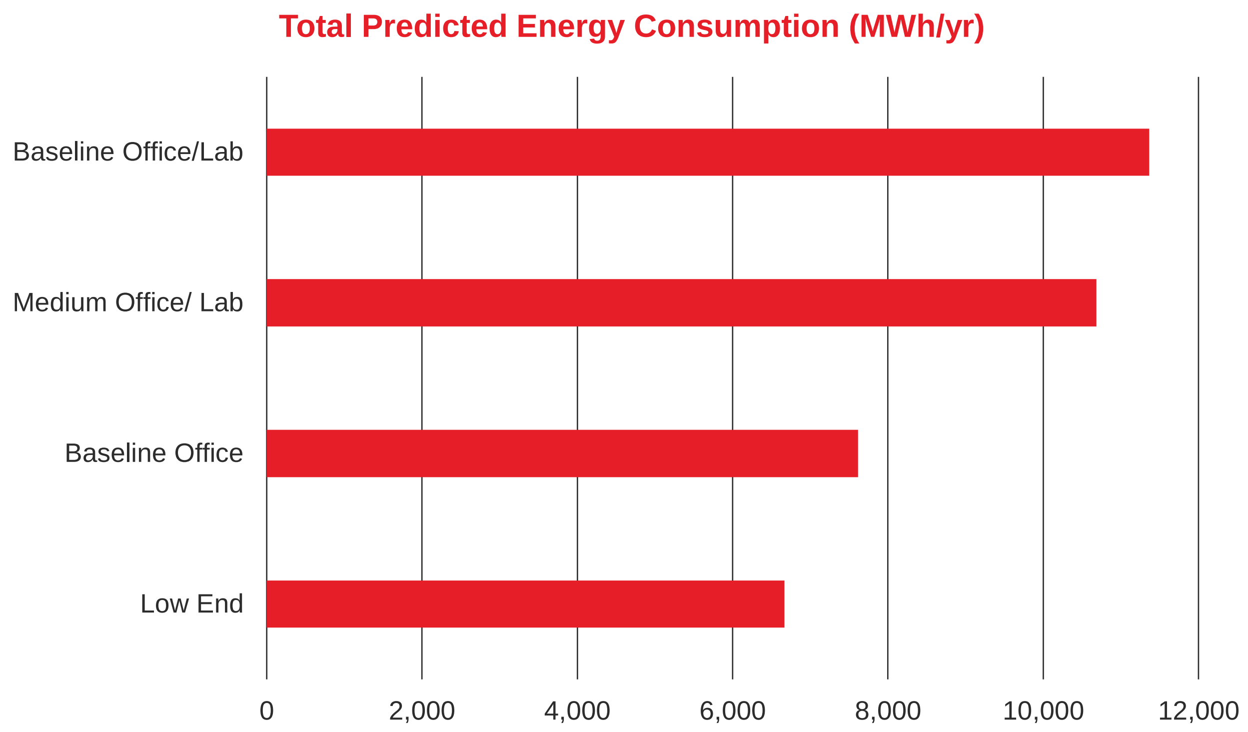


Figure 9 Predicted annual energy consumption per scenario for the Proposed Development

