

CCCG Tottenham

BREEAM ASSESSMENTS

February 2024



North Elevation



South Elevation



East Elevation



West Elevation

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P01	BREEAM Credits Report	09.02.2024	GB/MA	MC/AA
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1 Introduction

This document has been prepared by Introba on behalf of Capital City College Group ('the Applicant') in support of the application for full planning permission for the development of the Tottenham Campus ('the Site') within the London Borough of Haringey. This document focuses on certain BREEAM UK NC Version 6 (2022) credits that are listed in this section.

1.1 Site Description

The proposed site is a new Construction and Engineering Centre within the existing Tottenham Campus located in the London Borough of Haringey.



Figure 1-1: Campus Masterplan View taken by QRP Presentation 01.02.24.

The plan is the "demolition of existing gym/lecture theatre block and erection of a new Construction and Engineering Centre extending to 2,625 m² over five storeys including plant". The project proposes an all-electric energy strategy, and it will be designed to achieve BREEAM Very Good to comply with planning requirements.

1.2 BREEAM Credits Summary

A BREEAM New Construction (NC) 2022 v6 is being carried out with the following credits targeted in this report.

1. **BREEAM NC ENE01** Reduction of energy use and carbon emissions:
 - a. CCCG Tottenham: **8 credits** awarded.
2. **BREEAM NC ENE04**
 - a. CCCG Tottenham: **2 credits** awarded.
3. **BREEAM NC HEA01**
 - a. CCCG Tottenham: **0 credits** awarded.
4. **BREEAM NC HEA04**
 - a. CCCG Tottenham: **2 credits** awarded.

1.3 Energy Assessor details

For information, please find details relating to the accredited energy assessor and the dynamic simulation software utilised to generate this report:

Table 1-1: Energy Assessor Details

Dynamic Simulation Software	IES Version 2023.2.0.0
Energy Assessor	Adeel Ahmed (Associate at Introba Ltd.)
Energy Assessors Accreditation Body	CIBSE
Energy Assessors Accreditation Number	LCEA125791
Energy Assessor Status	Level 3, Level 4 and Level 5 EPC
Energy Assessor Qualifications	BEng, MSc, Low Carbon Consultant, Chartered Engineer

****Disclaimer:** The results are based on simulations of energy consumption and do not determine the measured consumption, emissions, or costs of the proposed design after construction. Measured results will differ from these calculations due to variations such as occupancy, building operation and maintenance, weather, unregulated energy, changes in carbon intensity of the electricity grid and precision of the calculation tool.

2 Proposed Development Inputs

2.1 Fabric Specifications

The fabric specifications assumed for the proposed building are listed in the table below.

Table 2-1: Fabric specifications assumed for the proposed building.

	Elements	Non-Domestic Spaces
Opaque Elements	External Wall U-Value (W/m ² .K)	0.15
	Ground Floor (W/m ² .K)	0.12
	Internal Walls U-Value (W/m ² .K)	1.80
	Internal Ceiling/Floor (W/m ² .K)	0.12
	Flat Roof U-Value (W/m ² .K)	0.12
	External Door U-Value (W/m ² .K)	1.0
Glazing Elements	Window / Glazed Door U-Value (W/m ² .K)	1.0
	Frame factor	15%
	Glazing G-Value	0.40
	Glazing light transmittance	70%
Air-Leakage	Air-Permeability (m ³ /hr.m ²)	1

2.2 Infiltration

An infiltration rate of 0.207 ach was assumed for the proposed design of the building, which represents an air permeability target of 1 m³/(h.m²) at 50 Pa.

2.3 Building Systems

Table 2-2 shows the building services systems used in the model.

Table 2-2: Building Services System adopted in the design.

Student Social Building		
Ventilation	Ventilation	Air Handling Unit + VAV System
	Specific Fan Power (SFP)	1.2
	Heat Recovery	80%
Heating	Heating System	ASHP
	Emitter	Duct Reheat Coils (Workshops and classrooms) Fan Coils (ICTs)
	Seasonal Efficiency	264% 264%
	Delivery Efficiency	included in efficiency
Cooling	Cooling System	ASHP
	Cooling Efficiency (EER)	54.5

	Delivery Efficiency	included in efficiency
DHW	DHW type	ASHP
	DHW Efficiency	286%
	Distribution Efficiency for DHW system	included in efficiency
Lighting	Lighting efficacy	115 lm/cw
	Daylight areas - Dimming	None
	Daylight areas - Sensor controls	No back sensors
	Occupancy Sensing	Circulation, Changing, Toilet – Auto ON OFF Office, Plant Rooms – Man ON Auto OFF

3 ENE01 Reduction of Energy Use and Carbon Emissions

The energy performance of the proposed development has been checked against the BREEAM New Construction (NC) 2022 version v6.0, ENE01 credit. The Energy Performance Ratio (EPRED) for the buildings heating and cooling demand is calculated and compared against the Energy Performance Ratio (EPRNC) benchmark scale. Based on the results of the EPRNC calculated with the BREEAM online tool, to provide a demonstration that the energy performance of the non-domestic areas of the development is in line with the required energy performance to meet a BREEAM Excellent equivalent. The BREEAM NC 2022 states a minimum of 4 credits are required to be achieved (equivalent to an EPRNC of at least 0.4) or 4 credits for prediction of operational energy consumption. The '_brukl.inp' file for the proposed buildings has been uploaded on the BREEAM online tool. A screenshot of the BREEAM online calculation tool with the generated outputs is provided in the image below.

Energy performance - Building score	
Heating and cooling demand energy performance ratio (EPRdem)	0.3
Primary consumption energy performance ratio (EPRpc)	0.233
CO ₂ -eq energy performance ratio (EPRco2-eq)	0.32
Overall building energy performance ratio (EPRnc)	0.853
Total BREEAM credits achieved	8.0

The results on the number of credits awarded for ENE01 are listed in the table below.

Table 3-1: EPRnc and BREEAM credits breakdown

Space	EPRnc	BREEAM Credits
CCCG Tottenham	0.233	8

4 ENE04 Low Carbon Design

This section of the report focuses on two of the BREEAM NC 2022 v6 Ene 04 – Low-carbon design credits that can be achieved:

1. The Passive analysis design credit and
2. The Low and Zero Carbon (LZC) technologies credit.

4.1 ENE04 - Passive Design (1 credit)

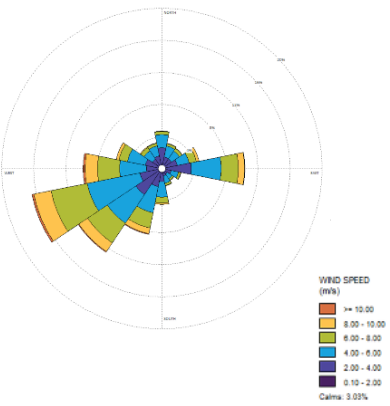
The BREEAM New Construction 2022 has the following requirements.

1. In order to achieve this credit, the 'HEA 04 Thermal Comfort credit' will need to be targeted to demonstrate that the building design delivers appropriate thermal comfort levels in occupied spaces.
2. This report has been generated at RIBA Stage 2, and identifies opportunities for the implementation of passive design measures, such as:
 - Reduced U-values for opaque constructions
 - Reduced U-values for glazed constructions
 - Solar control glazing
 - External shading overhangs and deep reveals
3. The proposed building will utilise passive design measures to reduce the total heating and cooling, loads and/or CO₂ emissions, when compared against the loads and carbon emissions of the actual building modelled with standard building specification passive design measures.

4.1.1 Methodology

The design team have analysed the following 12 design measures as recommended within the BREEAM NC 2022 manual. The table below shows an overview of each measure and the related design consideration.

Table 4-1: Design Measures recommended.

Design Measures	Design Consideration
1. Site Location	The site is located on High Road, north of Seven Sisters underground station. The proposed building is part of a wide campus masterplan developed for the Tottenham Centre, and more detail of the plan are set out in the Design and Access Statement report. The proposed building is a new Construction and Engineering Centre developed on 4 levels, and rooftop plant.
2. Site Weather	The site is in the London urban area, and it is mainly affected by Urban Heat Island (UHI). The prevailing wind on the area approach from the south-west, with most frequent winds from the West-Southwest as shown in the wind-rose. Due to the direction and speed of the prevailing winds, the south-west façade of the building could potentially benefit from natural cooling. 
3. Microclimate	Although the proposed development is influenced by the UHI effect, it can benefit from the south-westerly winds impacting the west façades. Due to the wind speed, reaching 8m/s, the north-east and south-east side of the

	construction centre sees acceleration and tunnelling effects. This condition influences the moderate cold stress experienced in winter, in the southeast side of the building. In spring the area experiences slight cold stress, while in summertime there is no thermal stress throughout the site.
4. Building Layouts	The proposed development includes various workshop spaces, classrooms, and ITC laboratories distributed across all four floors. The internal layouts of these rooms are designed along the perimeter of the building, incorporating large openings to ensure adequate internal daylight, outside views, and natural ventilation. Stairs and storage rooms are primarily situated in the north part and southwest side of the building.
5. Building Orientation	The site's orientation and topography have informed the proposed development's design and footprint. Occupied spaces are mostly East and West oriented, to maximise the use of natural light. However, the obstruction caused by the surrounding buildings is affecting the internal level of daylight. Table 5-2 in Section 5.5 reports VLT and light transmittance values recommended to mitigate the low levels of daylight within the building.
6. Building Form	The site orientation, topography and urban context have contributed to inform the development design: the massing is reflecting the urban context and enhances the optimal use of natural light even giving the constraints related to the obstruction caused by the surrounding context.
7. Building Fabric	The current design is aiming to meet and exceed the Building Regulations Part L limiting values, but also use improved U-Values and air-permeability rate.
8. Thermal Mass or other fabric thermal storage	The current proposals for the construction build ups include brickwork cavity walls, and concrete slabs for all floors, materials with high thermal mass. This will assist in the passive heating and cooling of the building.
9. Building occupancy type	The proposed development will accommodate workshop areas, classrooms, and laboratories for different engineering uses.
10. Daylight strategy	The use of daylight sensors was tested, and it is recommended that daylight sensors are installed in all educational areas with glazing.
11. Ventilation strategy	The building employs a mixed-mode ventilation strategy, utilizing both openable windows and mechanical ventilation systems. Spaces such as laboratories, and workshops rely entirely on mechanical ventilation due to noise restrictions. In contrast, classrooms and offices incorporate natural ventilation. Reduced window g-values contribute to lowering cooling loads and the requirements for mechanical ventilation.
12. Adaptation to climate change	Due to the predicted hot weather conditions in the future, energy consumption for heating is likely to decrease as less heating will be required while energy consumption for cooling may increase. Laboratories are provided of cooling capacity to avoid overheating risks.

To enable a baseline for comparison to be established, a 'standard building' should be modelled with fabric performance equivalent to that of the local building regulations notional building and without the passive design measures (where feasible, i.e. building orientation is likely to be fixed). The glazing areas specified in the 'standard building' should be the same as those required by the Building Regulations Notional building. Therefore, measures 7, 10 & 11, have been modelled in comparison to the Standard Building. The three measures are in line with the Be Lean case in the Energy Strategy.

4.1.2 Inputs

4.1.2.1 Proposed development

The Inputs including fabric specifications, infiltration and building systems which have been adopted for the proposed development are listed in Section 2 of this report.

4.1.2.2 Standard Building required for ENE04 assessment (not the values for the proposed design)

The inputs used for the Standard Building are listed in the table below:

Table 4-2: Inputs Summary

	Elements	Standard Building
Opaque Elements	External Wall U-Value (W/m ² .K)	0.18
	Ground/ Exposed Floor U-Value (W/m ² .K)	0.15
	Internal Walls U-Value (W/m ² .K)	1.80
	Flat Roof U-Value (W/m ² .K)	0.15
	External Door U-Value (W/m ² .K)	1.90
Glazing Elements	Frame factor	10%
	Window / Glazed Door U-Value (W/m ² .K)	1.40
	Glazing G-Value	0.29
	Glazing light transmittance	60%
Other	Thermal Bridging (W/m ² .K)	0.15 or calculated value if lower.
	Thermal Mass Parameter	n/a
Air-Leakage	Air-Permeability (m ³ /hr.m ²)	3
Ventilation	Ventilation	Mechanical Ventilation with Heat Recovery (MVHR) unit with HR of 76%
Lighting	Lighting efficacy	95 lm/W
	Display lighting efficacy	80 lm/W

*Both Standard Building and Be Lean case use the same systems.

4.1.3 Results

The following tables demonstrate that through the implementation of improved passive design measures beyond those within the notional building, reduction in energy consumption and carbon emission will be achieved.

Table 4-3: Energy Consumption and % improvement showing the benefit of Passive Design Measures.

	Energy Consumption of Standard Building (Built to Notional Building passive design measures) (kWh/m ²)	Energy Consumption of Actual Building (Be Lean) (kWh/m ²)	Improvement (%)
CCCG Tottenham	42.15	38.71	8.1%

Table 4-4: Carbon Dioxide Emissions and % improvement showing the benefit of Passive Design Measure.

	CO ₂ emissions of Standard Building (Built to Notional Building passive design measures) (Kg CO ₂ /m ²)	CO ₂ emissions of Actual Building (Be Lean) (Kg CO ₂ /m ²)	Improvement (%)
CCCG Tottenham	5.87	5.29	9.8%

1 credit could therefore be achieved for 'passive design analysis' under BREEAM credit reference ENE04.

4.2 ENE04 - Low and Zero Carbon technologies Credit (1 credit)

The BREEAM New Construction 2022 has the following requirements.

1. A feasibility study is completed by an energy specialist.
2. Identification and establishment the most appropriate LZO energy source for the proposed development.
3. Specify local LZO technologies for the proposed development.
4. Quantify the reduced regulated carbon dioxide emissions resulting from the feasibility study.

4.2.1 Methodology

BREEAM stipulates that a feasibility study should be carried out by the completion of the Concept Design stage (RIBA Stage 2 or equivalent) by an energy specialist to establish the most appropriate recognised local (on-site or near-site) LZO energy sources for the Site.

The low and zero carbon feasibility study should cover as a minimum:

1. Energy generated from LZO energy source per year.
2. Carbon dioxide savings from LZO energy source per year
3. Life cycle cost of the potential specification, accounting for payback
4. Local planning criteria, including land use and noise.
5. Feasibility of exporting heat or electricity from the system
6. Any available grants
7. All technologies appropriate to the site and energy demand of the development.
8. Reasons for excluding other technologies.
9. If appropriate:
 - a. The building is connected to an existing local community CHP system or
 - b. the building is connected to an existing source of waste heat or power or
 - c. a building or site CHP system is specified with the potential to export excess heat or power via a local community energy scheme or
 - d. a source of waste heat or power is specified with the potential to export excess heat or power via a local community energy scheme.
10. Energy storage.

