BURO HAPPOLD

Sister Manchester, Plot H
Operational Energy Report

SISPH-BHE-ZZ-ZZ-RP-SU-00003– TM54 Report

066862

16 January 2026

Revision P01

Copyright © 1976 - 2026 Buro Happold. All rights reserved

Revision	Description	Issued by	Date	Checked
P01	Issue for planning	KD	19/01/26	MP

Report Disclaimer

This Report was prepared by Buro Happold Limited ("BH") in accordance with, and remains subject to, the terms of BH's appointment for the benefit of RG Group in relation to Planning Issue. BH responsibility shall be limited to the purpose for which this Report was prepared, with BH assuming no liability for any reliance placed on this Report by any third party.

Notwithstanding the foregoing, the content of this Report shall remain subject to the following:

1. This Report is based upon the information and knowledge available to BH at the time of writing and, unless otherwise expressly stipulated herein, BH has not sought to verify or validate any data received by BH and/or which may underpin this Report.
2. BH assumes no ownership nor liability in respect of any third-party design, workmanship and/or deliverables, and shall not be held responsible for the consequences of any negligence, error or omission in respect of the same.
3. BH does not guarantee any particular outcome, nor does BH provide any warranty in respect of any third-party services, equipment requirements and/or software and is not responsible for the outcome or use of the same; regardless of whether the content of this Report is followed.
4. This Report shall not be construed as investment or financial advice.

author	**Kostas Doumanoglou**
date	**16/01/2026**
approved	**Matteo Policella**
signature	[redacted]
date	**16/01/2026**

..

Copyright © 1976 - 2026 Buro Happold. All rights reserved

Contents

1 Executive Summary **5**

1.1 Operational Energy Estimate 5

1.2 Risks 5

2 Introduction **6**

3 UK Net Zero Carbon Building Standard **7**

3.1 Operational energy limits 7

4 Basis of Energy Analysis **8**

4.1 Nature of simulation 8

4.2 Testing and Quality Assurance 8

4.3 Modelling Limitations 8

4.3.1 Approach 8

4.3.2 Simplifications and limitations 8

4.4 Building Performance Features 8

4.5 Operation Profiles 9

5 Results and Discussion **10**

5.1 Student accommodation 10

5.2 Commercial units 10

5.2.1 Comfort assessment 11

6 Sensitivity and off axis Analysis **12**

6.1 Off Axis Analysis 12

6.2 Risk Assessment 13

7 Energy Coverage and Metering Arrangement **14**

Copyright © 1976 - 2026 Buro Happold. All rights reserved

Glossary

Term	Definition
AHU	Air Handling Unit
ASHP	Air Source Heat Pump
Baseline model	A reference model that represents the office space as it is expected to operate
BMS	Building management system
CAV	Constant Air Volume
CHW	Chilled Water Service
CIBSE	Chartered Institute of Building Services Engineers
CWS	Cold Water Service
DCV	Demand Controlled Ventilation
DfP	Design for Performance
DHW	Domestic Hot Water
DOAS	Dedicated Outdoor Air System
FCU	Fan coil unit system
GIA	Gross Internal Area
HVAC	Heating Ventilation and Air Conditioning
ICT	Information and communication technology equipment
IDR	Independent Design Review
LTHW	Low Temperature Hot Water
MVHR	Mechanical Ventilation Heat Recovery
NIA	Net Internal Area
NLA	Net Lettable Area
Off-axis model	A model that represents the office space after factoring in a minimum of four off-axis scenarios
Off-axis scenario	A scenario representing operational change/s, (occupation, control, or operation) to test a building's ability to reach the targeted star rating with modelled changes to assumptions and inputs.
POE	Post-occupancy evaluation
POU	Point of use
PPM	Parts Per Million
PV	Photovoltaic (solar panels)
Rating Achievement Plan (RAP)	A description provided by the Applicant of how they will maintain sufficient control of the design, construction, and operation of the building to be able to deliver the target NABERS rating in post construction.
Reverse and Simple Calculator	The Simple Calculator tab allows for the calculation of a NABERS Energy star rating for energy specified. The Reverse Calculator tab allow the calculation of the maximum amounts of energy a building can use to achieve a star rating that is specified.
SCoP	Seasonal Coefficient of Performance
SEER	Seasonal Energy Efficiency Ratio
SHGC	Solar Heat Gain Coefficient
Simulation	The building energy model used to estimate of the energy consumption of the Project and create an estimate NABERS Energy, developed in accordance with the requirements of this Guide.
TRY	Teat Reference Year
VRF	Variable Refrigerant Flow Cooling / heating System
VAV	Variable Air Volume Box
UKNZCBS	UK Net Zero Building Carbon Standard

Copyright © 1976 - 2026 Buro Happold. All rights reserved

1 Executive Summary

Buro Happold has been appointed to carry out a prediction of operational energy consumption using advance simulation modelling in accordance with CIBSE TM54 requirements for the Sister Plot H building located in Manchester. The proposed development comprises Purpose Built Student Accommodation (PBSA) with a gross internal area (GIA) of 34,007.1 m2 with ground floor flexible commercial floorspace (612 m2 GIA) across three buildings of 8, 10 and 38 storeys, with a two-storey podium.

1.1 Operational Energy Estimate

The Estimate of the operational energy consumption of the building based on the RIBA Stage 2 design information predicts:

- **Student accommodation:** A gross EUI of between 70 and 90 kWh/m2 GIA representing the range that could be expected when operating the building varying usage. When including the benefit from the on-site energy generation from PV, the net EUI is between 68 and 85 kWh/m2 GIA
- **Commercial units:** An EUI of between 100 and 1000 kWh/m2 GIA representing the range that could be expected depending on the usage of the space, from general sales retail to supermarket.

The UK Net Zero Carbon Buildings Standard sets an Energy Use Intensity (EUI) limit of 72 kWh/m² GIA for higher education buildings beginning construction in 2027. Importantly, this threshold does not account for the benefits of on-site renewable energy generation, such as PV systems. The standard is intended to reflect performance achievable only by the top 5% of buildings. However, results from the pilot studies indicated that even high-performing projects struggled to meet the target, suggesting that the proportion of buildings able to comply in practice may be even lower.