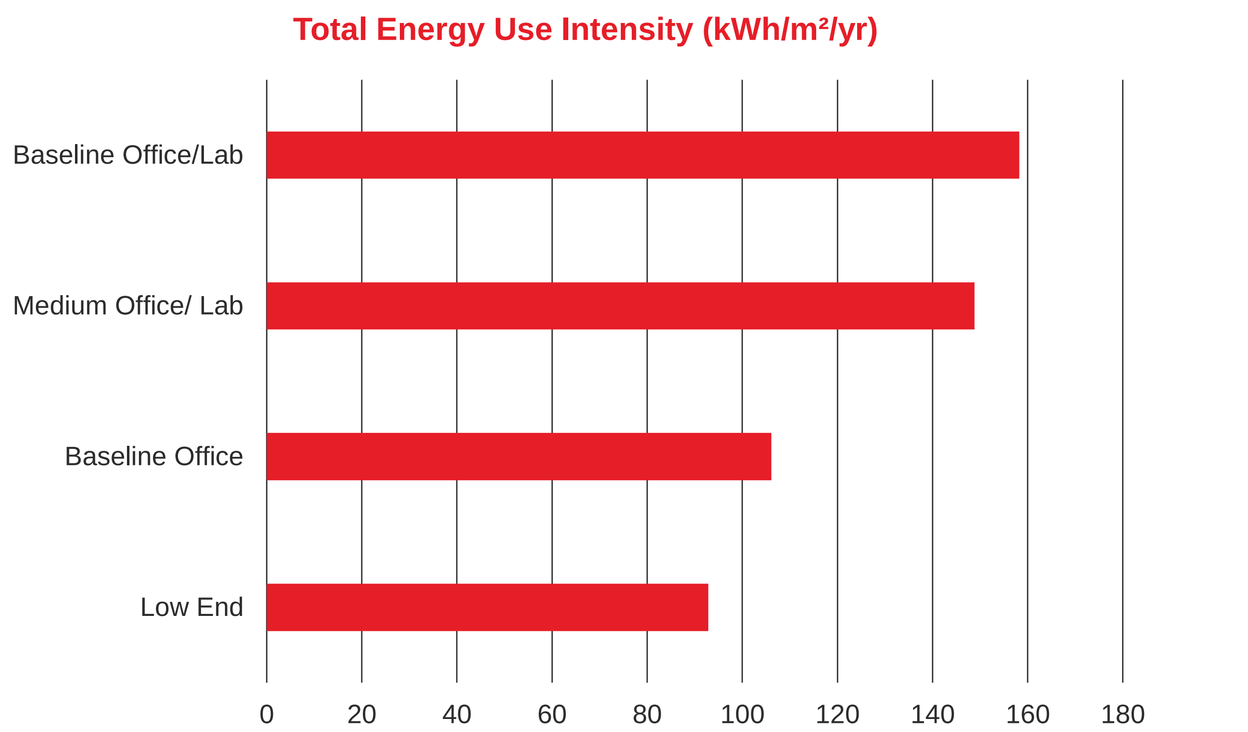


Figure 10 Energy Use Intensity per scenario for the Proposed Development

5.4 Next steps

5.4.1 Sensitivity analysis

Sensitivity analysis will be undertaken during Stage 3 design using the NABERS methodology. Several optioneering studies have been pre-selected to inform the design development.

- Simultaneous vs. reversable ASHP to determine greatest level of efficiency for the overall system.
- Assessment of 24 hour cooling circuit serving server rooms
- Analysis into the benefits of free cooling through natural ventilation and AHUs.

This list will be supplemented with additional sensitivity studies where appropriate, based on initial modelling results.