The methodology of the assessment is as follows:

- The baseline regulated CO₂ emissions are calculated.
- The recommended LZO technologies are applied to the energy calculations for the development; and
- The energy contributed by the proposed LZO technologies and reduction in the building's baseline CO₂ emissions are calculated.

For the purposes of this study, the baseline scheme is defined as the Building Regulations compliant baseline once passive design and energy efficiency measures have been implemented. For clarity, this is the 'Be Lean' building as outlined in London Plan assessments and covered in Section 4 of the Energy Statement (10379-IRB-01-XX-T-OS-5101).

4.2.2 Parameters required in LZC.

The criteria required are listed in the following table.

Table 4-5, LZC required parameters.

LZC requirements	Comments
1. Energy generated from LZC energy source per year	The energy consumption from LZC is listed in paragraph 4.2.4
2. Carbon dioxide savings from LZC energy source per year	The carbon dioxide savings from LZC is listed in paragraph 4.2.4
3. Life cycle cost of the potential specification, accounting for payback	The anticipated payback for an ASHP should consider both cost analysis and the energy savings analysis from the heat recovered when in cooling mode. Products similar to the ones recommended for the proposed development could offer as less as 3 years of payback period, if correctly applied, and up to 15 years.
4. Local planning criteria, including land use and noise	Planning policies are listed in Section 2 of the Energy Report (10379-IRB-01-XX-T-OS-5101) and in Appendix A.
5. Feasibility of exporting heat or electricity from the system	The equipment has been sized for using all the heating and cooling on the site only with maximum efficiency. It is feasible to discharge heat into a heat network, as electricity will be partially generated on site.
6. Any available grants	No grants were available.
7. All technologies appropriate to the site and energy demand of the development	This has been covered in the following paragraph.
8. Reasons for excluding other technologies	This has been covered in section 7.1 'LZC Technology Options' of the Energy Report (10379-IRB-01-XX-T-OS-5101) and in Appendix B.
9. If appropriate: • The building is connected to an existing local community CHP system or • the building is connected to an existing source of waste heat or power OR • a building or site CHP system is specified with the potential to export excess heat or power via a local community energy scheme or • a source of waste heat or power is specified with the potential to export excess heat or power via a local community energy scheme	Not applicable to the proposed development.
10. Energy storage	Buffer vessels of 1800 litres to store heating and cooling energy to account for peaks and drops in the load profiles have been allowed for, in conjunction to the heat pumps used for the co-living spaces.

4.2.3 LZC Technology options

Low and Zero Carbon (LZC) technologies that could be used for this development were evaluated and the results of the analysis showed that an all-air system using an Air-Handling-Unit is the most appropriate strategy for heating and cooling, while Air Source Heat Pumps (ASHPs) is the most appropriate technology for the Domestic Hot Water (DHW).

Photovoltaic (PV) Panels are considered on the roof area of the proposed development. Avoiding overshadowing of a PV array is critical to its energy output, carbon savings, and cost-effectiveness, so the first step in assessing PV options for a site is to identify suitable unshaded locations to mount PV panels.

All the technologies are reviewed in 4.2.2 LZO technology feasibility for the Site.

4.2.4 Results

This Low and Zero Carbon (LZO) feasibility study was carried out at RIBA Stage 3 by a suitably qualified energy specialist and establishes the most appropriate recognised local low or zero carbon energy sources for the development.

Local LZO technologies for the development will be specified in line with the recommendations of this feasibility study; this method of supply will result in a meaningful reduction in regulated carbon dioxide emissions.

Following the implementation of renewable technologies, such as the Air Source Heat Pumps (ASHP) and PV panels, the proposed development achieves a percentage reduction in energy consumption of 5.3% as shown in the following table:

Table 4-6: Energy Consumption of Be Lean and Be Green stages and the % of improvement showing the benefit of LZO technology.

	Energy Consumption Building (Be Lean ASHP Heating) (kWh/m ²)	Energy Consumption of Actual Building (Be Green with Air Source Heat Pumps & PVs) (kWh/m ²)	Improvement (%)
CCCG Tottenham	38.71	36.67	5.3%

The following table demonstrates the percentage reduction in regulated carbon emissions after using renewables (air source heat pumps) which together with the LZO feasibility study will result in achieving **1 credit** against BREEAM NC 2022 v6.

Table 4-7: CO₂ emissions of Be Lean and Be Green stages and the % of improvement showing the benefit of LZO technology.

	Carbon Emissions of Actual Building (Be Lean ASHP Heating) (Kg CO ₂ /m ²)	Carbon Emissions of Actual Building (Be Green with Air Source Heat Pumps & PVs) (Kg CO ₂ /m ²)	Improvement (%)
CCCG Tottenham	5.29	3.52	33.5%

*These figures are based on SAP10.2 carbon factors.

5 HEA01 Daylighting

5.1 Introduction

Introba was commissioned by Capital City College Group ('the Applicant') to carry out an internal daylight analysis for the development of the Tottenham Campus ('the proposed development') within London Borough of Haringey. The higher educational building consists primarily of workshop rooms, offices, laboratories, and classrooms distributed across four floors: ground, first, second and third floor.

The proposed development is assessed under BREEAM UK New Construction (NC) version 6.0 (2022), and the analysis has been carried out in support of the credit Hea 01, Visual Comfort – Daylighting (up to 3 credits)

5.2 Criterion for compliance

The BREEAM New Construction (NC) version 6.0 (2022) offers up to three credits for the Daylighting Criteria of the HEA 01 Visual comfort section. These credits can be awarded on a sliding scale depending on the percentage of relevant building area that complies with one of the following two daylight criteria:

1. The relevant building areas meet good practice daylight factor(s) of 2% for all occupied spaces, with one credit awarded if 40% of the area complies, 2 credits if 60% of the area complies and 3 credits if 80% of the area complies. This should be met in combination with point a or point b and c below:
 - a. A uniformity ratio of at least 0.3 or a minimum point daylight factor of at least 0.3 times the average daylight factor mentioned above, which in this case is 0.6 (2%*0.3). Spaces with glazed roofs, such as atria, must achieve a uniformity ratio of at least 0.7 or a minimum point daylight factor of at least 0.7 times the average daylight factor mentioned above, which would be the equivalent of 1.4 (2%*0.7).
 - b. At least 80% of the room has a view of sky from desk or tabletop height (0.85m in multi-residential buildings, 0.7m in other buildings).
 - c. The room depth criterion $d/w + d/HW < 2/(1-RB)$ is satisfied.
 Where:
 d = room depth w = room width
 HW = window head height from floor level RB = average reflectance of surfaces in the rear half of the room.
2. The relevant building areas meet good practice average daylight illuminance of 300lux for 2,000hours per year or more and minimum point daylight illuminance at worst lit point of at least 90lux for 2,000hours per year or more. One credit awarded if 40% of the area complies with the criteria in point 2, 2 credits if 60% of the area complies and 3 credits if 80% of the area complies with the criteria in point 2.

5.3 Modelling and software information

To carry out the daylight simulations, Introba uses Climate Studio plug-in for Rhinoceros 7. The software is a highly environmental performance analysis tool that produces advanced daylighting analysis of 3D models created in Rhinoceros 3D.

Rhinoceros 7 is an industry standard NURBS modelling software.

5.4 Building and model input Data

The geometrical data for the building has been based on the Revit model supplied by Atkins on the 12.09.2023.

The daylight assessment was carried out for the educational rooms reported in the table below.

Table 5-1: List of rooms included in the scope of the assessment.

	Room Reference
Ground Floor	R00-09_Bricklaying Workshop
	R00-11_Engineering Workshop
	R00-10_Workshop Store
	R00-14_Workshop Office
First Floor	R01-06 General Classroom 01
	R01-08_Electrical Installation Workshop
	R01-09_Workshop Office
	R01-11_Heating and Plumbing Workshop
	R01-14_Workshop Office
Second Floor	R02-07_Staff Room 01
	R02-08_Staff Office
	R02-09_ICT 01
	R02-12_ICT 02
	R02-14_ICT 03
	R02-13_Genral Classroom 02
	R02-15_Genral Classroom 03
Third Floor	R03-06_Project Based Learning Space
	R03-08_Engineering and Technology Lab 01
	R03-11_Genral Classroom 04
	R03-12_Technician Room
	R03-13_Engineering and Technology Lab 02
	R03-14_ICT 04

5.4.1 Building Data

The proposed development is located in London, within the London Borough of Haringey.

Building type: Higher Education
 Location: London
 Latitude: 51.48° North
 Longitude: 0.45° W
 Altitude: 25m

A 3D model was created in Rhinoceros, based on the provided Revit model and an axonometric view of the model is shown in Figure 5-1.

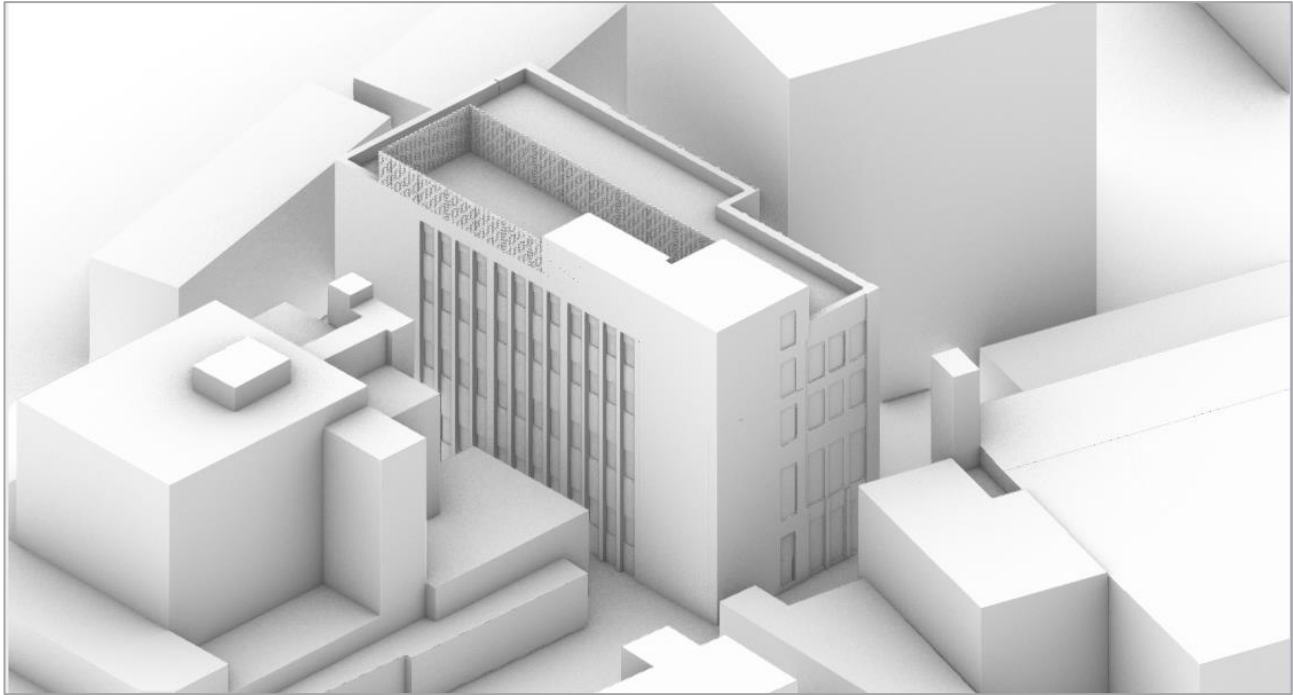


Figure 5-1: 3D model of Tottenham Campus produced using Rhinoceros 7.

5.5 Modelling Inputs

The tables below show the Visual Light Transmittance (VLT) assumed for the glazing elements within the model, and the recommended default light reflectance values adopted for the opaque elements. The values are in accordance with the default values recommended in the BRE 209 2022 Edition *Site layout planning for daylight and sunlight* while the VLT is the minimum target suggested by Introba in order to provide good level of daylight.

Table 5-2: Light Transmittance values of the surfaces within the model.

Glazing	Light Transmittance (Tn)
Glazing	0.74

Elements	Light Reflectance Value (LRV)
Interior walls	0.5
Ceilings	0.7
Floors	0.2
Exterior walls and obstructions	0.2
Exterior ground	0.2

5.6 Results

A daylight calculation using Climate Studio plugin for Rhinoceros has been performed to calculate average daylight factors, uniformity ratio, minimum point daylight factor, view of sky. The room depth criterion was calculated within the Grasshopper interface based on the geometry of each space.

The Daylight analysis has been carried out for relevant areas defined by BREEAM and includes workshop rooms, laboratories, classrooms, and offices. Internal spaces that are not occupied for longer than 30 minutes continuously have not been included in the daylighting analysis.

5.6.1 Baseline Results

The daylighting assessment results (Table 5-3) show that only 16.7% of the occupied rooms in the Baseline scenario meet the BREEAM HEA 01 – Visual comfort - Daylighting requirements for New Constructions.

Table 5-3: Baseline Results for BREEAM HEA01 criteria.

Floor Reference	Room Reference	Area m2	Daylight Factor Average%	Criterion A		BREEAM Standard met
				Uniformity Ratio	Min point DF	
Ground Floor	R00-09_Bricklaying Workshop	168.8	0.74%	0.05	0.04	FAIL
	R00-11_Engineering Workshop	164.3	0.92%	0.13	0.12	FAIL
	R00-10_Workshop Store	20.0	2.24%	0.27	0.60	PASS
	R00-14_Workshop Office	7.8	1.51%	0.29	0.44	FAIL
First Floor	R01-06 General Classroom 01	49.3	6.79%	0.31	2.08	PASS
	R01-08_Electrical Installation Workshop	130.8	0.37%	0.15	0.14	FAIL
	R01-09_Workshop Office	5.4	0.20%	0.69	0.14	FAIL
	R01-11_Heating and Plumbing Workshop	136.8	1.21%	0.08	0.10	FAIL
	R01-14_Workshop Office	5	1.97%	0.47	0.92	FAIL
Second Floor	R02-07_Staff Room 01	59.5	3.28%	0.42	1.38	PASS
	R02-08_Staff Office	4.3	12.13%	0.57	6.95	PASS
	R02-09_ICT 01	53.8	1.78%	0.13	0.24	FAIL
	R02-12_ICT 02	54.9	1.56%	0.12	0.19	FAIL
	R02-14_ICT 03	57.7	1.51%	0.14	0.21	FAIL
	R02-13_Genral Classroom 02	49.3	0.75%	0.17	0.13	FAIL
	R02-15_Genral Classroom 03	52.4	0.38%	0.20	0.08	FAIL
Third Floor	R03-06_Project Based Learning Space	99	4.49%	0.17	0.77	PASS
	R03-08_Engineering and Technology Lab 01	68.8	2.21%	0.26	0.58	FAIL
	R03-11_Genral Classroom 04	49.2	1.04%	0.20	0.21	FAIL
	R03-12_Technician Room	24.3	1.94%	0.14	0.26	FAIL
	R03-13_Engineering and Technology Lab 02	73.0	2.09%	0.22	0.45	FAIL
	R03-14_ICT 04	52.4	0.67%	0.27	0.18	FAIL

5.6.2 Option 1 Results

A new option (Option1) has been carried out to improve the internal daylight condition. The recommended strategies included in the assessment are as follow:

- Increased window glazing
- Removed internal partitions for plumbing placed in front of the window (workshop rooms).