1.2 Risks

Computer simulation provides an estimate of performance. This estimate is based on simplifications that do not and cannot fully represent all the intricacies of performance once built. Simulation results only represent an interpretation of the potential performance. Beyond these modelling challenges and limitations, many other factors will impact energy consumption when building is in operation such as the quality and workmanship with construction works, the nature of how the owner occupies the building, the quality of the owner's operation and maintenance regime and weather. As a result, no guarantee or warrantee of performance in practice can be based on simulation results alone.

The risks associated with the outcome of this work are:

- The proportion of student accommodation usage during term time and summer holidays is unknown and may differ from what has been assumed, and therefore impacting the energy usage.
- Energy Use Intensity (EUI) can be misleading because it's a fixed metric, and a building with higher occupancy or heavier use may show a higher EUI despite actually operating more efficiently per unit of service delivered
- Small power might be lower or higher than in reality which will have impact on the energy use for space heating and cooling.
- Detailed HVAC modelling has been undertaken, however, we have made assumptions as to how the building will be controlled which may impact the building energy use prediction.
- External lighting energy use is based on assumption as the actual design information is not available yet.
- Energy use from lifts is based on 'A' rated energy efficiency class as the BS EN 25745-2:2025 lift energy calculation is not available yet.
- As the commercial units are on a shell and core design currently, their energy estimate has been based on a general sales retail usage typology using Part L profiles. Actual usage may differ significantly.

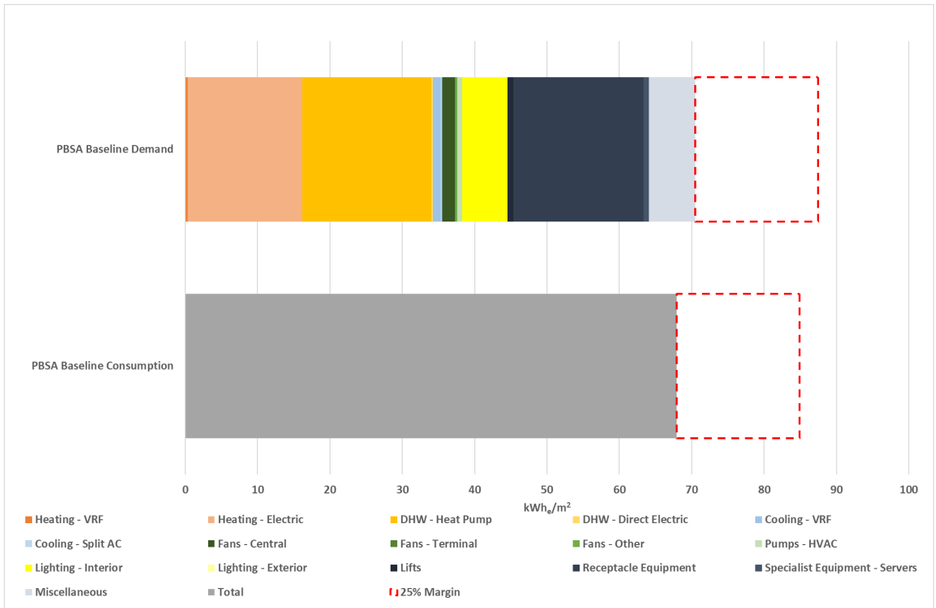


Figure 1—1 Energy use breakdown against UKNZBCS target – student accommodation

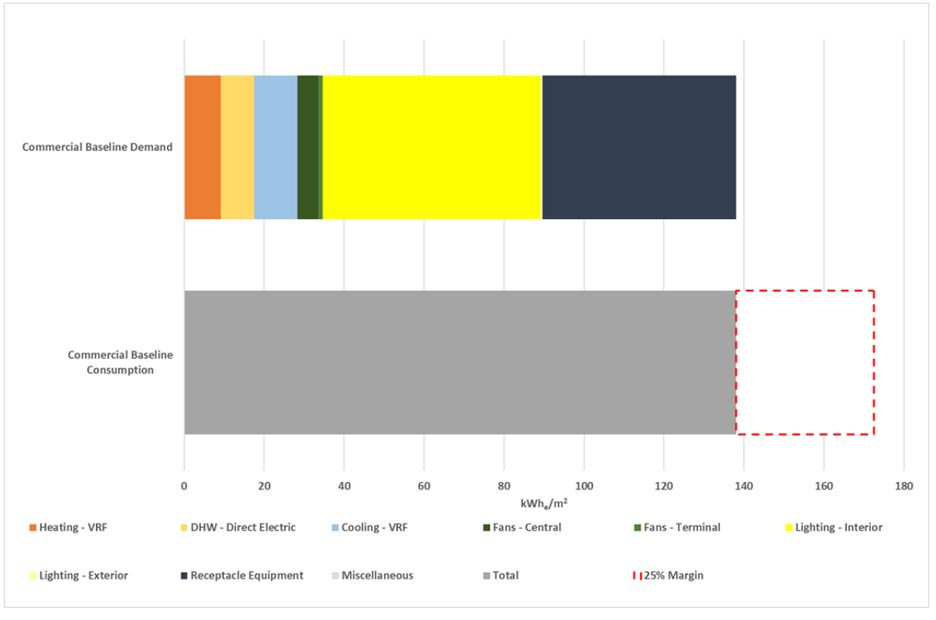


Figure 1—2 Energy use breakdown – commercial units

Copyright © 1976 - 2026 Buro Happold. All rights reserved

2 Introduction

This report has been prepared by Buro Happold to provide an energy estimate of the proposed Sister Plot H building located in Manchester.

Building simulation and energy estimation has been carried out to communicate the estimated energy consumption of the proposed RIBA Stage 2 design.