A.2 Be Lean BRUKL Report

Refer to accompanying documentation

A.3 Be Green BRUKL Report

Refer to accompanying documentation

A.4 SEER & SCoP Calculation

Euston Tower Arup

SEER & SCOP Calculation

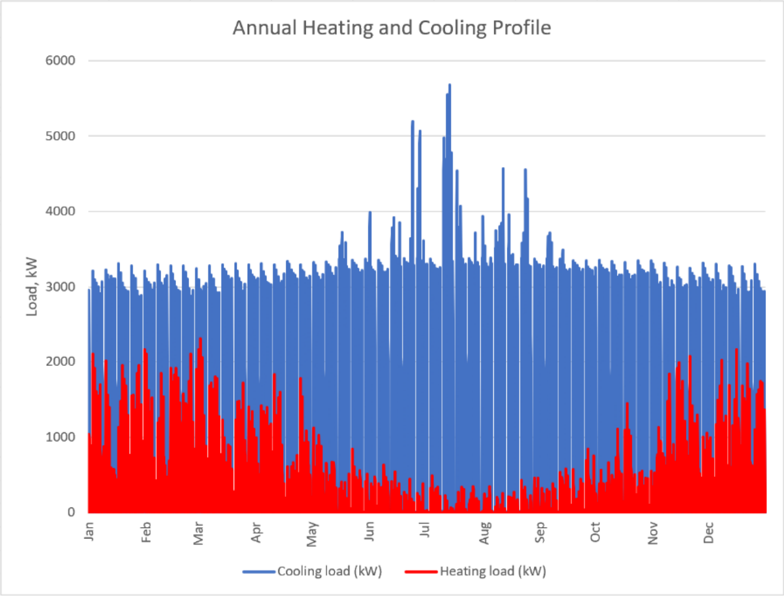
28/10/2023

This calculation determines the seasonal Energy Efficiency Ratio (SEER) and Seasonal Coefficient of Performance (SCOP) for the heat pumps and chillers on Euston Tower. The performance of the plants varies depending on whether they are in 'simultaneous' mode (generating heating and cooling simultaneously), or they are generating only cooling or only heating.

Annual Cooling Load	**546,800**	**kWh**	4.20	SEER	Calculated Seasonal Performance when in heat recovery mode @ 35°C External Ambient
Simultaneous Cooling	**93,831**	kWh	6.87	EER	
Air Cooling	452,969	kWh	2.87	EER	

Annual Heating load	**96,400**	**kWh**	**3.55**	SCOP	Calculated Seasonal Performance when in heat recovery mode @ -4°C External Ambient
Simultaneous Heating	21,208	kWh	7.47	COP	
Air Heating	75,192	kWh	2.57	COP	

Dynamic simulations were undertaken to determine the demand profiles, which can be seen withing the graph below. Implementing the heat pump arrangement significantly decrease the carbon emissions associated with the building, primarily due to its high efficiency in generating heat.



A.5 Overheating Assessment

ARUP

British Land Property Management Limited

Euston Tower

Overheating Assessment

| 26 November 2024

This report takes into account the particular instructions and requirements of our client. It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 281835

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1. Non-residential Overheating Assessment

This Overheating Assessment is a supplemental report to the Euston Tower Energy Statement (EST-ARP-XX-XX-RP-M-00002). The purpose of this assessment is to demonstrate the resilience of the proposed building against the risk of overheating. The assessment specifically responds to the requirements of London Plan (2021) planning policy SI 4: Managing Heat Risk, as set-out below.

Major development proposals should demonstrate through an energy strategy how they will reduce the potential for internal overheating and reliance on air conditioning systems in accordance with the following cooling hierarchy:

- reduce the amount of heat entering a building through orientation, shading, high albedo materials, fenestration, insulation and the provision of green infrastructure
- minimise internal heat generation through energy efficient design
- manage the heat within the building through exposed internal thermal mass and high ceilings
- provide passive ventilation
- provide mechanical ventilation
- provide active cooling systems.

The Overheating Assessment has been carried out in accordance with the methodology set out in:

- CIBSE TM52 "The limits of thermal comfort" (CIBSE, 2013)
- GLA Energy Assessment Guidance (June 2022)

Methodology

The following areas were identified as those with the highest risk and appropriate for this assessment:

- Level 00 - Public Entrance
- Level 30 – Highly Glazed Top Floor Office

In accordance with GLA and BREEAM guidance, the overheating risk for these areas has been undertaken following CIBSE TM52 and tested against the following weather profiles to determine current and future climate resilience.

- Design Summer Year 1 for the 2020s: current design year
- Design Summer Year 2 for the 2020s: a year with a very intense single warm spell
- Design Summer Year 3 for the 2020s: a year with a prolonged period of sustained warmth

In accordance with CIBSE TM52, if more than 3% of a building's occupied hours are above an operative temperature of 26°C, the building is determined to be at risk of overheating.

The GLA's guidance does not expect the building to pass with the more onerous weather files, DSY2 and DSY3.

Overheating Study Results Summary

All areas analysed showed that less than 3% of a building's occupied hours are above an operative temperature of 26°C when active cooling is provided, therefore the building is not considered to be at risk of overheating.

The building was also analysed under DSY2 and DSY3, and all areas analysed showed that less than 3% of a building's occupied hours are above an operative temperature of 26°C.