The Option 1 results (Table 5-4) show an improvement of 22% which is still not sufficient to achieve the BREEAM credits.

Given the constrains related to the fixed layout and requirement of the educational rooms to retain the partitions, further strategies, and the strategies in Opt1 cannot be implemented. Thus **0 no. of credits** can be achieved within the BREEAM UK New Construction (2022).

Table 5-4: Option 1 results for BREEAM HEA01 criteria.

Floor Reference	Room Reference	Area m2	Daylight Factor Average%	Criterion A		BREEAM Standard met
				Uniformity Ratio	Min point DF	
Ground Floor	R00-09_Bricklaying Workshop	168.8	1.42%	0.04	0.06	FAIL
	R00-11_Engineering Workshop	164.3	1.55	0.14	0.21	FAIL
	R00-10_Workshop Store	20.0	2.24%	0.29	0.64	PASS
	R00-14_Workshop Office	7.8	2.56%	0.26	0.67	FAIL
First Floor	R01-06 General Classroom 01	49.3	4.97%	0.33	1.66	PASS
	R01-08_Electrical Installation Workshop	130.8	1.49%	0.05	0.08	FAIL
	R01-09_Workshop Office	5.4	0.68%	0.56	0.38	FAIL
	R01-11_Heating and Plumbing Workshop	136.8	2.21%	0.20	0.44	FAIL
	R01-14_Workshop Office	5.0	1.88%	0.43	0.80	FAIL
Second Floor	R02-07_Staff Room 01	59.5	3.04%	0.32	0.98	PASS
	R02-08_Staff Office	4.3	11.60%	0.61	7.09	PASS
	R02-09_ICT 01	53.8	2.02%	0.14	0.28	FAIL
	R02-12_ICT 02	54.9	1.90%	0.13	0.24	FAIL
	R02-14_ICT 03	57.7	1.93%	0.14	0.28	FAIL
	R02-13_Genral Classroom 02	49.3	0.89%	0.19	0.17	FAIL
	R02-15_Genral Classroom 03	52.4	0.45%	0.20	0.09	FAIL
Third Floor	R03-06_Project Based Learning Space	99	4.05%	0.16	0.65	PASS
	R03-08_Engineering and Technology Lab 01	68.8	2.81%	0.23	0.65	FAIL
	R03-11_Genral Classroom 04	49.2	1.24%	0.21	0.26	FAIL
	R03-12_Technician Room	24.3	2.39%	0.13	0.31	FAIL
	R03-13_Engineering and Technology Lab 02	73.0	2.59%	0.21	0.53	FAIL
	R03-14_ICT 04	52.4	0.79%	0.30	0.24	FAIL

5.7 Conclusion and Recommendations

The daylighting assessment shows that only 16.7% of the occupied rooms meet the BREEAM HEA 01 – Visual comfort requirements for New Construction version 6.0. Thus, 0 no. of credits can be achieved within the BREEAM UK New Construction (2022).

Due to the condition of the building, i.e. being heavily shaded by the surrounding context, and considering the constraints related to the layout requirements of the educational building and the constraints related to the façade, Introba advice that the VLT values and reflectance values adopted for the glazing and internal surface meet or exceed the recommended values reported in the table below.

The implementation of the recommended values will mitigate the poor daylight condition within the educational building.

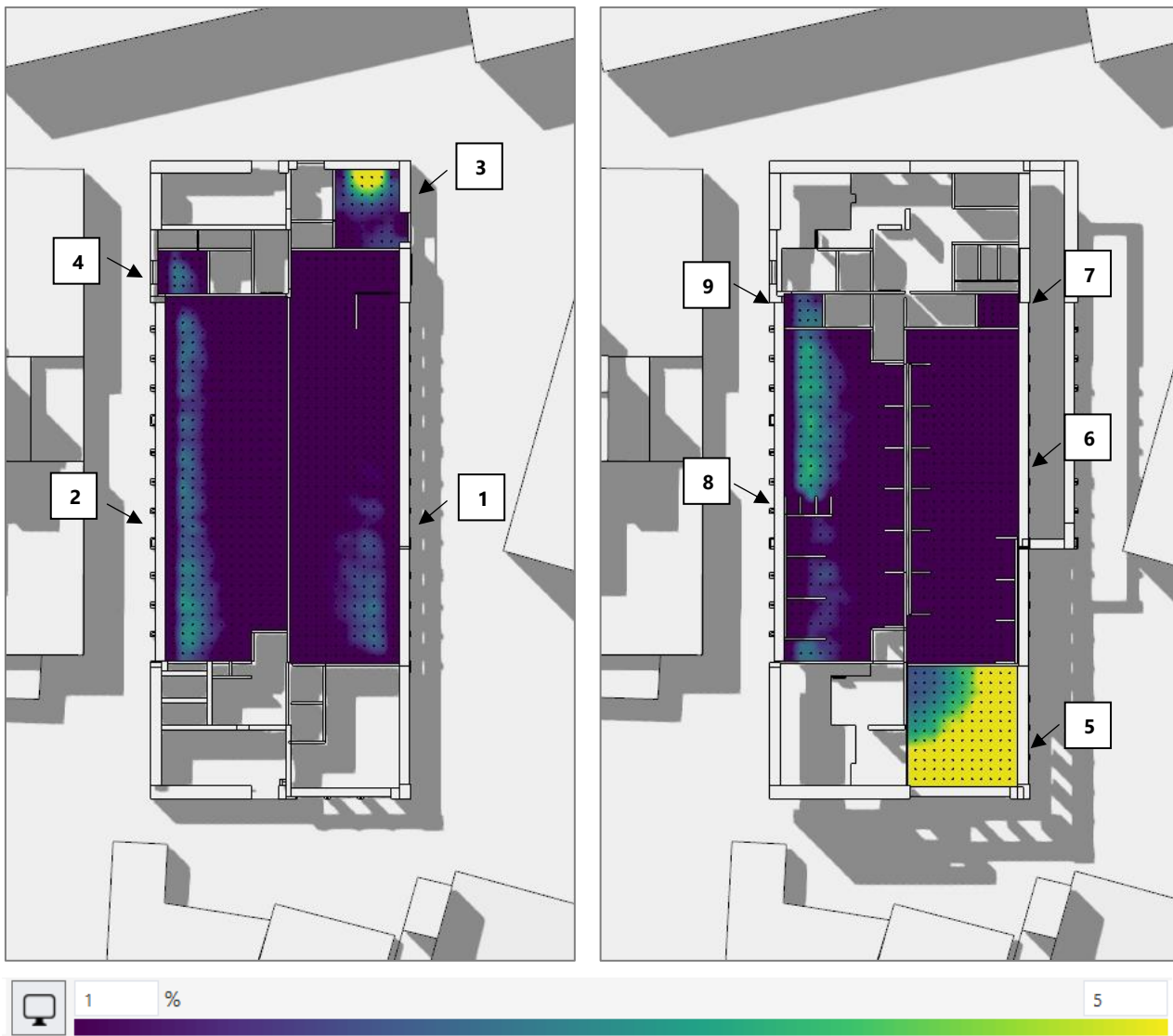
Table 5-5: Light Transmittance values recommended for the building surface.

Glazing	Light Transmittance (Tn)
Glazing	0.74

Elements	Light Reflectance Value (LRV)
Interior walls	0.5
Ceilings	0.7
Floors	0.2
Exterior walls and obstructions	0.2
Exterior ground	0.2

5.8 ADF Results Plots

5.8.1 Images of Daylight factor calculations: Baseline

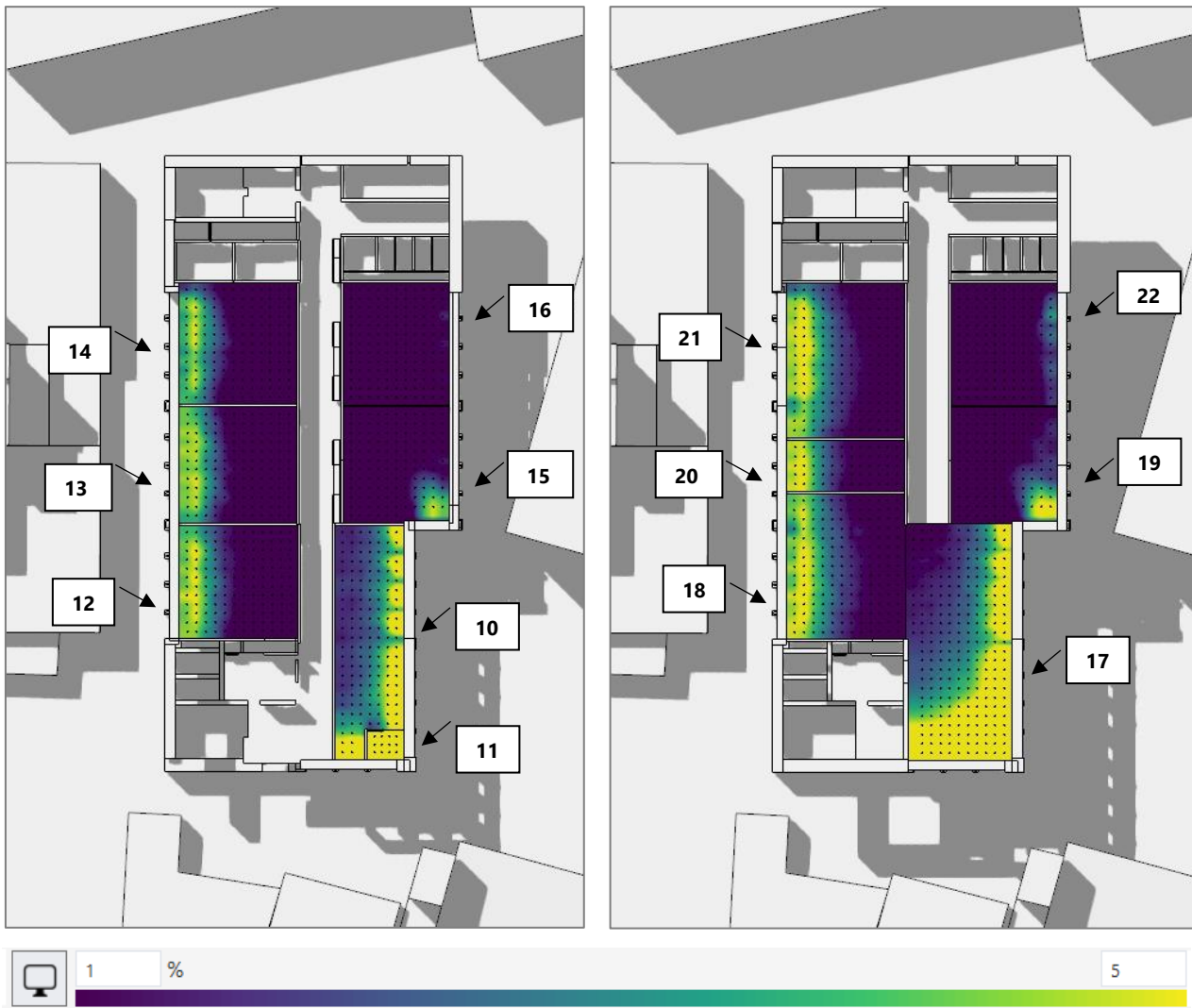


Ground Floor

- 1 R00-09_Bricklaying Workshop
- 2 R00-11_Engineering Workshop
- 3 R00-10_Workshop Store
- 4 R00-14_Workshop Office

First Floor

- 5 R01-06 General Classroom 01
- 6 R01-08_Electrical Installation Workshop
- 7 R01-09_Workshop Office
- 8 R01-11_Heating and Plumbing Workshop
- 9 R01-14_Workshop Office



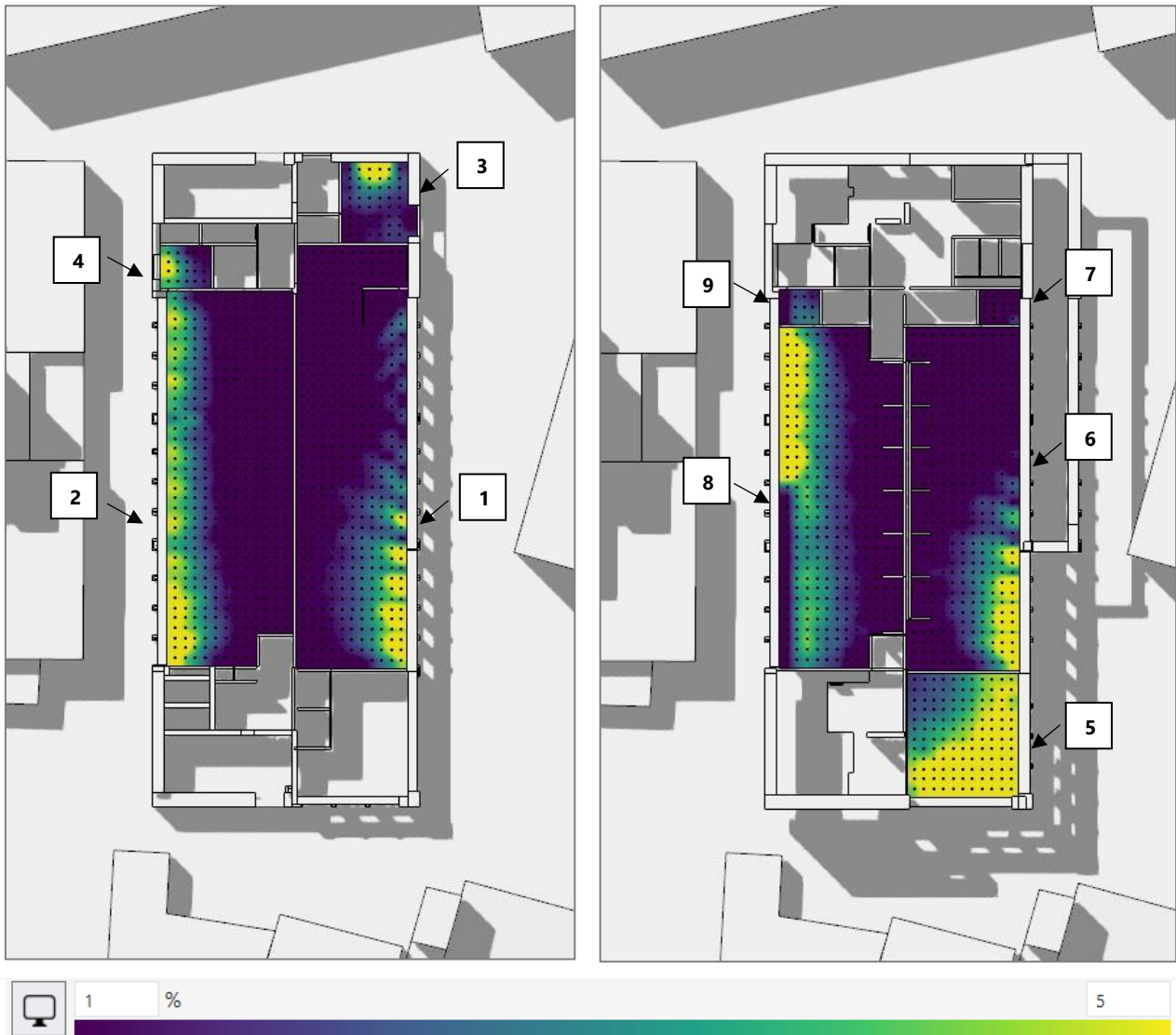
Second Floor

- 10** R02-07_Staff Room 01
- 11** R02-08_Staff Office
- 12** R02-09_ICT 01
- 13** R02-12_ICT 02
- 14** R02-14_ICT 03
- 15** R02-13_Genral Classroom 02
- 16** R02-15_Genral Classroom 03