The report is structured as follows:

- Section 3 – UK Net Zero Building Carbon Standard – An overview of the standard with the target set out for the building
- Section 4 – Basis of Energy Analysis: Summarises the nature of simulation and its limitations as well as the software and methods used in arriving at the predicted performance
- Section 5 – Results and Discussion: A discussion on the simulation results to provide greater insight into the nature of mechanical system energy use and performance
- Section 6 – Sensitivity & Off-Axis Analysis – Quantifies the potential impact of a range of risks to performance and sensitivity to simulation assumptions
- Section 7 – Energy Coverage and Metering Arrangements – a summary of the metering strategy
- Appendix A – Building Assumptions provides a detailed summary of the building related assumptions on which the predicted performance has been based
- Appendix B – Definitions of what is included in each energy use category
- Appendix C – Occupancy profiles and simulation calendar for the student accommodation
- Appendix D – Detailed results for the student accommodation including the off-axis scenarios

Copyright © 1976 - 2026 Buro Happold. All rights reserved

3 UK Net Zero Carbon Building Standard

The Pilot Version of the UK Net Zero Carbon Buildings Standard (UKNZCBS) was launched in September 2024 and has been used to set the operational energy targets for the project included within the MMU Sustainable Construction Tracker.

The UKNZCBS Pilot Version contains the technical details on how a building should meet the Standard, including what limits and targets it needs to meet, the technical evidence needed to demonstrate this and how it should be reported. In the future, projects will be able to verify that a project conforms to the Standard.

The creation of the standard has been a joint industry effort which included over 140 task group members, 190 sector group members and involved data from over 800 projects for embodied carbon and operational energy from over 3,200 metered projects.

The UKNZCBS has set limits, targets and reporting requirements that must be adhered to establish your building as UKNZCBS compliant.

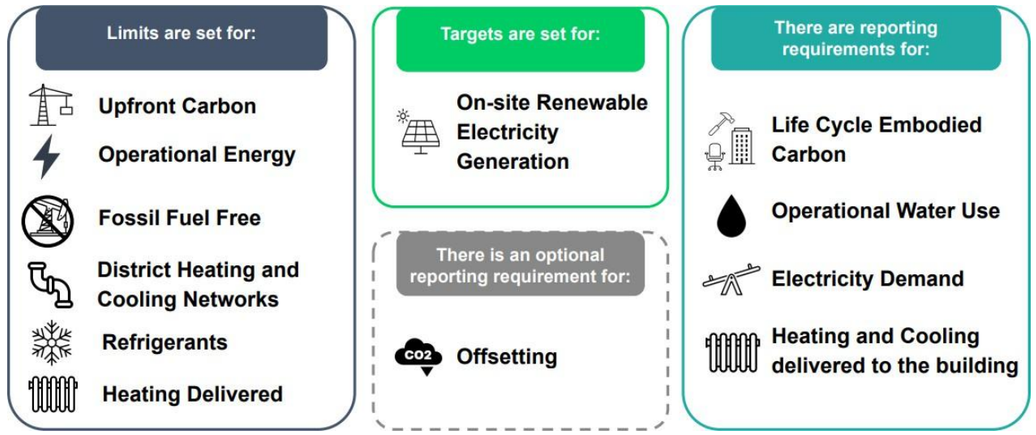


Figure 3—1 UKNZBCS overview

Figure 3-1 highlights that limits have been put in place for upfront carbon and operational energy based on commencement on site for construction, they also require buildings to be fossil fuel free, meet <675 GWP refrigerant limit and in some cases meet limits on heating delivered to a building. Targets have also been set for on-site renewable electricity generation.

The UKNZCBS Pilot, at this point, is a whole building assessment this means that tenant usage is included for energy. It also means that the typologies of the buildings and any subsectors they have within them should be assessed.

3.1 Operational energy limits

Table 3-1 shows the operational energy limits for student residential buildings. The construction of the Sister Plot H is expected to start in 2027 and therefore the operational energy limit to benchmark against is 72 kWh/m^2.yr.

The standard is intended to reflect performance achievable only by the top 5% of buildings. However, results from the pilot studies indicated that even high-performing projects struggled to meet the target, suggesting that the proportion of buildings able to comply in practice may be even lower.

Table 3—1 UKNZCBS operational energy limits for higher education buildings

Typology	Start on Site	kWh/m2.yr (GIA)
Commercial Residential – Student Residential	2026	74
	2027	72
	2028	70
	2029	69

Copyright © 1976 - 2026 Buro Happold. All rights reserved

4 Basis of Energy Analysis

4.1 Nature of simulation

This computational building energy simulation provides an estimate of building energy performance based on a simplified and idealised model of the building and its control. It does not and cannot fully represent all the intricacies of the as constructed building in operation. These simulation results only represent an interpretation of the potential performance of the building.

Care has been taken in interpreting the design intent of the base building and its systems and developing a representation of the building in an energy model / simulation. However, the performance in operation will vary from the assumptions underlying the energy model. These base building assumptions have been clearly outlined in Appendix A of this report.

4.2 Testing and Quality Assurance

The dynamic energy simulation modelling software IES Virtual Environment, version 2024.1.1.0 has been used for this analysis to provide an hourly energy demand prediction for the building. The following software components have been utilised:

- **ModelIT** – defining the building geometry, its façade shading features, and the surrounding buildings
- **Apache** – defining the building fabric properties accounting for total U-value including thermal bridging, glazing properties including the total Solar Heat Gain Coefficient (SHGC), and internal gains
- **Suncast** – to model direct solar gain into the building through windows and rooflights accounting for shading from the building form and surroundings
- **MacroFlo** – for calculating bulk air flow between zones
- **Apache HVAC** – systems simulation to represent the air and water systems and their control and the part load performance of fans, heating and cooling coil loads, air handling units, fan coil units, and heat recovery devices. Other landlord energy loads including pumping have been estimated using robust spreadsheet methods.

The software has been validated through ANSI/ASHRAE Standard 140, Standard Method of Test for the Evaluation of Building Energy Analysis Computer Programs and has compared favourably to the reference programs. We note that software that has undergone validation does not guarantee a reasonable modelling outcome. The user's interpretation of inputs and recognition of the limitations of a package are more significant and important variables.

4.3 Modelling Limitations

The approach to the analysis along with how some of the key limitations have been overcome are described below.