The results do not include the benefit of natural ventilation through façade openings.

The passive and active design measures adopted, successfully limit the overheating risk and in a manner that is resilient to climate change.

Results: Level 00 – Public Entrance

The public entrance on Level 00 is prone to overheating due to the significant amount of glazed façade. To effectively limit internal operative temperatures, the terrace at level 02 provides shading, in combination with high performance glazing, with low G-value. Although these measures are effective in reducing solar gains, they do not prevent overheating in the space, therefore active cooling is proposed. This can be seen from the results in Table 1.

Figure 1 - Public Entrance

Table 1 - Public Entrance Operative Temperatures

Weather File	Operative Temperature (°C) -% hours in range	
	Passive Measures	Active Cooling
	> 26	> 26
DSY1	53.5	0.0
DSY2	53.1	0.0
DSY3	51.5	0.0

Results: Level 30 – Double Height Glazed Office Floor

To reduce the risk of overheating, the façade design provides shading though a combination of projecting panels and overhangs, reducing solar gain. A number of investigations were undertaken to look at the effects of varying the g-value of the glazing and of varying the projection of the solid façade elements to quantify the benefit of the shading they provide. Although these measures are effective in reducing solar gains, they do not prevent overheating in the space, therefore active cooling is proposed. This can be seen from the results in Table 2.

Figure 2 - Tower Shading

Table 2 - Level 30 Operative Temperatures

Weather File	Operative Temperature (°C) -% hours in range	
	Passive Measures	Active Cooling
	> 26	> 26
DSY1	42.1	0.0
DSY2	43	0.0
DSY3	41.8	0.0

Results: Occupied Spaces Breakdown

Table 3 shows an overheating breakdown of all occupied spaces assessed. The results are under DSY 1 annual weather conditions, with assessments carried out for the scenario with mechanical ventilation only. Results are centred around the aforementioned occupied spaces that have been identified as at risk of overheating as defined by TM52 criteria, therefore it is expected they will not meet criteria with mechanical ventilation alone and require active cooling to mitigate risk of overheating. The results reflect this, demonstrating a requirement for active cooling in these spaces. As illustrated in the final column, the as-modelled proposed active cooling is sufficient to meet the overheating criteria.

Table 3 - Space Operative Temperatures

Room Name	Peak Internal Temperature at DSY 365 days, 24hrs a day		Thermal comfort Occupied hours > 26°C		Thermal comfort Occupied hours > 28°C		Thermal comfort Occupied hours > 30°C		Mech Vent	Active Cooling
	Time / Date	(°C)	Total	%	Total	%	Total	%	% Hours over 3%	% Hours over 3%
13_Perimeter-Office	19:30,25/Jul	39.55	148	53.7	79	28.6	38	13.6	Fail	Pass
13_Perimeter-Office	18:30,25/Jul	37.59	187	67.7	96	34.6	39	14.2	Fail	Pass
13_Perimeter-Office	19:30,25/Jul	37.9	144	52	70	25.3	34	12.2	Fail	Pass
13_Office-Internal	19:30,25/Jul	37.61	182	66	87	31.6	36	13.2	Fail	Pass
13_Office-Internal	19:30,25/Jul	37.8	149	53.8	68	24.5	33	11.8	Fail	Pass
13_Office-Internal	19:30,25/Jul	39.09	155	56.1	75	27	35	12.6	Fail	Pass
13_Perimeter-Office	18:30,25/Jul	39.25	182	65.8	106	38.4	43	15.6	Fail	Pass
13_Office-Internal	19:30,25/Jul	38.79	179	64.9	94	34	38	13.9	Fail	Pass
13_Office-Internal	19:30,25/Jul	38.8	158	57.2	71	25.8	33	12	Fail	Pass
13_Office-Internal	19:30,25/Jul	38.5	177	64.1	85	30.7	36	13	Fail	Pass
13_Office-Internal	19:30,25/Jul	37.51	177	64.2	79	28.7	35	12.5	Fail	Pass
13_Office-Internal	19:30,25/Jul	37.6	153	55.3	66	23.9	31	11.3	Fail	Pass
30_Office-Internal	18:30,25/Jul	35.02	104	37.5	59	21.4	29	10.6	Fail	Pass
30_Office-Internal	17:30,25/Jul	35.26	126	45.7	73	26.5	37	13.3	Fail	Pass
30_Office-Internal	17:30,25/Jul	34.78	117	42.5	67	24.4	33	11.9	Fail	Pass
30_Office-Internal	19:30,25/Jul	34.05	101	36.6	57	20.8	27	9.6	Fail	Pass
30_Office-Internal	17:30,25/Jul	34.12	116	42.1	67	24.3	32	11.6	Fail	Pass
30_Office-Internal	18:30,25/Jul	35.39	109	39.3	62	22.6	32	11.6	Fail	Pass
30_Office-Internal	18:30,25/Jul	34.4	107	38.6	64	23.3	31	11.1	Fail	Pass
30_Office-Internal	17:30,25/Jul	34.38	123	44.6	74	26.9	36	12.9	Fail	Pass
30_Perimeter-Office	17:30,25/Jul	35.71	134	48.6	80	29.1	42	15.2	Fail	Pass
30_Perimeter-Office	17:30,25/Jul	34.64	129	46.5	79	28.7	40	14.4	Fail	Pass
30_Perimeter-Office	18:30,25/Jul	35.83	113	40.8	67	24.1	36	12.9	Fail	Pass
30_Perimeter-Office	18:30,25/Jul	34.66	109	39.4	67	24.3	33	11.8	Fail	Pass
31_Office-Void	12:30,12/Sep	41.66	214	77.4	193	69.8	169	61	Fail	Pass
31_Office-Void	12:30,12/Sep	41.95	211	76.5	191	69.1	167	60.5	Fail	Pass