Third Floor

- 17** R03-06_Project Based Learning Space
- 18** R03-08_Engineering and Technology Lab 01
- 19** R03-11_Genral Classroom 04
- 20** R03-12_Technician room
- 21** R03-13_Engineering and Technology Lab 02
- 22** R02-14_ICT 04

5.8.2 Images of Daylight factor calculations: Option 1

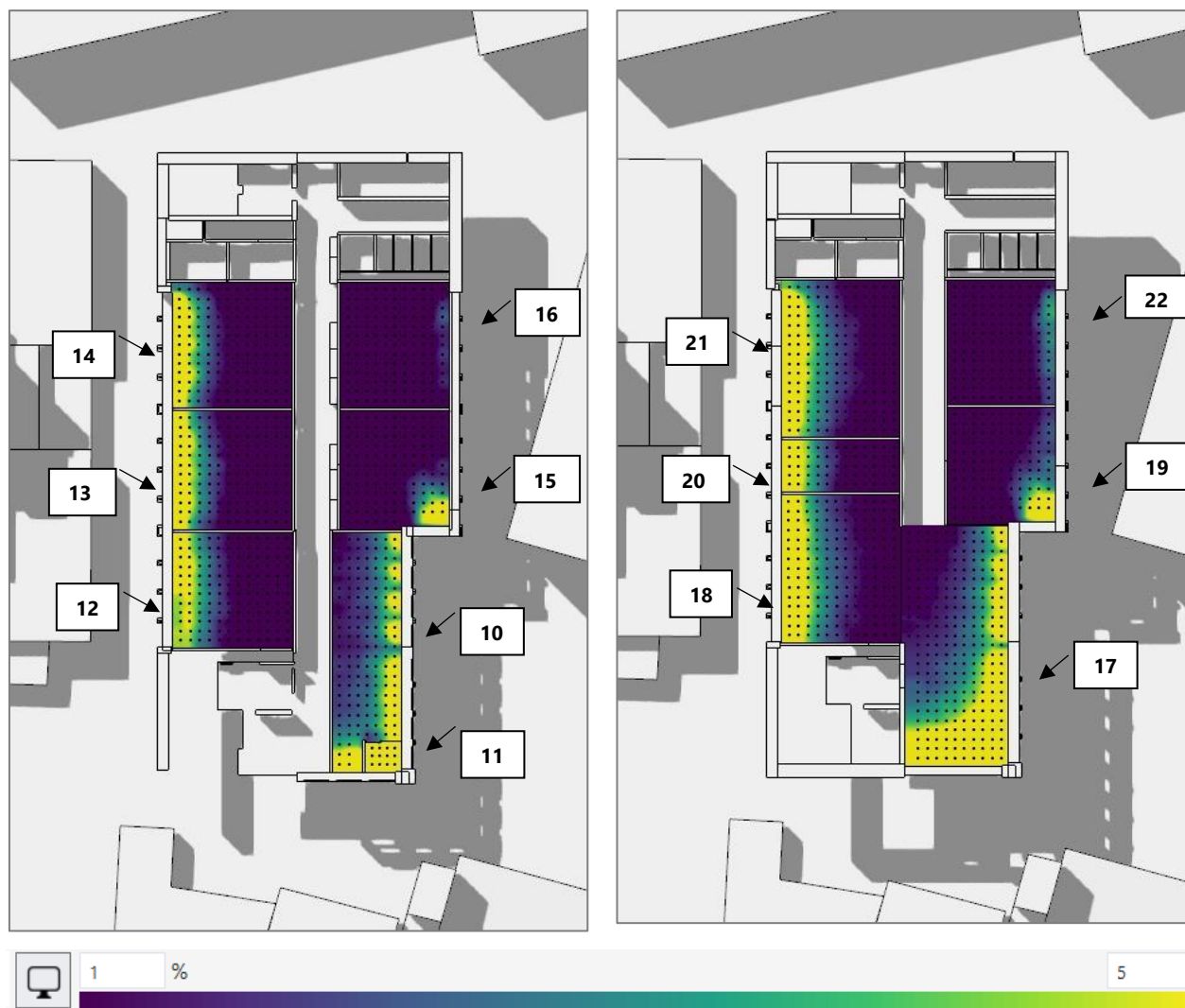


Ground Floor

- 1 R00-09_Bricklaying Workshop
- 2 R00-11_Engineering Workshop
- 3 R00-10_Workshop Store
- 4 R00-14_Workshop Office

First Floor

- 5 R01-06 General Classroom 01
- 6 R01-08_Electrical Installation Workshop
- 7 R01-09_Workshop Office
- 8 R01-11_Heating and Plumbing Workshop
- 9 R01-14_Workshop Office



Second Floor

- 10** R02-07_Staff Room 01
- 11** R02-08_Staff Office
- 12** R02-09_ICT 01
- 13** R02-12_ICT 02
- 14** R02-14_ICT 03
- 15** R02-13_Genral Classroom 02
- 16** R02-15_Genral Classroom 03

Third Floor

- 17** R03-06_Project Based Learning Space
- 18** R03-08_Engineering and Technology Lab 01
- 19** R03-11_Genral Classroom 04
- 20** R03-12_Technician room
- 21** R03-13_Engineering and Technology Lab 02
- 22** R02-14_ICT 04

6 HEA04 Thermal Comfort

6.1 Criteria for Compliance

6.1.1 BREEAM HEA04

BREEAM UK New Construction Version 6 (2022) is the applicable version for the proposed development. BREEAM is an environmental performance standard against which new and refurbished, non-domestic buildings in the UK can be assessed and achieve a BREEAM rating.

This report focuses on the BREEAM UK NC Version 6 (2022) HEA04 Thermal Comfort credits that can be achieved. BREEAM UK New Construction Version 6.0 2022 Credit HEA04 (Thermal Comfort) offer three credits for this assessment. In this report all credits under HEA04 category will be assessed.

1. **First credit - Thermal modelling:** A thermal modelling analysis must be carried out to demonstrate that the building design and services strategy can deliver thermal comfort levels in the occupied¹ spaces in accordance with the criteria set out in the appropriate industry standards.
2. **Second credit - Design for future thermal comfort:** The thermal modelling must demonstrate that the thermal comfort requirements set out above are also achieved for a projected climate change environment.
3. **Third credit - Thermal zoning and controls:** A third credit is available if the design team can demonstrate that the thermal modelling analysis has informed the temperature controls strategy for the building and its users.

6.1.1.1 First credit – Thermal modelling

The following is required to demonstrate compliance:

1. Thermal modelling has been carried out using software in accordance with CIBSE AM11 Building Energy and Performance Modelling.
2. The software used to carry out the simulation at the detailed design stage provides full dynamic thermal analysis. For smaller and more basic building designs with less complex heating or cooling systems, an alternative less complex means of analysis may be appropriate (such methodologies must still be in accordance with CIBSE AM11).
3. The modelling demonstrates that:
 - a. For air-conditioned buildings, summer and winter operative temperature ranges in occupied spaces are in accordance with the criteria set out in CIBSE Guide A Environmental design, Table 1.5; or other appropriate industry standard (where this sets a higher or more appropriate requirement or level for the building type)²; or the thermal environment in occupied spaces meet the Category B requirements for PPD, PMV and local discomfort set out in Table A.1 of Annex A of ISO 7730:2005.
 - b. For naturally ventilated buildings,
 - i. Winter operative temperature ranges in occupied spaces are in accordance with the criteria set out in CIBSE Guide A Environmental design, Table 1.5. Or other appropriate

¹ According to BREEAM, an occupied space is a room or space within the assessed building that is likely to be occupied for 30 minutes or more by a building user. Please note there is a specific, unrelated, definition of “unoccupied” with reference to acoustic testing and measurement and this should not be confused with the definition used here. However, for the purpose of this issue, the definition excludes the following:

- atria or concourses.
- entrance halls or reception areas; and
- ancillary space, e.g. circulation areas, storerooms and plant rooms.

² According to BREEAM definitions, for education building types, as an alternative to CIBSE TM52, an appropriate industry standard for schools is Building Bulletin 101, Ventilation of school buildings (April 2014).

industry standard (where this sets a higher or more appropriate requirement or level for the building type).

- ii. The building is designed to limit the risk of overheating, in accordance with the adaptive comfort methodology outlined in either of the following standards as appropriate; CIBSE TM52: The limits of thermal comfort: avoiding overheating in European buildings or CIBSE TM59: Design methodology for the assessment of overheating risk in homes.
4. For air-conditioned buildings, the PMV (predicted mean vote) and PPD (predicted percentage of dissatisfied) indices based on the above modelling are reported via the BREEAM assessment scoring and reporting tool.

6.1.1.2 Second Credit – Design for future thermal comfort

The following is required to demonstrate compliance:

5. Criteria 1 to 4 are achieved.
6. The thermal modelling demonstrates that the relevant requirements set out in criterion 3 are achieved for a projected climate change environment.
7. Where criterion 6 is not met, the project team demonstrates how the building has been adapted or designed to be easily adapted in future using passive design solutions in order to subsequently meet the requirements under criterion 6.
8. For air-conditioned buildings, the PMV and PPD indices based on the above modelling are reported via the BREEAM assessment scoring and reporting tool.

6.1.1.3 Third credit - Thermal zoning and controls

The following is required to demonstrate compliance:

9. Criteria 1 to 4 are achieved.
10. The thermal modelling analysis (criteria 1 to 4) has informed the temperature control strategy for the building and its users.
11. The strategy for proposed heating or cooling systems demonstrates that it has addressed the following:
 - a. Zones within the building, and how the building services could efficiently and appropriately heat or cool these areas. For example, consider the different requirements for the central core of a building compared with the external perimeter adjacent to the windows.
 - b. The degree of occupant control required for these zones. This is based on discussions with the end user (or alternatively building type or use specific design guidance, case studies, feedback) and considers:
 - i. User knowledge of building services.
 - ii. Occupancy type, patterns and room functions (and therefore appropriate level of control required).
 - iii. How the user is likely to operate or interact with the systems, e.g. are they likely to open windows, access thermostatic radiator valves (TRV) on radiators, change air-conditioning settings etc.
 - iv. The user expectations (this may differ in the summer and winter) and degree of individual control (i.e. obtaining the balance between occupant preferences, for example some occupants like fresh air and others dislike draughts).
 - c. How the proposed systems will interact with each other (where there is more than one system) and how this may affect the thermal comfort of the building occupants.

The need or otherwise for an accessible building user actuated manual override for any automatic systems.

6.1.2 CIBSE Guide A

CIBSE Guide A: Environmental design provides guidance on design criteria and calculation methods such as fabric performance, heating and ventilation system sizing, methods for thermal comfort evaluation and energy demand.

Table 1.5 in the CIBSE Guide A document gives general guidance and recommendations, based on professional experience and judgement, on suitable winter and summer temperatures (together with outdoor air supply rates, filtration grades, maintained illuminances and suggested maximum noise ratings) for a range of room and building types. Operative temperature set-points within the ranges suggested are likely to be found satisfactory, provided the guidance given in Section 1.4.1, on within-day and day-on-day variation is observed. The values of the clothing insulation and metabolic rates indicated apply approximately to the centre of the range. Adjustments can be made for the circumstance that the clothing and activity differ from those in Table 1.5 (Tables 1.3 and 1.4). Fluctuations of up to 1K about the set point would largely pass unnoticed, while fluctuations of 2 K would be noticed and could result in some mild discomfort at the extremes. (An operative temperature 2 K away from the optimum corresponds to about 0.6 units of PMV or PPD about 12%).

Table 6-1 below shows the recommended comfort criteria for different building and room types, according to CIBSE Guide A Table 1.5, which are used to assess the winter and summer thermal comfort for the proposed development.

Table 6-1: Recommended summer/winter operative temperature, clothing, and activity levels.

Building/ room type	Customary winter operative temperatures for stated activity and clothing levels			Customary summer operative temperatures (air-conditioned buildings) for stated activity and clothing levels		
	Temp./ °C	Activity/ met	Clothing/ clo	Temp./ °C	Activity/ met	Clothing/ clo
Educational buildings/ Lecture halls	19-21	1.4	1.0	21-25	1.3	0.6
Offices/ General	21-23	1.2	0.9	22-25	1.2	0.7
Restaurants/ Dining rooms	21-23	1.1	1.0	24-25	1.1	0.6
General building areas/ Kitchen	15-18	1.8	1.0	18-25	1.6	0.6

6.1.3 CIBSE TM52

The CIBSE Technical Memorandum 52 (TM52) sets out the definition and compliance with limiting overheating in indoor building environments.

The standard introduces three categories of building:

- Category I – Buildings whose occupants are sensitive or fragile.
- Category II – Normal expectation, recommended for new build or renovations.
- Category III – Moderate expectation, mainly applicable in existing buildings

6.1.3.1 Overheating in Buildings without Mechanical Cooling

The CIBSE Overheating Task Force has decided that a new approach to the definition of overheating is necessary, particularly for buildings without mechanical cooling. This will follow the methodology and recommendations of BS EN 15251 (BSI, 2007) to determine whether an existing occupied building can be classed as overheating or a proposed building is in danger of becoming overheated.