4.3.1 Approach

- All regularly occupied spaces, toilets, air conditioning systems (air handling, variable refrigerant flow systems, electric heating) are simulated within IES VE using ApHVAC
- Water loop loads associated with DHW have been estimated by spreadsheet calculation using design information and making representative adjustments and efficiency assumptions. The daily weekday hot-water demand for the building has been estimated for the ensuites and handwashing and cleaning within the communal toilets.
- The electric heating through electric radiant panels in the bedrooms, studios and kitchens has been modelled using IES-VE ApacheHVAC,
- The variable refrigerant flow system has been modelled using IES-VE ApacheHVAC. The VRF system has been defined using the IES default VRF part load performance data corrected to account for the refrigerant pipe lengths and drops, scheduled reverse cycle defrost for 5% of the time below 2.5ºC outside air temperature has been included. Heat recovery within the system has been assumed when there are simultaneous heating and cooling loads.
- Miscellaneous mechanical fans and equipment (i.e. extract fans) are estimated using spreadsheets from design duty information, making representative adjustments and efficiency assumptions where required, and then estimating full load equivalent run hours based on likely control philosophies.
- The energy use of other non-mechanical loads are estimated by spreadsheet calculations or by benchmarking to past similar project experience. This includes lifts, external lighting, pump energy, and domestic hot water usage.

4.3.2 Simplifications and limitations

The following simplifications and limitations in the estimate are summarised below. Where possible, slightly conservative assumptions have been made to address these limitations. We have also outlined any material departures from the Guide to Design for Performance modelling requirements. Appendix A provides additional detail where appropriate.

Infiltration

Building air permeability has been assumed to achieve an average 3.0 m^3/hr per m^2 of façade @ 50 Pa. To represent this air permeability in the energy model, the infiltration rate has been set at an overall air change rate of 0.15ach.

Pumps

The heating hot water pumps are modelled in a spreadsheet using techniques that are more advanced than the simple turndown curves IES ApHVAC provides. The excel based calculator allows for more accurate and robust modelling of high flow low ΔT hydronic plant equipment.

Lifts

The vertical transportation within the building has considered the lifts as an 'A' rated energy efficiency class using ISO 25745-2 method were utilised to estimate the lift energy use.

4.4 Building Performance Features

The prosed development is committed to reducing its carbon emissions as much as possible. In the pursuit of such high levels of energy efficiency, the design team have already incorporated the following base building features:

- High Performance Facade – Optimised Window-to-Wall ratios to limit unwanted solar gains. Glazing with optimum g-value and U-value to reduce heat gains and losses.
- Insulation levels – Insulation levels to walls, roofs, pipework and ductwork is in line with the Part L of the Building Regulations.
- Air Handling – Local mechanical ventilation units have been designed to minimise system pressures and maximise fan wire to air efficiencies. Outdoor air is supplied to the student bedrooms to satisfy the minimum requirements according to Part F whereas the outdoor air is boosted whenever is required to mitigate overheating. Outdoor air is supplied to student amenities and commercial units via air handling units at a maximum rate of 12 L/s/person and adjusted to maintain a maximum CO2 level of 1000ppm (assuming 400ppm ambient). Economy and night purge cycles increase outdoor air rates above minimum when conditions are favourable.

Copyright © 1976 - 2026 Buro Happold. All rights reserved

- Heat Recovery – all major air handling systems incorporate heat recovery wheels. These are total heat recovery based with a minimum effectiveness of 80% specified.
- Pumping – Pumping systems are generally variable flow and variable pressure to minimise energy use.
- Common Light & Power – High efficiency LED lighting will be used throughout with demand based addressable controls as appropriate (daylight switched/dimmed, occupancy sensors etc.).
- Renewable Energy Systems – A 86.6 kWp photovoltaic (PV) array has been included on the rooftop of the development.
- Cooling Plant – Space cooling is limited to student amenities and commercial units and delivered by variable refrigerant flow systems.
- DHW Plant – DHW is provided by a dedicated CO_2 air-source heat pump. A 73% diversity factor has been applied to maximum building occupancy to represent a realistic operation of the building.

4.5 Operation Profiles

The key operating parameters assumed for the purposes of estimating the energy consumption are detailed in the table below. The operational assumptions used in the energy analysis assume load diversification. While the extent of load diversification is uncertain and will impact the predicted rating, it is highly unlikely that the building will be operated at full design capacity at all times.

Table 4—1 Assumed operating parameters

Assumption	Unit	Mechanical Design Criteria	Operational Assumption for Analysis
Student bedrooms occupancy	(number of people)	1 person	1 @ 90% diversity
Communal kitchen occupancy	(number of people)	6 persons	6 @ 90% diversity
Student amenities occupancy density	(m^2GIA/p)	10	10 @ 100% diversity
Commercial units occupancy density	(m^2GIA/p)	5	5 @ 100% diversity
Student bedrooms lighting heat gain	(W/m^2 GIA)	2	2 @ 90% diversity
Student amenities and commercial units lighting heat gain	(W/m^2 GIA)	6	6 @ 90% diversity
Studio equipment heat gain	(W)	450	450 @ 90% diversity
Cluster equipment heat gain	(W)	80	80 @ 90% diversity
Communal kitchen equipment heat gain	(W)	450	450 @ 90% diversity
Student amenities and commercial units equipment heat gain	(W/m^2 GIA)	12	12 @ 100% diversity
Established Building Hours	(hrs/week)		<table><tr><th>Start date</th><th>End date</th><th>Occupancy profile</th></tr><tr><td>Jan 1st</td><td>Jan 5th</td><td>Christmas break</td></tr><tr><td>Jan 6th</td><td>April 13th</td><td>University Term</td></tr><tr><td>Apr 14th</td><td>April 21st</td><td>Spring break</td></tr><tr><td>April 22nd</td><td>June 11th</td><td>University Term</td></tr><tr><td>June 12th</td><td>Sep 28th</td><td>Summer break</td></tr><tr><td>Sep 29th</td><td>Dec 24th</td><td>University Term</td></tr><tr><td>Dec 25th</td><td>Dec 31st</td><td>Christmas break</td></tr></table>
Occupied and in use Area			100% NIA
Space Temperature Set points	(°C)	CLG 24 ± 2 HTG 22 ± 2	Proportional Bands CLG 24 ± 1 HTG 21 ± 1
Weather			Manchester TRY

Copyright © 1976 - 2026 Buro Happold. All rights reserved

5 Results and Discussion

5.1 Student accommodation

This section summarises the predicted building performance in detail to understand the relative of impact of different end uses and how variable and weather sensitive systems are predicted to perform over the course of a year.