31_Office-Void	19:30,25/Jul	37.48	111	40.2	75	27.3	47	17	Fail	Pass
31_Office-Void	19:30,25/Jul	36.68	108	39	76	27.4	48	17.5	Fail	Pass
31_Office-Void	17:30,25/Jul	47.31	161	58.4	131	47.4	107	38.8	Fail	Pass
31_Office-Void	17:30,25/Jul	47.15	146	52.9	122	44	99	35.8	Fail	Pass
31_Office-Void	08:30,25/Jul	43.36	150	54.4	120	43.5	104	37.6	Fail	Pass
31_Office-Void	08:30,25/Jul	43.24	132	47.8	116	41.9	95	34.5	Fail	Pass
31_Office-Void	16:30,12/Sep	55.48	202	73.1	181	65.6	164	59.2	Fail	Pass
31_Office-Void	10:30,25/Jul	55.7	210	75.9	188	68	164	59.5	Fail	Pass
31_Office-Void	18:30,25/Jul	56.29	130	46.9	104	37.5	82	29.6	Fail	Pass
31_Office-Void	09:30,25/Jul	42.65	122	44.3	106	38.5	86	31.1	Fail	Pass
31_Office-Void-Inner	19:30,25/Jul	39.12	120	43.6	79	28.6	48	17.2	Fail	Pass
31_Office-Void-Inner	20:30,25/Jul	38.33	114	41.3	75	27	43	15.5	Fail	Pass
31_Office-Void-Inner	20:30,25/Jul	38.19	112	40.6	72	26	42	15.1	Fail	Pass
31_Office-Void-Inner	20:30,25/Jul	38.39	111	40.1	72	26	42	15.3	Fail	Pass
31_Office-Void-Inner	11:30,25/Jul	34.06	110	39.9	86	31.1	53	19.3	Fail	Pass
31_Office-Void-Inner	16:30,25/Jul	33.67	107	38.7	80	28.9	46	16.7	Fail	Pass
31_Office-Void-Inner	16:30,25/Jul	33.7	106	38.3	76	27.5	44	15.8	Fail	Pass
31_Office-Void-Inner	16:30,25/Jul	34.19	105	38	76	27.4	44	15.9	Fail	Pass
31_Office-Void-Inner	18:30,25/Jul	39	174	62.9	119	43	73	26.3	Fail	Pass
31_Office-Void-Inner	18:30,25/Jul	38.1	173	62.7	116	41.8	68	24.5	Fail	Pass
31_Office-Void-Inner	18:30,25/Jul	37.8	170	61.6	113	40.8	65	23.4	Fail	Pass
31_Office-Void-Inner	18:30,25/Jul	38.09	175	63.4	119	43	71	25.7	Fail	Pass
31_Office-Void-Inner	11:30,25/Jul	37.39	159	57.5	116	42.1	84	30.4	Fail	Pass
31_Office-Void-Inner	12:30,25/Jul	36.91	158	57	114	41.3	79	28.7	Fail	Pass
31_Office-Void-Inner	12:30,25/Jul	36.72	156	56.5	112	40.6	77	27.7	Fail	Pass
31_Office-Void-Inner	13:30,25/Jul	37.33	163	59	118	42.8	80	28.8	Fail	Pass
31_Office-Void	18:30,25/Jul	55.01	113	40.9	91	33.1	73	26.5	Fail	Pass
31_Office-Void-Inner	19:30,25/Jul	38.38	122	44.1	80	28.8	47	17	Fail	Pass
31_Office-Void-Inner	20:30,25/Jul	38.16	109	39.4	69	24.9	41	14.7	Fail	Pass
31_Office-Void-Inner	19:30,25/Jul	41.57	86	31.1	61	22.2	43	15.7	Fail	Pass
31_Office-Void	16:30,25/Jul	52.14	163	58.9	141	51.1	127	46	Fail	Pass
31_Office-Void-Inner	19:30,25/Jul	37.8	132	47.6	86	31.3	50	18.1	Fail	Pass