The standard provides a robust, yet balanced, assessment of the risk of overheating of buildings in the UK and Europe. A room or building that fails any two of the three following criteria is classed as overheating:

- Criterion 1 sets a limit of 3% on the number of occupied hours that the operative temperature can exceed the threshold comfort temperature, T_{max} , by 1K or more during the occupied hours of a typical non-heating season (1 May to 30 September). T_{max} is a function of the outdoor running-mean temperature.
- Criterion 2 deals with the severity of overheating within any one day, which can be as important as its frequency. This is a function of both temperature above T_{max} and its duration. This criterion sets a daily limit for acceptability. If each hour (or part-hour) in which the temperature exceeds T_{max} by at least 1K is multiplied by the number of degrees by which it is exceeded, then this 'excess' should not be more than six degree-hours.
- Criterion 3 sets an absolute maximum temperature of $(T_{max} + 4)$ °C for a room (T_{upp}), beyond which the level of overheating is unacceptable.

It is to be noted that the TM52 overheating criteria apply to "free running" buildings, i.e., buildings where the peak internal temperature is not controlled by air-conditioning. The TM52 overheating criteria therefore supersedes the CIBSE Guide A 2006 fixed temperature threshold for "non-air conditioned" buildings.

6.1.3.2 Overheating in Buildings with Mechanical Cooling

Buildings that are cooled or heated mechanically can also overheat if the ventilation system is, for example, undersized or poorly controlled. Here BS EN 15251 (BSI, 2007) defines the acceptable indoor conditions according to the PMV index, and overheating is therefore a function not only of temperature but of the humidity, air speed and the clothing and activity of the occupants. The extent of overheating will also be judged according to the PPD, as suggested in Table 6-2: Weighting factors based on temperature difference (or PPD for mechanically heated or cooled buildings) following the assumptions shown in the text (BSI, 2007) Table 6-2.

Table 6-2: Weighting factors based on temperature difference (or PPD for mechanically heated or cooled buildings) following the assumptions shown in the text (BSI, 2007)³

Description	Temperature (°C)	Weighting factors	
		WF (Temp.)	WF (PPD)
Cool	20	3	4.7
	21	2	3.1

³ This table assumes a Category I building where acceptable temperatures lie within $\pm 2^\circ\text{C}$ of the optimum and that the optimum temperature is between 24 and 25°C.

	22	1	1.9
Neutral	23	0	0
	24	0	0
	25	0	0
	26	0	0
Warm	27	1	1.9
	28	2	3.1
	29	3	4.7

Testing for overheating in mechanically cooled buildings using PMV/ PPD

A mechanically cooled building should aim to provide an indoor environment where the PMV index is near to or equal to zero. According to Table 6-3, it will be considered as overheating if the value of the PMV index is above 0.5 (PPD $\geq$ 10%).

Table 6-3: Suggested applicability of the categories and their associated acceptable temperature range for free-running buildings and of PMV for mechanically ventilated buildings (from BS, 2007). The CIBSE suggestion is that designers should aim to remain within the Category II limits.

Category	Explanation	Suggested acceptable range (K)	Suggested acceptable limits PMV
I	High level of expectation only used for spaces occupied by very sensitive and fragile persons	± 2	± 0.2
II	Normal expectation (for new buildings and renovations)	± 3	± 0.5
III	A moderate expectation (used for existing buildings)	± 4	± 0.7
IV	Values outside the criteria for the above categories (only acceptable for a limited periods)	> 4	> 0.7

The PMV/ PPD system for assessing thermal comfort is described in BS EN ISO 7730:2005. The predicted mean vote (PMV) combines the influence of air temperature, mean radiant temperature, and air movement with that of clothing and activity level into one value on a thermal sensation scale. The PMV is the predicted mean value of the "votes" of a large group of people, exposed to the same environment.

Testing for overheating in mechanically conditioned buildings using operative temperature

The procedure for testing for overheating in mechanically conditioned buildings (including naturally conditioned buildings during months when the heating is in use) can follow the general methodology shown in Section 6.1.1 in CIBSE TM52 but use the maximum temperatures in **Error! Reference source not found.**, which apply for Category II limits that would give rise to $PMV = \pm 0.5$ ⁴.

Again, simulation can be used to calculate indoor temperature and the rest of the procedure follows as for free-running buildings.

Table 6-4: Maximum temperatures for different types of indoor space. Clothing is assumed to be 1.0 clo in winter and 0.5 clo in summer (after BS EN 15251 (BSI, 2007), Table A2).

Type and use of space	Assumed met	Winter (clo = 1.0) PMV < +0.5	Summer (clo = 0.5) PMV < +0.5
Residential (sedentary)	1.2	25.0	26.0
Residential (active)	1.5	25.0	
Offices	1.2	24.0	26.0
Public spaces (auditoria, café etc.)	1.2	24.0	26.0
Classrooms	1.2	24.0	26.0
Kindergarten	1.4	22.5	25.5
Shops	1.6	22.0	25.0

⁴ Where the building is occupied, a more realistic estimate can be made of the actual metabolic rate and clothing insulation of the inhabitants to improve the estimate of PMV. For this calculation assume RH = 50%, air velocity = 0 and operative temperature = radiant temperature = air temperature.

6.2 Approach

6.2.1 Thermal Modelling Software

The VE compliance module of IES Virtual Environment version 2023 was used to model the proposed building and establish the regulated Buildings Energy Rate (BER), which is used as the baseline. IES complies with the requirements of the CIBSE AM11, which is BREEAM requirement, and has been validated under the CIBSE TM34 and has been approved by the Department for Communities and Local Government (DCLG) for carrying out Building Regulations Part-L2 calculations.

6.2.2 Methodology

This assessment has analysed the building design is in accordance with the BREEAM criteria. Dynamic thermal modelling (DTM) has been used to show that appropriate comfort levels are achieved throughout the design.

A 3D model of the building has been built using architect's drawings. All building input data, such as fabric U-values, lighting, and HVAC data reflect the design specification and elements. The annual dynamic simulation has been undertaken to determine the building's comfort levels.

As mentioned in the previous section, the following calculations will be undertaken for this report:

- Winter underheating using the TRY weather file.
- Summer overheating using a CIBSE TM52 pDSY1 that models current weather data for the year 2020 high emissions 50 percentile, which is expected to be used for overheating studies rather than the standard DSY weather file.
- Summer overheating using a CIBSE TM52 pDSY2 that models current weather data for the year 2020 high emissions 50 percentile,
- Summer overheating using a CIBSE TM52 pDSY3 that models current weather data for the year 2020 high emissions 50 percentile,

Tottenham Campus building is both naturally/mechanically ventilated and air conditioned therefore, the thermal comfort for all occupied spaces will be assessed against the overheating criteria of CIBSE TM52 and the Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD) indices.

6.2.3 PMV/PPD

The PMV/ PPD system for assessing thermal comfort is described in BS EN ISO 7730:2005. The predicted mean vote (PMV) combines the influence of air temperature, mean radiant temperature, and air movement with that of clothing and activity level into one value on a thermal sensation scale. The PMV is the predicted mean value of the "votes" of a large group of people, exposed to the same environment, and with identical clothing and activity. A negative value vote indicates that the occupants feel cold, and a positive value vote indicated that the occupants feel warm (Table 6-5)

Table 6-5: PMV/PPD Scale.

Scale	Description
+3	Hot
+2	Warm
+1	Slightly warm
0	Neutral
-1	Slightly cool
-2	Cool
-3	Cold

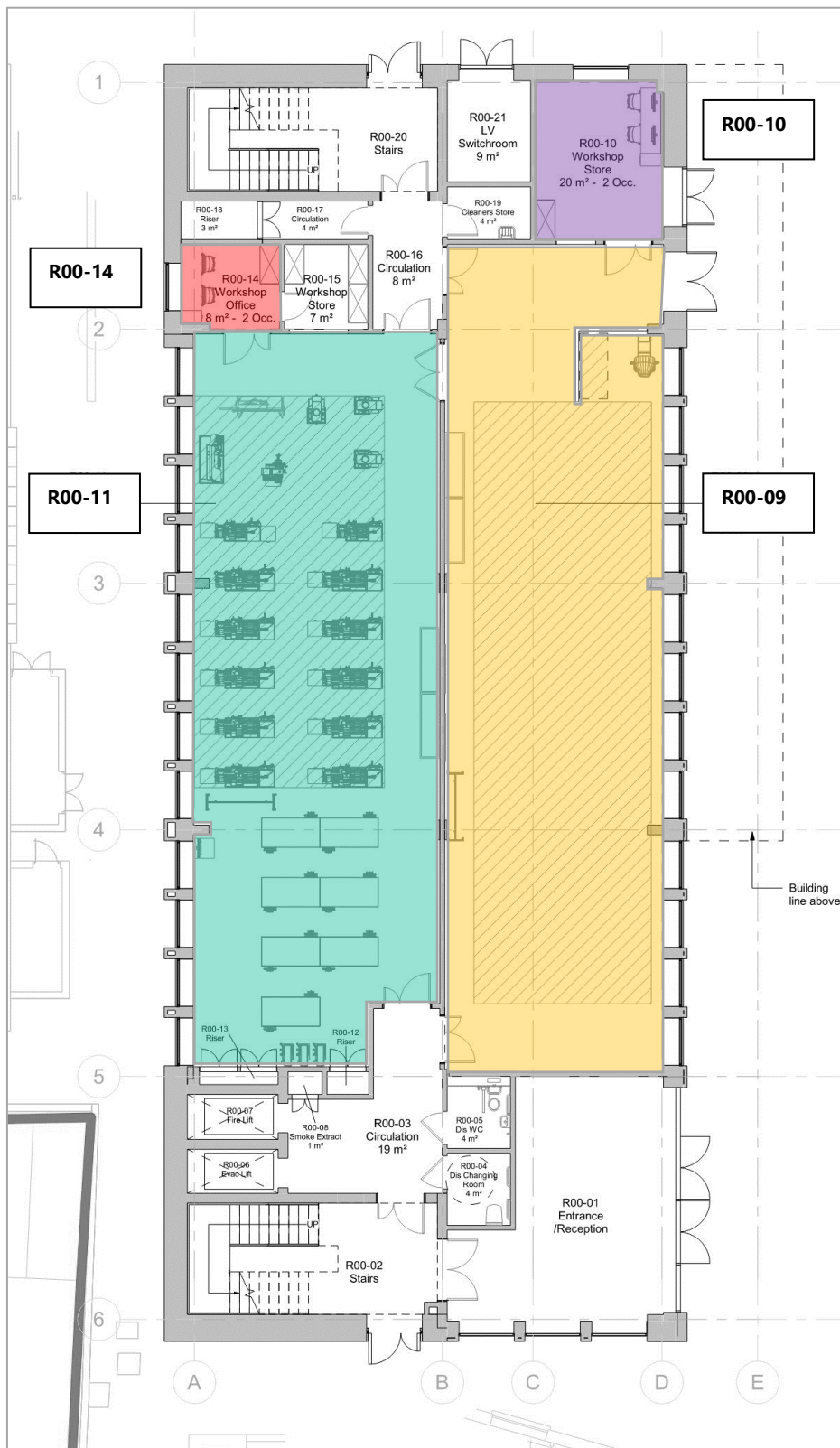
The percentage of people dissatisfied (PPD) is used to predict the percentage of people who would feel too cool or too warm. The equation for deriving the PPD can be found in BS EN ISO 7730:2005. The PPD and PMV vary hour by hour and zone by zone and BS EN ISO 7730:2005, Annex H suggests that one way to assess them over time is to take the average value during occupied hours. Criteria are set for different categories of thermal environment as shown in Table 6-6 below.

Table 6-6: Thermal Comfort Criteria.

Category	PMV	PPD %
A	$-0.2 < \text{PMV} < +0.2$	< 6
B	$-0.5 < \text{PMV} < +0.5$	< 10
C	$-0.7 < \text{PMV} < +0.7$	< 15

6.2.4 Assessment Areas

Ground Floor



First Floor**Rooms:**

- R01-06 General Classroom 01
- R01-08 Electrical Installation Workshop
- R01-09 Workshop Office
- R01-11 Heating & Plumbing Workshop
- R01-14 Workshop Office

Second Floor**Rooms:**

- R02-07 Staff Room 01
- R02-08 Staff Office
- R02-09 ICT 01
- R02-12 ICT 02
- R02-13 General Classroom 02
- R02-14 ICT 03
- R02-15 General Classroom 03

Third Floor



Rooms:

- R03-06 Project Based Learning Space
- R03-08 Engineering and Technology Lab 01
- R03-11 General Classroom 04
- R03-12 Technician Room
- R03-13 Engineering and Technology Lab 02
- R03-14 ICT 04

6.3 Building Input Data

The following section outlines the input data used to carry out the required calculations for the thermal comfort analysis. All building input data, such as fabric U-values, lighting, and HVAC data for retained elements, reflect the existing design specification and elements. The annual dynamic simulation has been undertaken to determine the building's comfort levels.

6.3.1 Geometry Data

The VE compliance module of IES Virtual Environment version 2023 was used to model the existing building and establish the regulated Buildings Energy Rate (BER), which is used as the baseline. IES complies with the requirements of the CIBSE AM11, which is BREEAM requirement, and has been validated under the CIBSE TM34 and has been approved by the Department for Communities and Local Government (DCLG) for carrying out Building Regulations Part-L2 calculations.