The table below summarises energy use by key end use for the student accommodation part of building under the baseline scenario. The estimate of the operational energy consumption of the PBSA based on RIBA Stage 2 design information predicts:

- An EUI of between 701 and 90 kWh/m^2 GIA representing the range that could be expected when operating the building varying usage. This is without the benefit from the PV.
- When including the benefit from the on-site energy generation from PV, the EUI reduces between 68 and 85 kWh/m^2 GIA representing the range that could be expected when operating the building varying usage.
- Space heating and domestic hot water along with the small power equipment were predicted to contribute ¾ of the energy use.
- The use of mechanical ventilation with heat recovery for fresh air in the heating season with opening windows being used for purge ventilation only was a key energy efficiency feature.

Table 5—1 Building end use energy breakdown – student accommodation

Energy End Use	Baseline (kWh/m^2/year)	Baseline Annual electricity (kWh/year)
Heating - VRF	0.35	11,850
Heating - Electric	15.82	538,040
Cooling - VRF	1.09	37,141
Cooling – Split AC	0.19	6,368
DHW – Heat Pump	17.88	607,985
DHW - Electric	0.15	5,186
AHU Fans	1.76	59,789
Terminal Fans	0.06	1,876
Misc Fans	0.33	11,224
HVAC Pumps	0.63	21,470
Internal lighting	6.27	213,373
External lighting	0.03	916
Small power	18.0	612,038
Servers	0.69	23,625
Lifts	0.81	27,680
Miscellaneous systems	6.41	217,856
Total	**70.47**	**2,396,417**
25% Margin	16.98	577,439
Total with margin	**87.45**	2,973,856
PV	2.53	86,068
Total net without margin	**67.94**	**2,310,349**
Total net with margin	84.92	2,887,788

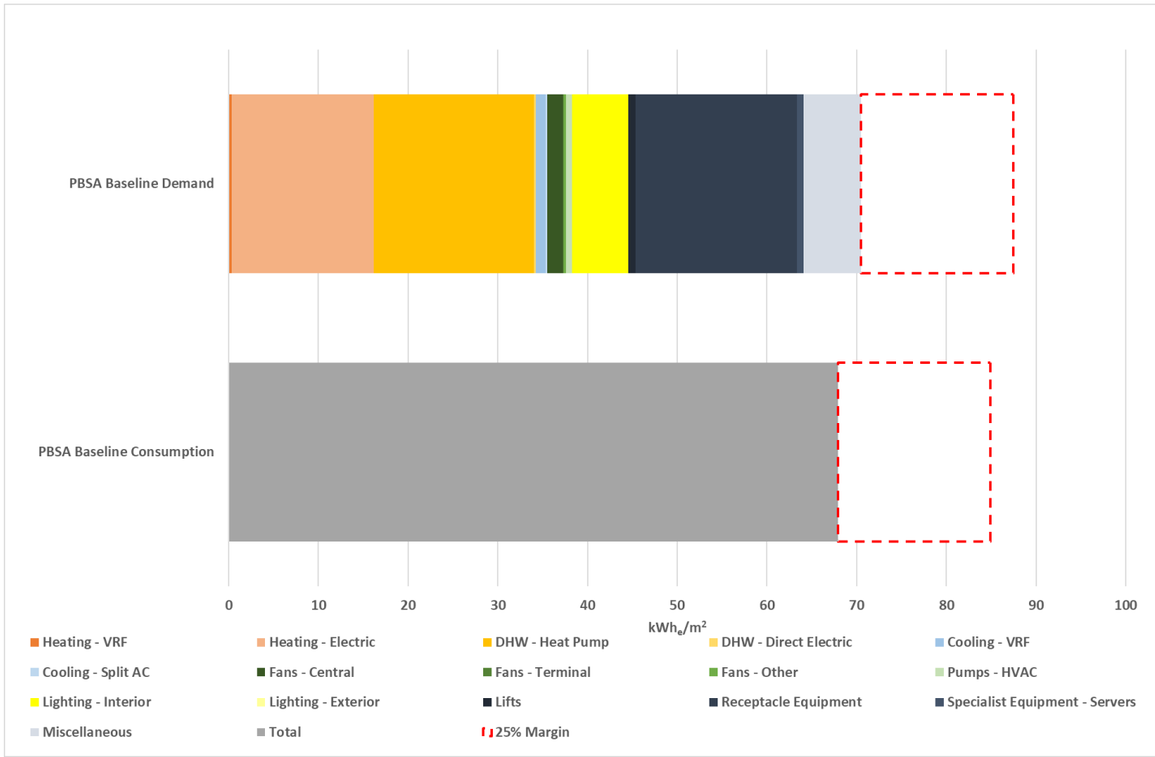


Figure 5—1 Building operational energy breakdown against the UKNZCBS target – student accommodation

It should be noted that the benefit of on-site energy generation from PV is not included in the NZCBS. The standard is intended to reflect performance achievable only by the top 5% of buildings. However, results from the pilot studies indicated that even high-performing projects struggled to meet the target, suggesting that the proportion of buildings able to comply in practice may be even lower.

Therefore, the predicted range of between 70 and 90 kWh/m^2 is within the expected range for this building typology.

5.2 Commercial units

The estimate of the operational energy consumption for the shell and core commercial units based on the RIBA Stage 2 design information for a mix of sales typologies predicts:

- An EUI of between 138 and 173 kWh/m^2 GIA representing the range that could be expected when operating the building as a retail sales space.
- Small power equipment and lighting (including display lighting) to be the biggest energy consumers as they contribute ¾ of the total energy use.

It should be noted that the energy use of the commercial units is based on a general sales retail usage typology using Part L profiles. Actual usage may differ significantly. Table 5-2 below shows the CIBSE Guide F benchmarks for various retail typologies.