31_Office-Void-Inner	19:30,25/Jul	37.07	119	43	74	26.7	43	15.5	Fail	Pass
31_Office-Void-Inner	18:30,25/Jul	40.15	79	28.5	55	20	36	13.2	Fail	Pass
31_Office-Void	15:30,25/Jul	39.8	114	41.4	98	35.3	78	28.2	Fail	Pass
31_Office-Void-Inner	16:30,25/Jul	33.89	112	40.5	86	31	51	18.3	Fail	Pass
31_Office-Void-Inner	17:30,25/Jul	34.04	103	37.2	70	25.4	40	14.3	Fail	Pass
31_Office-Void-Inner	16:30,25/Jul	39.33	89	32.1	63	22.8	43	15.5	Fail	Pass
31_Office-Void	10:30,25/Jul	52.23	156	56.5	140	50.6	125	45.1	Fail	Pass
31_Office-Void-Inner	12:30,25/Jul	35.71	121	43.9	97	35.2	64	23.2	Fail	Pass
31_Office-Void-Inner	13:30,25/Jul	35.54	114	41.3	90	32.7	57	20.7	Fail	Pass
31_Office-Void-Inner	18:30,25/Jul	38.66	89	32.3	68	24.6	48	17.2	Fail	Pass
31_Office-Void	19:30,13/Jun	49.45	84	30.5	67	24.2	50	18.1	Fail	Pass
31_Office-Void-Inner	20:30,25/Jul	35.24	94	34	59	21.4	31	11.1	Fail	Pass
31_Office-Void-Inner	20:30,25/Jul	35.62	87	31.5	53	19.3	28	10.1	Fail	Pass
31_Office-Void-Inner	20:30,25/Jul	38.27	71	25.7	48	17.4	29	10.5	Fail	Pass
31_Office-Void	16:30,25/Jul	38.14	87	31.6	65	23.5	43	15.4	Fail	Pass
31_Office-Void-Inner	19:30,25/Jul	33.67	92	33.4	56	20.1	27	9.7	Fail	Pass
31_Office-Void-Inner	19:30,25/Jul	33.82	83	30.2	49	17.7	23	8.5	Fail	Pass
31_Office-Void-Inner	18:30,25/Jul	39.56	66	23.8	45	16.3	30	11	Fail	Pass
31_Office-Void	15:30,25/Jul	50.24	191	69.1	171	61.9	152	54.9	Fail	Pass
31_Office-Void-Inner	16:30,25/Jul	35.47	170	61.6	103	37.3	58	21.1	Fail	Pass
31_Office-Void-Inner	16:30,25/Jul	35.46	141	51.2	84	30.4	45	16.4	Fail	Pass
31_Office-Void-Inner	16:30,25/Jul	39.18	94	34	65	23.7	42	15.1	Fail	Pass
31_Office-Void	11:30,12/Sep	48.49	205	74.2	182	65.9	157	56.7	Fail	Pass
31_Office-Void-Inner	14:30,25/Jul	35.09	165	59.6	109	39.3	65	23.4	Fail	Pass
31_Office-Void-Inner	18:30,25/Jul	35.03	141	51.1	91	32.9	56	20.4	Fail	Pass
31_Office-Void-Inner	18:30,25/Jul	41.3	99	35.7	70	25.4	49	17.8	Fail	Pass
00_Public	17:30,25/Jul	33.69	66	24	25	8.9	6	2.3	Fail	Pass
00_Open-Lobby	17:30,25/Jul	33.12	113	40.8	29	10.5	3	1.2	Fail	Pass
01_Meeting-Office	17:30,25/Jul	34.34	92	33.4	38	13.7	13	4.8	Fail	Pass
01_Meeting-Office	17:30,25/Jul	35.13	99	35.9	42	15.3	17	6	Fail	Pass
00_Public	17:30,25/Jul	32.16	52	18.7	14	5.1	2	0.6	Fail	Pass
00_Open-Lobby	17:30,25/Jul	44.92	165	59.7	97	35	65	23.7	Fail	Pass