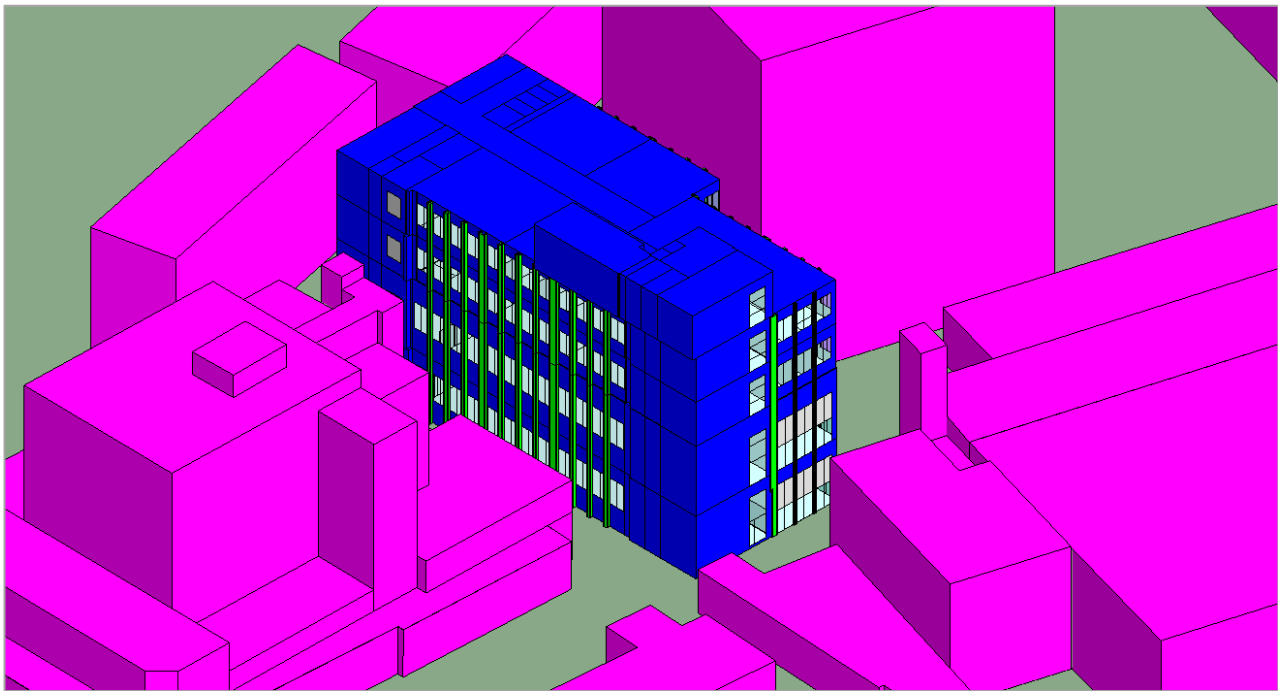


Figure 6-1: Three-dimensional Model of Tottenham Campus - IESVE.

6.3.2 Location and Weather Data

The building is located in London, within the London Borough of Haringey. The model is simulated using the CIBSE London Test Reference Year (London_TRY) for the winter under-heating criteria and London Design Summer Year for the London Weather Centre 2020 high emission 50 percentile (LHR_DSY1 _2020High50), for the summer overheating criteria. For the Design for future thermal comfort credit, the analysis will be carried out using both London LHR DSY-2 for 2020s, High emissions, 50% percentile scenario and London LHR DSY-3 for 2020s, High emissions, 50% percentile scenario.

6.3.3 Proposed Building Inputs

Fabric specifications, Infiltration data and building system inputs adopted for the proposed development are listed in Section 2.

6.3.4 Schedules

The heating/cooling, occupancy and equipment schedules are listed in the following Table 6-7.

Table 6-7: Heating/cooling and Occupancy schedules.

6.3.5 Internal Gains

The internal conditions in each zone have been initially set in accordance with CIBSE guide A (Appendix A). The lighting, occupancy and equipment loads have been afterwards agreed with the MEP engineers. Table 6-8 lists the final inputs adopted.

Table 6-8: Internal Conditions proposed for each room.

Rooms	Lighting Gain (W/m ²)	Occupancy Gain (n. of people)	Equipment Gain (W/m ²)
R00-09_Bricklaying Workshop	9	24	5
R00-10_Workshop Store	7	2**	10
R00-11_Engineering Workshop	9	24	10
R00-14_Workshop Office	7	2**	10
R01-06_General Classroom 01	7	23	10
R01-08_Electrical Installation Workshop	9	24	10
R01-09_Workshop Office	7	2**	25
R01-11_Heating and Plumbing Workshop	9	24	10
R01-14_Workshop Office	7	2**	10
R02-07_Staff Room 01	7	14	20
R02-08_Staff Office	7	2**	5
R02-09_ICT 01	7	23	25
R02-12_ICT 02	7	23	25
R02-13_General Classroom 02	7	23	10
R02-14_ICT 03	7	23	24
R02-15_General Classroom 03	7	23	10
R03-06_Project Base learning Space	7	40	10
R03-08_Engineering and Technology Lab 01	7	23	10
R03-11_General Classroom 04	9	23	10

R03-12_Technician Room	7	2**	25
R03-13_Engineering and Technology Lab 02	9	23	25
R03-14 ICT 04	7	23	25

*Kitchen equipment loads are estimates and should be checked/revised by the manufactures/installers at a later stage.

**Diversity factor of 0.5 applied.

6.3.6 Comfort Criteria: clothing and activity levels

The following Table 6-9 lists the occupied room types identified in the proposed development and the category of thermal environment they will be measured against. All areas are tested against the Category B criteria; normal expectation (for new buildings and renovations). Activity and clothing levels for winter and summer are also provided and are based on the most appropriate data available in CIBSE Guide A Table 1.5 and BS EN ISO 7730:2005.

For the thermal comfort analysis, the activity levels for each room type were set as shown in the table below.

Table 6-9: Activity and Clothing Levels.

Room Type	Category	Winter Activity Levels (Met)	Winter Clothing Levels (Clo)	Summer Activity Levels (met)	Summer Clothing Levels (Clo)
Workshops	B	1.8	0.9	1.8	0.7
Teaching Space	B	1.4	1.0	1.3	0.6
Office	B	1.2	0.9	1.2	0.7

6.3.7 Ventilation Strategies

6.3.7.1 Natural Ventilation

Windows were assumed to be operable or fixed according to the architectural info received. Proposed elevations of Tottenham Campus are shown in Figure 6-2, Figure 6-3 and Figure 6-4.

The following assumptions with regards to the natural ventilation provision were made and implemented in the thermal model:

Operable Windows

- All the operable rooms marked in the elevations are provided with 1500mm restrictors for safety purpose thus the operable area will be restricted.
- Operable windows were modelled as open in accordance with the aperture profiles (Table 6-10)

Non-Operable Windows

- Following the recommendations provided by 24Acoustic in the Noise Assessment Report (January 2024) *-In order to control noise breakout from the proposed workshops, all windows and external doors to the workshops shall be kept closed whilst in-use, with a mechanical ventilation strategy in place, and cooling as required* – the windows serving the workshop rooms will not be operable during the occupancy hours, therefore an adequate ventilation rate will be proposed for those rooms.
- Glazed fixed panels were modelled as always closed according to the architectural design.
- Windows serving the ground floor rooms won't operate night ventilation due to security and safety.

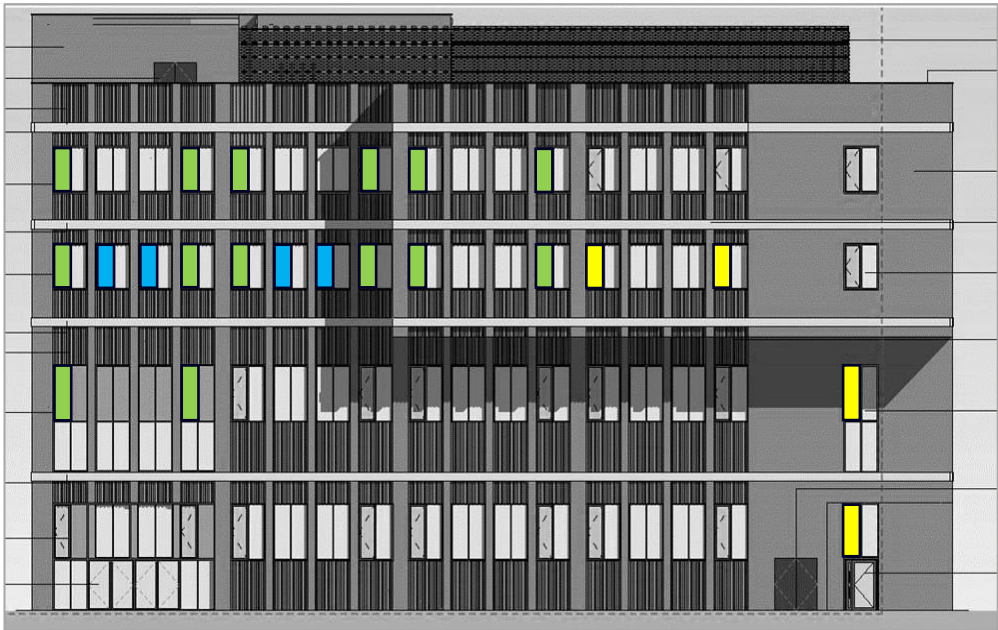


Figure 6-2: Tottenham Campus East Elevation.



Figure 6-3: Tottenham Campus West Elevation.

Table 6-10: Window Typologies reference.

	Typology1: Operable Window with 150 mm restrictor		Typology 2: Operable Window with 150 mm restrictor providing night ventilation.
	<i>Profile: (Ta>To) & (Ta>22)</i>		<i>Profile: (Ta>To) & (Ta>22)</i>
	<i>9am to 9pm (Monday to Saturday)</i>		<i>9am to 9pm (Monday to Saturday)</i>
	<i>9am to 5pm (Friday & Saturday)</i>		<i>9am to 5pm (Friday & Saturday)</i>
			<i>Night ventilation: max aperture</i>
	Additional operable windows recommended same as typology 2.		

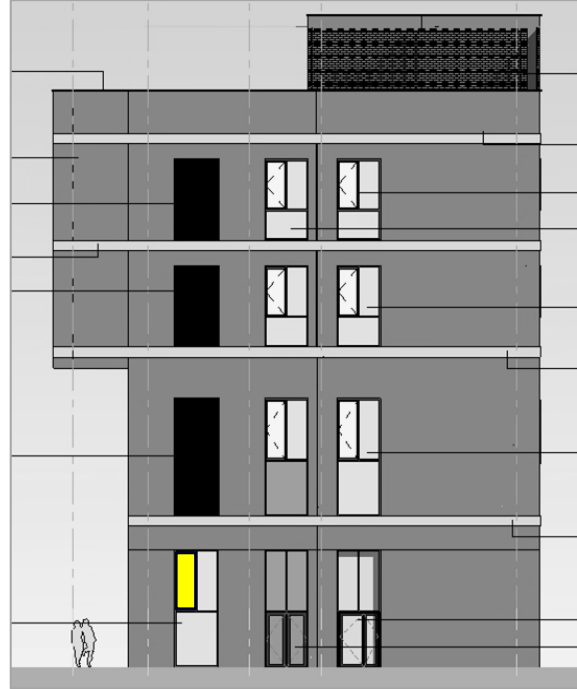


Figure 6-4: Tottenham Campus North & South Elevation.



Typology 1: Operable Window with 150 mm restrictor

Profile: $(T_a > T_o)$ & $(T_a > 22)$

9am to 9pm (Monday to Saturday)

9am to 5pm (Friday & Saturday)



Additional operable windows recommended same as typology 2.



Typology 2: Operable Window with 150 mm restrictor providing night ventilation.

Profile: $(T_a > T_o)$ & $(T_a > 22)$

9am to 9pm (Monday to Saturday)

9am to 5pm (Friday & Saturday)

Night ventilation: max aperture

6.3.7.2 Mechanical Ventilation

The ventilation rates proposed for the areas of the scope are shown in the Table 6-11 below.

Table 6-11: Summer and Winter Ventilation Rate.

	Ventilation Supply & extract (l/s/person) summer	Ventilation Supply & extract (l/s/person) winter	Ventilation Supply Temperature – Winter (°C)	Ventilation Supply Temperature – Summer (°C)
R00-09_Bricklaying Workshop	8 l/s/p/14 l/s/p max	2.5 l/(s*m2)	External Air	Tempered air at 16 degrees
R00-10_Workshop Store	8 l/s/p/14 l/s/p max	8l/s/p	External Air	Tempered air at 16 degrees
R00-11_Engineering Workshop	8 l/s/p/14 l/s/p max	2.5 l/(s*m2)	External Air	Tempered air at 16 degrees
R00-14_Workshop Office	8 l/s/p/14 l/s/p max	8 l/s/p	External Air	Tempered air at 16 degrees
R01-06-General Classroom 01	8 l/s/p/14 l/s/p max	8 l/s/p	External Air	Tempered air at 16 degrees
R01-08_Electrical Installation Workshop	8 l/s/p/14 l/s/p max	2.5 l/(s*m2)	External Air	Tempered air at 16 degrees
R01-09_Workshop Office	8 l/s/p/14 l/s/p max	8 l/s/p	External Air	Tempered air at 16 degrees
R01-11_Heating and Plumbing Workshop	8 l/s/p/14 l/s/p max	2.5 l/(s*m2)	External Air	Tempered air at 16 degrees
R01-14_Workshop Office	8 l/s/p/14 l/s/p max	8 l/s/p	External Air	Tempered air at 16 degrees
R02-07-Staff Room 01	8 l/s/p/14 l/s/p max	8 l/s/p	External Air	Tempered air at 16 degrees
R02-08_Staff Office	8 l/s/p/14 l/s/p max	8 l/s/p	External Air	Tempered air at 16 degrees
R02-09_ICT 01	8 l/s/p/14 l/s/p max	14 l/s/p	Tempered air at 16 degrees	Tempered air at 16 degrees
R02-12_ICT 02	8 l/s/p/14 l/s/p max	14 l/s/p	Tempered air at 16 degrees	Tempered air at 16 degrees
R02-14_ICT 03	8 l/s/p/14 l/s/p max	14 l/s/p	Tempered air at 16 degrees	Tempered air at 16 degrees
R02-13_General Classroom 02	8 l/s/p/14 l/s/p max	8 l/s/p	External Air	Tempered air at 16 degrees
R02-15_General Classroom 03	8 l/s/p/14 l/s/p max	8 l/s/p	External Air	Tempered air at 16 degrees
R03-06_Project Base learning Space	8 l/s/p/14 l/s/p max	8 l/s/p	External Air	Tempered air at 16 degrees
R03-08_Engineering and Technology Lab 01	8 l/s/p/14 l/s/p max	14 l/s/p	Tempered air at 16 degrees	Tempered air at 16 degrees

R03-11_General Classroom 04	8 l/s/p/14 l/s/p max	8 l/s/p	External Air	Tempered air at 16 degrees
R03-12_Technician Room	8 l/s/p/14 l/s/p max	8 l/s/p	External Air	Tempered air at 16 degrees
R03-13_Engineering and Technology Lab 02	8 l/s/p/14 l/s/p max	14 l/s/p	Tempered air at 16 degrees	Tempered air at 16 degrees
R03-14_ICT 04	8 l/s/p/14 l/s/p max	14 l/s/p	Tempered air at 16 degrees	Tempered air at 16 degrees

Ventilation Profiles

The Ventilation Profiles adopted in the summer assessment are listed in the Table 6-12 below.

Table 6-12: Variation Profile of the Ventilation rates.