Copyright © 1976 - 2026 Buro Happold. All rights reserved

Table 5—2 CIBSE Guide F benchmarks for various retail typologies

Retail typology	CIBSE Guide F Benchmark (kWh/m²)
Book store	210
Catalogue store	100
Clothe shop	270
Department store	209
Electrical goods retail	172
Shoe shop	197
Supermarket	1,034

Table 5—3 Building end use energy breakdown – commercial units

Energy End Use	Baseline (kWh/m²/year)	Baseline Annual electricity (kWh/year)
Heating - VRF	9.19	5,620
Cooling - VRF	10.81	6,611
DHW - Electric	8.27	5,058
AHU Fans	5.25	3,208
Terminal Fans	1.12	684
Internal lighting	54.42	33,275
External lighting	0.60	366
Small power	48.39	29,593
Total	**138.05**	**84,415**
25% Margin	34.51	21,120
Total with margin	**172.56**	105,535

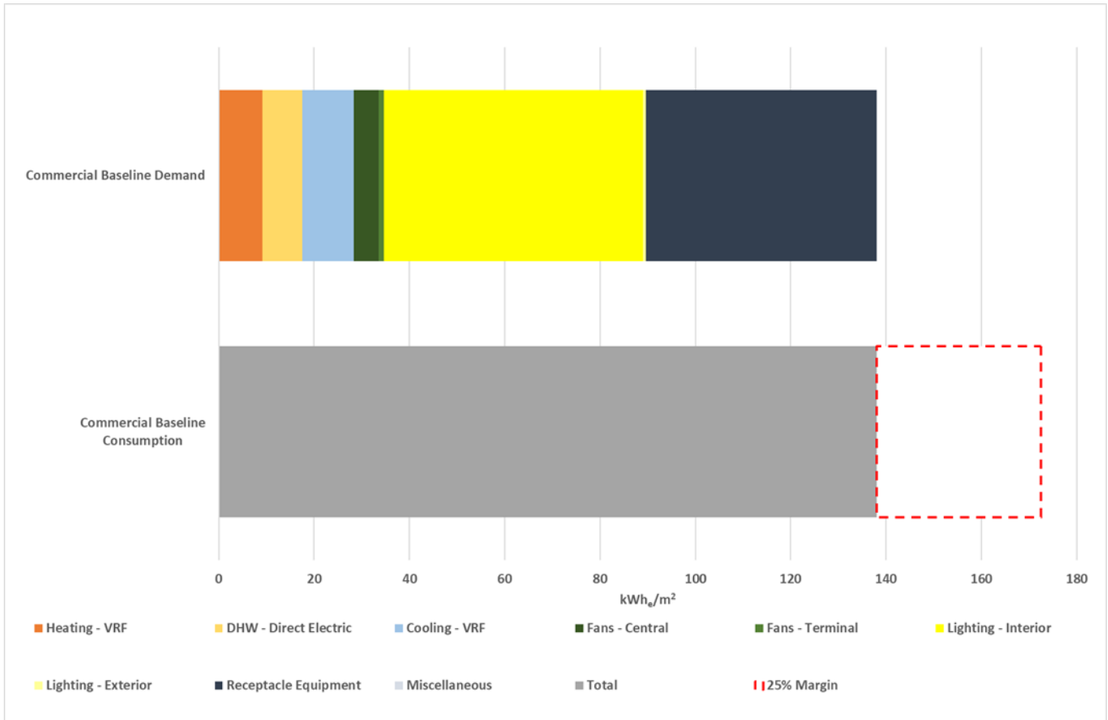


Figure 5—2 Building operational energy breakdown – commercial units

5.2.1 Comfort assessment

A thermal comfort assessment has been undertaken to assess the thermal comfort in the occupied spaces. It is noted that while HVAC systems are controlled based on air temperature, operative temperature more accurately reflects thermal comfort. Please refer to the thermal comfort report prepared by HG Consulting Engineers (DN06 – Thermal Comfort Report).

Copyright © 1976 - 2026 Buro Happold. All rights reserved

6 Sensitivity and off axis Analysis

6.1 Off Axis Analysis

In line with the CIBSE TM54 guidance, a range of scenarios have been assessed to understand building resilience to operational changes, performance risks and the sensitivity to some simulation inputs and assumptions. The scenarios are summarised in the table below. It should be noted that the scenarios run, refer to the student accommodation part of the development as the use of the commercial units is unknown at this stage. The scenarios are summarised in the table below.

Table 6—1 Off-axis scenarios simulated

No.	Off-Axis Scenario	Net Annual electricity (kWh/m²year)	Impact
1	**Impact of climate change:** Consideration for the future development on site has been made together with the projected changes to the external climate in accordance with CIBSE future climate change weather data.	62 – 77	- 9 %
2	**Sealed building:** Consideration for the student bedrooms to be fully mechanically ventilated. Benefit of natural ventilation via openable windows has been excluded.	69 - 86	+ 1 %
3	**Student bedrooms occupied during summer holidays:** Consideration for some of the bedrooms to be occupied during the summer holidays. Bedrooms in levels 1 to 7have been assumed to be occupied.	72 - 90	+ 5.5 %
4	**Combined:** Scenarios 1 to 3 have been applied	66 - 82	- 3 %