01_Meeting-Office	17:30,25/Jul	33.57	86	31.2	35	12.6	10	3.7	Fail	Pass
01_Meeting-Office	17:30,25/Jul	35.04	101	36.4	41	14.8	15	5.6	Fail	Pass
01_Meeting-Office	16:30,25/Jul	36	116	41.9	58	21.1	23	8.2	Fail	Pass
01_Meeting-Office	19:30,25/Jul	33.8	95	34.5	45	16.3	13	4.6	Fail	Pass
01_Meeting-Office	19:30,25/Jul	33.32	83	29.9	35	12.6	9	3.2	Fail	Pass
01_Meeting-Office	16:30,25/Jul	34.1	98	35.3	48	17.3	13	4.8	Fail	Pass
01_Class-E	17:30,25/Jul	35.27	104	37.6	27	9.8	5	1.8	Fail	Pass
01_Meeting-Office	16:30,25/Jul	34.89	108	39	62	22.3	22	7.8	Fail	Pass
02_Class-E	17:30,25/Jul	35.25	83	30	30	11	7	2.7	Fail	Pass
02_Class-E	15:30,25/Jul	37.48	177	63.9	59	21.2	16	5.8	Fail	Pass
00_Open-Lobby	16:30,25/Jul	33.68	76	27.6	31	11.3	8	2.9	Fail	Pass
00_Open-Lobby	09:30,25/Jul	35.92	94	34.1	51	18.5	21	7.5	Fail	Pass
04_Office-Perimeter	06:30,23/Jul	31.03	276	100	276	100	276	100	Fail	Pass
04_Office-Perimeter	06:30,23/Jul	30.42	276	100	276	100	276	100	Fail	Pass
04_Office-Perimeter	06:30,23/Jul	28.07	276	100	276	100	276	100	Fail	Pass
04_Office-Perimeter	06:30,23/Jul	28.35	276	100	276	100	276	100	Fail	Pass
04_Office_Inner	06:30,23/Jul	30.71	276	100	276	100	276	100	Fail	Pass
04_Office_Inner	06:30,23/Jul	28.55	276	100	276	100	276	100	Fail	Pass
04_Office_Inner	06:30,23/Jul	29.02	276	100	276	100	276	100	Fail	Pass
04_Office_Inner	06:30,23/Jul	30.7	276	100	276	100	276	100	Fail	Pass