	Summer Ventilation Profile	Winter Ventilation Profile
R00-09_Bricklaying Workshop	2.5 l/(s*m2) 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)	2.5 l/(s*m2) 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R00-10_Workshop Store	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday) & 14lsp during peak hours (12pm to 5pm Monday to Saturday)	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R00-11_Engineering Workshop	2.5 l/(s*m2) 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)	2.5 l/(s*m2) 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R00-14_Workshop Office	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday) & 14lsp during peak hours (12pm to 5pm Monday to Saturday)	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R01-06-General Classroom 01	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday) & 14lsp during peak hours (12pm to 5pm Monday to Saturday)	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R01-08_Electrical Installation Workshop	2.5 l/(s*m2) 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)	2.5 l/(s*m2) 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R01-09_Workshop Office	8 l/s/p 9am to 9pm (Mond - Thursday)	8 l/s/p 9am to 9pm (Mond - Thursday)

	9am-5pm (Friday - Saturday)	9am-5pm (Friday - Saturday)
R01-11_Heating and Plumbing Workshop	2.5 l/(s*m2) 7am to 9pm (Mond - Thursday) 7am-5pm (Friday - Saturday)	2.5 l/(s*m2) 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R01-14_Workshop Office	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday) & 14lsp during peak hours (12pm to 5pm Monday to Saturday)	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R02-07-Staff Room 01	14 l/s/p 7am to 9pm (Mond - Thursday) 7am-5pm (Friday - Saturday)	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R02-08_Staff Office	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday) & 14lsp during peak hours (12pm to 5pm Monday to Saturday)	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R02-09_ICT 01	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)	14 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R02-12_ICT 02	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)	14 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R02-14_ICT 03	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)	14 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R02-13_General Classroom 02	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R02-15_General Classroom 03	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R03-06_Project Base learning Space	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R03-08_Engineering and Technology Lab 01	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)	14 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)

R03-11_General Classroom 04	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R03-12_Technician Room	14 l/s/p 7am to 9pm (Mond - Thursday) 7am-5pm (Friday - Saturday)	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R03-13_Engineering and Technology Lab 02	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)	14 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)
R03-14_ICT 04	8 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)	14 l/s/p 9am to 9pm (Mond - Thursday) 9am-5pm (Friday - Saturday)

6.3.8 Heating and Cooling Strategy

Heating will be produced via 2 air source heat pumps operating in reversible heating and cooling changeover. Since the building is well insulated and can utilise openable windows in mid-season the building is unlikely to require simultaneous heating and cooling. Heating and cooling will be distributed to the classrooms via VAV duct system with terminal heater battery. The ducted cooling is tempered air only designed to prevent overheating, not to air condition the rooms. Rooms with higher heat gains such as ICT rooms will require fan coil units to supplement the VAV cooling. The workshops require unit heaters to achieve heat distribution to low level because of their high volume.

6.4 Results

6.4.1 Thermal Comfort Results

6.4.1.1 Winter Thermal Comfort

Operative temperature Ranges

Table 6-13 below includes results obtained for all assessed spaces falling under the BREEAM HEA04 definition of "occupied space". Average operative temperature results (during occupied hours only) during winter period, have been extracted for each space and shows that all spaces meet the recommended CIBSE Guide A winter temperature ranges. The analysis has been performed using LondonTRY05.fwt weather file.

Table 6-13: Operative Temperature Results for Winter Underheating.

Thermal Zone	Heating Setpoint (°C)	Recommended CIBSE Guide A Winter Operative Temperature (°C)	Average Operative Temperature (°C)	Compliance with CIBSE Guide A
R00-09_Bricklaying Workshop	18	$16^{\circ}\text{C} \leq T_{\text{op}} \leq 19^{\circ}\text{C}$	18.60	Yes
R00-10_Workshop Store	21	$21^{\circ}\text{C} \leq T_{\text{op}} \leq 23^{\circ}\text{C}$	20.88*	Yes
R00-11_Engineering Workshop	18	$16^{\circ}\text{C} \leq T_{\text{op}} \leq 19^{\circ}\text{C}$	18.88	Yes
R00-14_Workshop Office	21	$21^{\circ}\text{C} \leq T_{\text{op}} \leq 23^{\circ}\text{C}$	20.90*	Yes
R01-06-General Classroom 01	21	$19^{\circ}\text{C} \leq T_{\text{op}} \leq 21^{\circ}\text{C}$	21.35*	Yes
R01-08_Electrical Installation Workshop	18	$16^{\circ}\text{C} \leq T_{\text{op}} \leq 19^{\circ}\text{C}$	19.11*	Yes
R01-09_Workshop Office	21	$21^{\circ}\text{C} \leq T_{\text{op}} \leq 23^{\circ}\text{C}$	20.94*	Yes
R01-11_Heating and Plumbing Workshop	18	$16^{\circ}\text{C} \leq T_{\text{op}} \leq 19^{\circ}\text{C}$	19.12*	Yes
R01-14_Workshop Office	21	$21^{\circ}\text{C} \leq T_{\text{op}} \leq 23^{\circ}\text{C}$	21.02	Yes
R02-07-Staff Room 01	21	$21^{\circ}\text{C} \leq T_{\text{op}} \leq 23^{\circ}\text{C}$	22.73	Yes
R02-08_Staff Office	21	$21^{\circ}\text{C} \leq T_{\text{op}} \leq 23^{\circ}\text{C}$	21.28	Yes
R02-13_General Classroom 02	19	$19^{\circ}\text{C} \leq T_{\text{op}} \leq 21^{\circ}\text{C}$	21.34*	Yes
R02-15_General Classroom 03	19	$19^{\circ}\text{C} \leq T_{\text{op}} \leq 21^{\circ}\text{C}$	21.22*	Yes
R03-06_Project Base learning Space	19	$19^{\circ}\text{C} \leq T_{\text{op}} \leq 21^{\circ}\text{C}$	20.52	Yes
R03-11_General Classroom 04	19	$19^{\circ}\text{C} \leq T_{\text{op}} \leq 21^{\circ}\text{C}$	20.83	Yes
R03-12_Technician Room	21	$21^{\circ}\text{C} \leq T_{\text{op}} \leq 23^{\circ}\text{C}$	22.51	Yes

*The winter operative temperatures areas slightly fall out of the recommended CIBSE Guide A winter ranges, yet this is acceptable. According to CIBSE Guide A (also mentioned in Section 3.3), the daily mean operative temperature for comfort (the current comfort temperature) is likely to be somewhere within the ranges given. A variation of $\pm 1\text{K}$ within the day would attract little notice, while a variation of $\pm 2\text{K}$ would be noticed and might cause some complaint at the extremes. More active people are more tolerant of temperature variations.

PMV-PPD Indices

Table 6-14 presents the results for PPD and PMV values during winter months (January-April and October-December) and shows that all spaces comply with the PMV/PPD scale system. The analysis has been performed using London_TRY.epw weather file.

Table 6-14: PMV/PPD Results for Winter Underheating.

Thermal Zone	Heating Setpoint (°C)	PMV	PPD	Compliance with CIBSE Guide A
R02-09_ICT 01	20	0.09	6.40	Yes
R02-12_ICT 02	20	0.09	6.41	Yes
R02-14_ICT 03	20	0.09	6.45	Yes
R02-14_ICT 04	20	0.03	5.74	Yes
R02-08_Engineering and Technology Lab 01	20	0.02	5.65	Yes
R02-13_Engineering and Technology Lab 02	20	0.09	6.45	Yes

6.4.1.2 Summer Thermal Comfort

Operative Temperature ranges

Table 6-15 below includes results obtained for all assessed spaces falling under the BREEAM HEA04 definition of "occupied space". Average operative temperature results (during occupied hours only) during summer period, have been extracted for each space and shows that all spaces are compliant with CIBSE TM52 criteria. The analysis has been performed using London_LHR_DSY1_2020High50.epw weather file.

Table 6-15: Operative Temperature Results for Summer Overheating.

Space	Criterion 1 - Hours of exceedance <i>Target < 3%</i>	Criterion 2 - Daily weighted exceedance <i>Target < 6</i>	Criterion 3 - Upper limit temperature <i>Target < 4</i>	Criteria Failing	Overall Pass/Fail
R00-09_Bricklaying Workshop	0	0	0	-	Pass
R00-10_Workshop Store	1	7	1	2	Pass
R00-11_Engineering Workshop	0.1	1	1	-	Pass
R00-14_Workshop Office	0	0	0	-	Pass
R01-06-General Classroom 01	0.1	1	1	-	Pass
R01-08_Electrical Installation Workshop	0	0	0	-	Pass
R01-09_Workshop Office	1	6	1	-	Pass
R01-11_Heating and Plumbing Workshop	1.1	2	1	-	Pass

R01-14_Workshop Office	0.9	4	1	-	Pass
R02-07_Staff Room 01	0.6	5	1	-	Pass
R02-08_Staff Office	0.1	1	1	-	Pass
R02-13_General Classroom 02	0.3	3	1	-	Pass
R02-15_General Classroom 03	0.6	5	1	-	Pass
R03-06_Project Base learning Space	0	0	0	-	Pass
R03-11_General Classroom 04	0	0	0	-	Pass
R03-12_Technician Room	1.4	7	2	2	Pass

PMV/PPD Indices

Table 6-16 presents the results for PPD and PMV values during summer months (May-September) and shows that all spaces comply with the PMV/PPD scale system. The analysis has been performed using London_LHR_DSY1_2020High50.epw weather file.

Table 6-16: PMV/PPD Results for Summer Overheating.

Thermal Zone	Cooling Setpoint (°C)	PMV	PPD	Compliance with CIBSE Guide A
R02-09_ICT 01	24	0.23	6.37	Yes
R02-12_ICT 02	24	0.22	6.24	Yes
R02-14_ICT 03	24	0.23	6.38	Yes
R02-14_ICT 04	24	0.17	5.90	Yes
R02-08_Engineering and Technology Lab 01	24	0.17	6.04	Yes
R02-13_Engineering and Technology Lab 02	24	0.21	6.21	Yes

6.5 Projected Climate Change Scenario

Under the DSY2 weather file scenario, results indicate that all assessed occupied spaces meet the PMV-PPD recommended ranges under Category B and CIBSE TM52 criteria.

Operative Temperature Ranges DSY2

Table 6-17 below includes results obtained for all assessed spaces falling under the BREEAM HEA04 definition of "occupied space". Average operative temperature results (during occupied hours only) during summer period, have been extracted for each space and shows that all spaces are compliant with CIBSE TM52 criteria. The analysis has been performed using London_LHR_DSY2_2020High50.epw weather file.

Table 6-17: Operative Temperature for Summer Overheating DSY2.

Space	Criterion 1 - Hours of exceedance <i>Target < 3%</i>	Criterion 2 - Daily weighted exceedance <i>Target < 6</i>	Criterion 3 - Upper limit temperature <i>Target < 4</i>	Criteria Failing	Overall Pass/Fail
R00-09_Bricklaying Workshop	0	0	0	-	Pass
R00-10_Workshop Store	2.3	17	2	2	Pass
R00-11_Engineering Workshop	0.4	2	1	-	Pass
R00-14_Workshop Office	0	0	0	-	Pass
R01-06-General Classroom 01	0.9	12	2	2	Pass
R01-08_Electrical Installation Workshop	0.4	6	1	-	Pass
R01-09_Workshop Office	2.1	10	1	2	Pass
R01-11_Heating and Plumbing Workshop	1.5	5	1	-	Pass
R01-14_Workshop Office	0.7	5	1	-	Pass
R02-07-Staff Room 01	1.4	14	2	2	Pass
R02-08_Staff Office	1.1	23	4	2	Pass
R02-13_General Classroom 02	1	8	1	2	Pass
R02-15_General Classroom 03	0.4	3	1	-	Pass
R03-06_Project Base learning Space	0.8	11	1	2	Pass
R03-11_General Classroom 04	0.4	6	1	-	Pass
R03-12_Technician Room	1.4	5	1	-	Pass

PMV/PPD Indices DSY2

Table 6-18 presents the results for PPD and PMV values during summer months (May-September) and shows that all spaces comply with the PMV/PPD scale system. The analysis has been performed using London_LHR_DSY2_2020High50.epw weather file.

Table 6-18: PMV/PPD Results for Summer Overheating DSY2.

Thermal Zone	Cooling Setpoint (°C)	PMV	PPD	Compliance with CIBSE Guide A
R02-09_ICT 01	24	$20^{\circ}\text{C} \leq T_{\text{op}} \leq 25^{\circ}\text{C}$	21.34	Yes
R02-12_ICT 02	24	$20^{\circ}\text{C} \leq T_{\text{op}} \leq 25^{\circ}\text{C}$	20.97	Yes
R02-14_ICT 03	24	$20^{\circ}\text{C} \leq T_{\text{op}} \leq 25^{\circ}\text{C}$	21.33	Yes
R02-14_ICT 04	24	$20^{\circ}\text{C} \leq T_{\text{op}} \leq 25^{\circ}\text{C}$	20.97	Yes
R02-08_Engineering and Technology Lab 01	24	$20^{\circ}\text{C} \leq T_{\text{op}} \leq 25^{\circ}\text{C}$	21.29	Yes
R02-13_Engineering and Technology Lab 02	24	$20^{\circ}\text{C} \leq T_{\text{op}} \leq 25^{\circ}\text{C}$	21.29	Yes

Operative Temperature Ranges DSY3

Under the DSY3 weather file scenario, results shown in Table 6-19 indicate that all assessed occupied spaces meet the PMV-PPD recommended ranges under Category B and CIBSE TM52 criteria.

Table 6-19: Operative Temperature for Summer Overheating DSY3.

Space	Criterion 1 - Hours of exceedance <i>Target < 3%</i>	Criterion 2 - Daily weighted exceedance <i>Target < 6</i>	Criterion 3 - Upper limit temperature <i>Target < 4</i>	Criteria Failing	Overall Pass/Fail
R00-09_Bricklaying Workshop	0	0	0	-	Pass
R00-10_Workshop Store	2.6	10	2	2	Pass
R00-11_Engineering Workshop	0.8	2	1	-	Pass
R00-14_Workshop Office	0	0	0	-	Pass
R01-06-General Classroom 01	0.9	6	2	-	Pass
R01-08_Electrical Installation Workshop	0.1	1	1	-	Pass
R01-09_Workshop Office	1.9	7	1	2	Pass
R01-11_Heating and Plumbing Workshop	2	6	2	-	Pass
R01-14_Workshop Office	2.6	9	2	2	Pass
R02-07-Staff Room 01	2.9	11	2	2	Pass

R02-08_Staff Office	1.3	10	2	2	Pass
R02-13_General Classroom 02	1.5	7	1	2	Pass
R02-15_General Classroom 03	0.4	3	1	-	Pass
R03-06_Project Base learning Space	1.7	10	1	2	Pass
R03-11_General Classroom 04	0.8	5	1	-	Pass
R03-12_Technician Room	2.3	9	2	2	Pass

PMV/PPD Indices DSY2

Table 6-20 presents the results for PPD and PMV values during summer months (May-September) and shows that all spaces comply with the PMV/PPD scale system. The analysis has been performed using London_LHR_DSY3_2020High50.epw weather file.