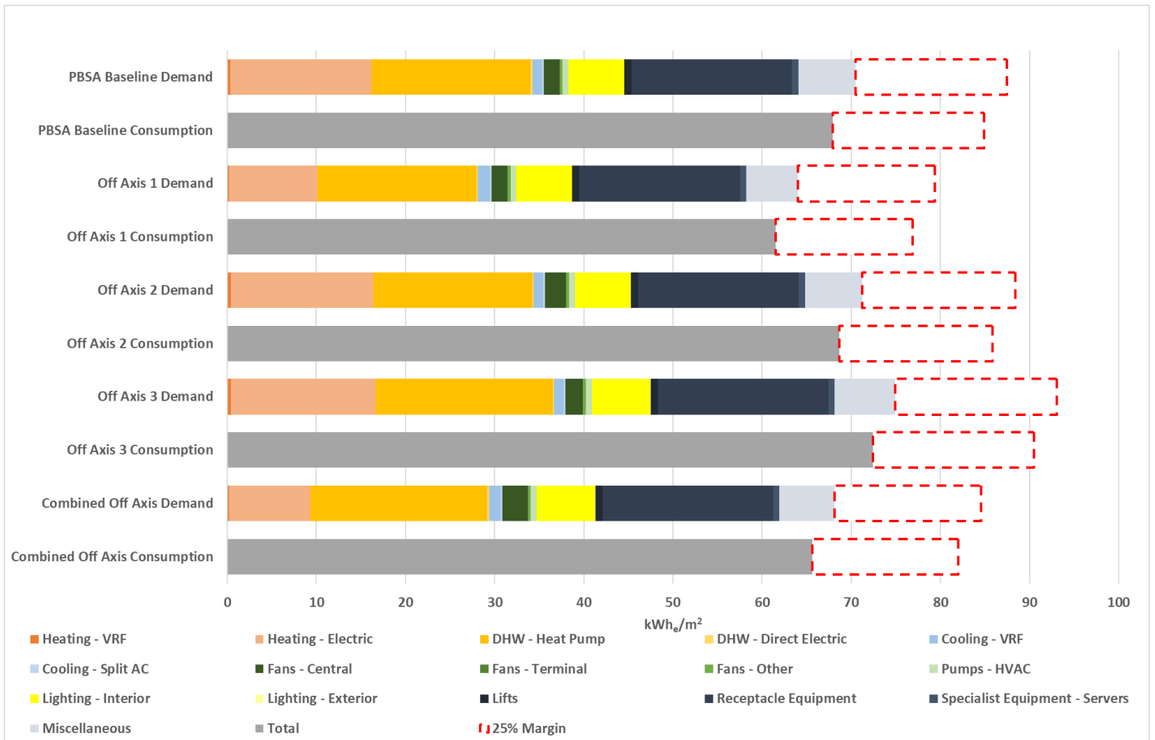


Figure 6-1 Baseline operational energy breakdown including the off-axis scenarios – student accommodation

As it can be seen, the scenario with the bedrooms being occupied during the summer holidays, has the biggest negative impact on the energy consumption. This is mainly due to the increased energy use of the lighting, small power and domestic hot water as a result of the extended occupied period across the year. On the other hand, the impact of the projected future weather scenario, has a positive impact on the energy use as it reduces it by 9%. The building has a high heating demand which is reduced by 37% due to the projected warmer weather. It should be noted that the sealed building scenario has a negative impact on the overall energy use by 1% due to the increased fan energy as a result of the windows being closed. The combined off-axis scenario has a positive impact on the energy use by 3% as the reduction in the heating demand offsets the increase of the energy use due to longer occupied period.

Copyright © 1976 - 2026 Buro Happold. All rights reserved

6.2 Risk Assessment

The following risk assessment considers the factors that may impact the energy performance of the building.

Table 6—2 Risk assessment – PBSA

No.	Risk	Potential Impact
1	Small power	Small power might be lower or higher than in reality which will have impact on the energy use for space heating and cooling
2	HVAC Controls	Detailed HVAC modelling has been undertaken however, the controls might be different in reality which will impact the energy use for heating, cooling, fans and pumps.
3	External lighting	External lighting energy use is based on assumption as the actual design information was not available at the time of writing this report.
4	Lifts energy use	Energy use from lifts is based on 'A' rated energy efficiency class as the BS EN 25745-2:2015 Lift calculation was not available at the time of writing this report.
5	VRF efficiency	Typical values for the seasonal efficiencies of the VRF systems have been used as the plant equipment selections are not available yet.
6	Miscellaneous energy	Booster pumps and other miscellaneous equipment have not been calculated at this stage as the design information is not available yet. A 10% allowance of the total energy use has been allocated for this piece of plant equipment.
7	Openable windows	Not having windows open in the heating season will impact the energy use.
8	Operational usage	The proportion of usage during term time is unknown and may differ from what has been assumed, and therefore impacting the energy usage. Extent of usage during summer holidays may differ from what has been assumed, and therefore impacting the energy usage.
9	Overheating	As the current design doesn't include comfort cooling in the student bedrooms there is a risk that it might be needed in the future due to the warmer weather which will impact the energy use.

Table 6—3 Risk assessment – Commercial units

No.	Risk	Potential Impact
1	Operational usage	As they are on a shell and core design currently, their energy estimate has been based on a general sales retail usage typology using Part L NCM profiles. Actual usage may differ significantly.
2	Model inputs	Where they have been made assumptions, these have been based on assumptions used in previous estimates.

Copyright © 1976 - 2026 Buro Happold. All rights reserved

7 Energy Coverage and Metering Arrangement

A metering system and the submeters will be provided for all key systems and equipment. The proposed strategy allows to meter over 90% of the energy consumption in line with CIBSE TM39. Please refer to the LV schematics prepared by the HG Consulting Engineers (5011-HGC-XX-XX-DR-E-61900 series).

To achieve the lowest possible in use energy consumption, it is highly recommended that accurate metering is provided to allow measurement and recording of:

- Electricity used by each DHW heat pump
- Heating and cooling output of each VRF system
- Heating output of the electric radiant panels
- AHU and MVHR fan energy
- Electricity used by each circulating DHW pump
- Electricity used by lighting and equipment
- Lift motor energy
- Cold-water feeding domestic hot water systems
- Energy generated by PV systems
- Energy exported to the grid (if PV energy generated exceeds building electrical consumption)

The building will be provided with a computerised Building Management System (BMS). This will provide automatic control and logging facilities for all mechanical and electrical plant.

It should be noted that 'CIBSE TM39: Building energy metering' guidance will be updated later in the year we recommend that the new guidance is adopted for the design and validation of the metering and submetering system.

Copyright © 1976 - 2026 Buro Happold. All rights reserved

Appendix A Building Assumptions

A.1 Introduction

This document details the inputs and assumptions underlying the Base case building energy model for the Sister Plot H building located in Manchester for the purposes of providing an energy estimate against a standard set of assumptions. The energy model has been based on a combination of spreadsheet type calculations and advanced energy simulation using the IES Virtual Environment (ApacheHVAC) energy simulation software.

A.2 Documentation

The following drawings, reports and specifications used in the energy model have been packaged and attached to this report for the convenience to review.