Table 6-20: PMV/PPD Results for Summer Overheating DSY3.

Thermal Zone	Cooling Setpoint (°C)	PMV	PPD	Compliance with CIBSE Guide A
R02-09_ICT 01	24	0.22	6.30	Yes
R02-12_ICT 02	24	0.21	6.17	Yes
R02-14_ICT 03	24	0.22	6.31	Yes
R02-14_ICT 04	24	0.15	5.88	Yes
R02-08_Engineering and Technology Lab 01	24	0.14	6.07	Yes
R02-13_Engineering and Technology Lab 02	24	0.19	6.16	Yes

6.6 Thermal Zoning and Controls

Credit is pending.

The heating, cooling and ventilation layouts are in progress and will be added in the next revision of the report to satisfy the third credit requirements.

7 Conclusion

This document has been prepared by Introba on behalf of Capital City College Group ('the Applicant') in support of the application for full planning permission for the development of the Tottenham Campus ('the Site').

The report focuses on the assessment of BREEAM UK NC Version 6 (2022) credits, in particular EN01(Reduction of energy use and carbon emissions), ENE04 (Passive Design credit and Low and Zero Carbon Technology credit), HEA01 (Daylighting) and HEA04 (Thermal Comfort).

The following credits have been targeted for the development of Tottenham Campus:

1. **BREEAM NC ENE01** Reduction of energy use and carbon emissions:
 - a. CCCG Tottenham: **8 credits** awarded.
2. **BREEAM NC ENE04**
 - a. CCCG Tottenham: **2 credits** awarded.
3. **BREEAM NC HEA01**
 - a. CCCG Tottenham: **0 credits** awarded.
4. **BREEAM NC HEA04**
 - a. CCCG Tottenham: **2 credits** awarded.

8 Appendix A: Policy Requirements

8.1 Legislative and Policy Requirements

The proposed development was assessed in accordance with the following legislations and policies during RIBA Stage 2, the key aspects of which are then described further below:

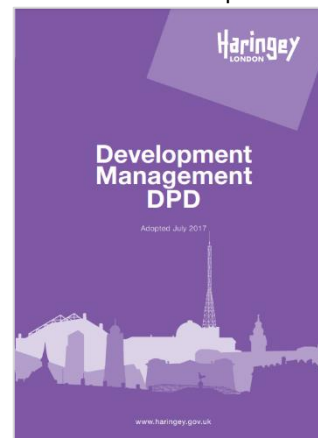
1. The Local Plan – Development Management DPD (July 2017)
2. The London Plan (March 2021)
3. Mayor of London's Energy Assessment Guidance (June 2022)
4. Climate Change Act 2008 (2008)
5. National Planning Policy Framework (2023)
6. Building Regulations

8.1.1 Local Policy Drivers

8.1.1.1 Local Plan – Development Management DPD, July 2017

All new development, including building and landscape works, will be expected to consider and implement sustainable design, layout, and construction techniques. Proposals should:

- a) Apply the energy hierarchy to minimise energy use in order to meet, and if possible exceed, minimum carbon dioxide reduction requirements;
- b) Apply cooling hierarchy to reduce the potential for overheating and limit reliance on mechanical air conditioning systems.
- c) Maximise opportunities to enhance biodiversity on-site, including through appropriate landscaping, Sustainable Drainage Systems, living roofs and green walls.
- d) Wherever possible, use building materials with high environmental performance ratings; and
- e) Seek opportunities for locally sourced labour.



8.1.2 Regional Policy Drivers

8.1.2.1 The London Plan (2021)

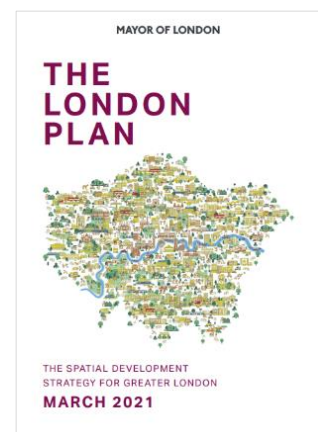
Policy GG6: Increasing efficiency and resilience

To help London become a more efficient and resilient city, those involved in planning and development must:

- A. Seek to improve energy efficiency and support the move towards a low carbon circular economy, contributing towards London becoming a zero-carbon city by 2050.

Policy SI1: Improving air quality.

- A. Development plans should seek opportunities to identify and deliver further improvements to air quality and should not reduce air quality benefits that result from the Mayor's or boroughs' activities to improve air quality.



- B. Describes what development proposals should not do, in order to 'tackle poor air quality, protect health and meet legal obligations....'
- C. 'Masterplans and development briefs for large-scale development proposals subject to an Environmental Impact Assessment should consider how local air quality can be improved...'
- D. In order to reduce the impact on air quality during construction and demolition phase development proposals must demonstrate how they plan to comply with the non-road mobile machinery low emission zone to reduce emissions from the demolition and construction of buildings following best practice guidance.
- E. 'Development proposals should ensure that where emissions need to be reduced to meet the requirements of Air Quality Neutral or to make the impact of development on local air quality acceptable, this is done on site.' It also describes when off-site measures may be appropriate.

Policy SI2: Minimising greenhouse gas emissions

- A. Major developments should be net zero-carbon. This means reducing greenhouse emissions in operation and minimising both annual and peak energy demand in accordance with the following energy hierarchy:

1. **Be Lean:** use less energy and manage demand during operation.
2. **Be Clean:** exploit local energy resources and supply energy efficiently and cleanly.
3. **Be Green:** maximise opportunities for renewable energy by producing, storing, and using renewable energy on-site.
4. **Be Seen:** monitor, verify and report on energy performance.

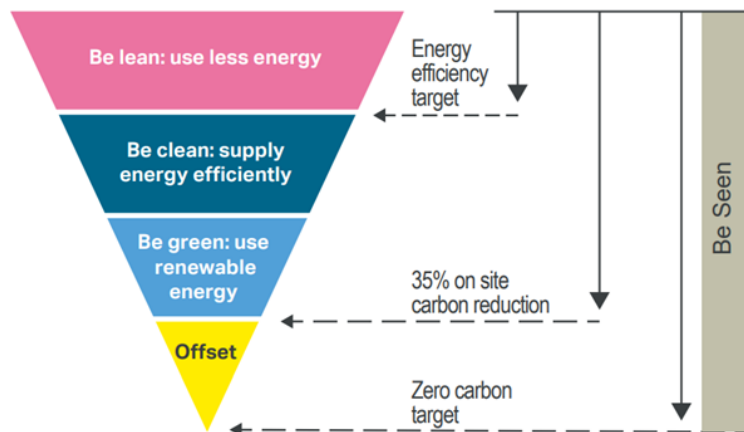


Figure 8.1: The Energy Hierarchy and associated targets (The London Plan 2021)

- B. Major development proposals should include a detailed energy strategy to demonstrate how the zero-carbon target will be met within the framework of the energy hierarchy.
- C. A minimum on-site reduction of at least 35 per cent beyond Building Regulations is required for major developments. Residential development should achieve 10 per cent, and non-residential development should achieve 15 per cent through energy efficiency measures. Where it is clearly demonstrated that the zero-carbon target cannot be fully achieved on-site, any shortfall should be provided.
- D. Boroughs must establish and administer a carbon offset fund.
- E. Major development proposals should calculate and minimise carbon emissions from any other part of the development, including plant or equipment that are not covered by Building Regulations, i.e. unregulated emissions.
- F. Development proposals referable to the Mayor should calculate whole life-carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.

Policy SI3: Energy Infrastructure

- A. Boroughs and developers should engage at an early stage with relevant energy companies and bodies to establish the future energy and infrastructure requirements arising from large-scale development proposals such as Opportunity Areas, Town Centres, other growth areas or clusters of significant new developments.
- B. Energy masterplans should be developed for large-scale development locations which establish the most effective energy supply options. The requirements for such masterplans are set out.
- C. Development plans should:

1. Identify the need for any energy infrastructure requirements including energy centres, energy storage and upgrades to existing infrastructure.
 2. Identify existing heating and cooling networks, identify proposed locations for future heating and cooling networks and identifying opportunities for expanding and inter-connecting existing networks as well as establishing new networks.
- D. Major developments proposals within Heat Network Priority Areas should have a communal low-temperature heating system:
1. The heat source for the communal heating system should be selected in accordance with the following heating hierarchy:
 - i. Connect to local existing or planned heat networks
 - ii. Use zero-emission or local secondary heat sources (in conjunction with heat pumps, if required)
 - iii. 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)
 - iv. Use ultra-low NOx gas boiler
 2. CHP and ultra-low NOx gas boiler communal or district heating systems should be designed to ensure that they meet the requirements in Part B of 'Policy SI 1 Improving air quality'.
 3. Where a heat network is planned but not yet in existence the development should be designed to allow for the cost-effective connection at a later date.
- E. Heat networks should achieve good practice design and specification standards for primary, secondary and tertiary systems comparable to those set out in the CIBSE/ADE Code of Practice CP1 or equivalent.

Policy SI4: Managing heat risk

- A. Development proposals should minimise adverse impacts on the urban heat island through design, layout, orientation, materials, and the incorporation of green infrastructure.
- B. 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:
 - a. Reduce the amount of heat entering a building through orientation, shading, high albedo materials, fenestration, insulation, and the provision of green infrastructure.
 - b. Minimise internal heat generation through energy efficient design
 - c. Manage the heat within the building through exposed internal thermal mass and high ceilings
 - d. Provide passive ventilation
 - e. Provide mechanical ventilation
 - f. Provide active cooling systems

8.1.2.2 The Mayor of London's Energy Assessment Guidance (June 2022)

This document sets out the purpose, structure and content of energy assessments. This must include those matters set out in para 1.7 of the guidance. Major developments are required to achieve net zero-carbon by following the energy hierarchy (The London Plan, Policy SI 2). This means that regulated carbon emissions should be reduced so they are as close as possible to zero. Once on-site reductions have been maximised, the residual emissions should be offset via a payment into the relevant borough's carbon offset fund.

Major developments are required to achieve a minimum 35 per cent on-site carbon reduction over Part L 2021. Residential developments are expected to be able to exceed this, and so an additional benchmark has been set that residential developments should be aiming to achieve over 50 per cent.

8.1.3 National Legislative and Policy Drivers

8.1.3.1 Climate Change Act 2008

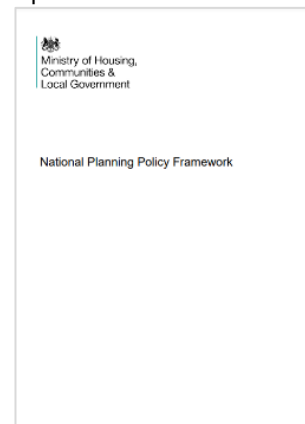
The Climate Change Act (2008) (as amended) sets a legally binding target to reduce UK carbon emissions by 100% by 2050, against a 1990 baseline. The Committee on Climate Change advises the Government on the setting of binding 5-year carbon budgets on a pathway to achieving the 2050 target. The first six carbon budgets covering the period up to 2037 have been set in law. The current budget requires a 29% emissions reduction by 2017, while future budgets require reductions of 35% by 2020 and 50% by 2025.

The Act is the driver behind a framework of national strategy and policy documents such as the UK Low Carbon Transition Plan (2009) and previously anticipated zero carbon homes policy. These in turn have informed the development of local planning policy and updates to the Building Regulations.

8.1.3.2 National Planning Policy Framework (NPPF), 2023

The NPPF requires that plans take a proactive approach to mitigating and adapting to climate change considering, among others, the risk of overheating from rising temperatures. To help increase the use and supply of renewable and low carbon energy and heat, plans should:

- Provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);
- Consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and
- Identify opportunities for the development to draw its energy supply from decentralised, renewable or low carbon energy supply systems and for co-locating potential heat customers and suppliers.



8.2 Building Regulations Part L 2021 and SAP10.2

Part L of the Building Regulations in England sets standards for the energy performance of new and existing buildings; the current version is Part L 2021.

As of June 2022, the latest Part L Building Regulations was published which includes two main criteria, carbon emission and primary energy. The carbon emission criteria are in line with SAP10.2 as published by the BRE. The key changes are the further adjustment of the carbon factors of electricity and (to a lesser extent) natural gas, as shown in the table below, along with the newly introduced primary energy factors.

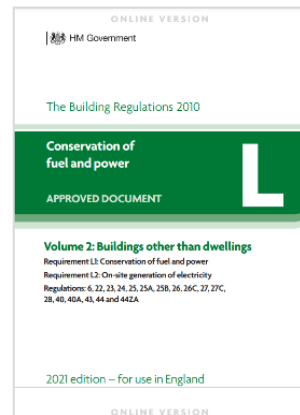


Table 8.1: Part L 2021 carbon emission and primary energy factors

	Emission Factor kgCO ₂ /kWh	Primary Energy Factor kWh _{PE} /kWh
Grid Electricity (kgCO₂/kWh)	0.136	1.501
Natural Gas (kgCO₂/kWh)	0.210	1.126

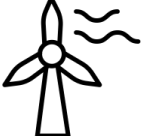
8.3 Appendix B: LZC Technology Options

Low and Zero Carbon (LZC) technologies that could be used for this development were evaluated and the results of the analysis showed that Air Source Heat Pumps (ASHPs) are the most appropriate technology for space heating, cooling, and Domestic Hot Water (DHW) for the building, along with PV panels.

The table below lists all the technologies reviewed:

Table 8.2: LZC technology feasibility for the Site.

LZC technology	Technically feasible	Recommended	Comments
ASHP 	Yes	Yes	Technically feasible on the site and highly efficient system – it will be used for heating, cooling and DHW for the whole building.
WSHP 	Yes	No	There is no sizeable water body in close proximity to the site.
Biomass 	No	No	Biomass heating will negatively impact air quality and the site doesn't have any capacity to store the fuel.
CHP 	Yes	No	No carbon savings due to decarbonisation of UK electricity grid.
GSHP 	No	No	This option is not feasible for the site.
Hydrogen Technology 	No	No	Technology not yet economically viable.
PV 	Yes	Yes	The PV area has been maximized on the building's rooftops. PV panels will be installed on the top floor roofs. Section 7.3 of the Energy Report shows the PV assessment in more detail.
Solar thermal	Yes	No	The use of this technology can be further investigated during detailed design stages to assess any possibility of installation.

			
Tri-Generation 	No	No	Structural limitations, height issues.
Wind Power 	No	No	Not viable due to the urban nature of the development and the historic setting surrounding the Site.