Table A—1 Documentation

Documents	Revision	Purpose
General arrangement plans 0667-HOD-XX-00-DR-A-(--)200 series	010 Planning	Floor geometry
Area Schedule 0667-HOD-XX-XX-SC-A-00001 & 00002	Planning issue	Area schedule to compare to model
Façade types elevations 0667-HOD-XX-00-DR-A-(--)300 series	03 Planning	Façade geometry and types
LTHW schematic 25011-HGC-XX-XX-DR-M-59902 series	Planning issue	Modelling the hot water loop and air source heat pumps for DHW
Mechanical Riser schematic 25011-HGC-XX-XX-DR-M-59903 series	Planning issue	Modelling the hot water loop and air source heat pumps for DHW
Ventilation layouts 25011-HGC-XX-XX-DR-57801 & 57802	Planning issue	Modelling ventilation systems in studios and clusters
DN05 - Energy and Carbon Statement	Planning issue	Basis of design
DN06 - Thermal Comfort Report	Planning issue	
DN04 - Ventilation and Extraction Statement	Planning issue	

A.3 Site

The site in Manchester City Centre is bounded by Charles Street (south), the Manchester South Junction and Altrincham Railway Viaduct and Granby Row (north), Sackville Street (east), and Princess Street (west). The site currently comprises a vacant multi-storey car park (closed October 2024) and three vacant retail units (last occupied June 2025). The car park and retail units are no longer fit for purpose and the planning application for demolition was approved 4th December 2025.

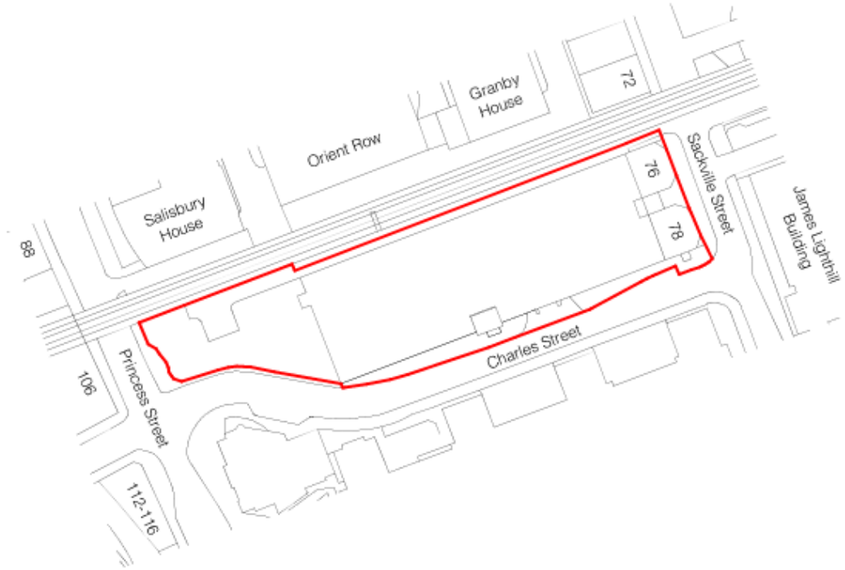


Figure A—1 Site plan of Sister Plot H location (red line boundary shown)

Copyright © 1976 - 2026 Buro Happold. All rights reserved

A.3.2 Weather

CIBSE Test Reference Year (TRY) weather data for Manchester has been used in the Stage 2 analysis. The TRY weather data represents the average month selected from 1984 – 2013.

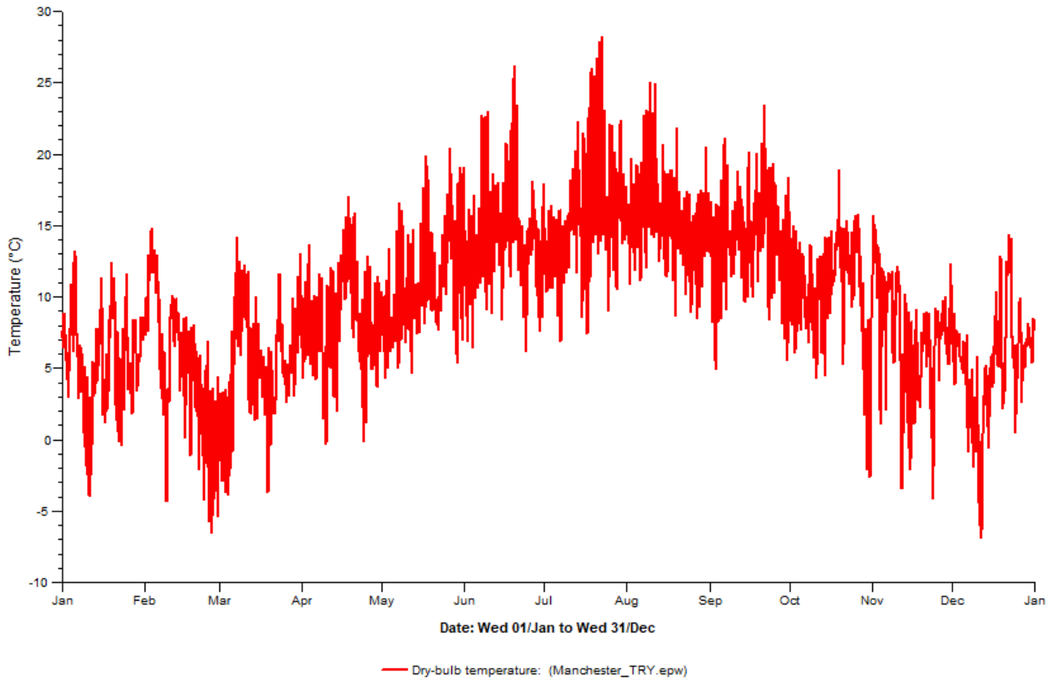


Figure A—2 CIBSE weather file Manchester TRY 2020

A.3.3 Surrounding context

The orientation has been taken from the site plan with project north being 21 degrees East of North (Figure A—3 Typical floor in IES model

A ground reflectance of 20% has been assumed. Reflectance of all surrounding buildings and external shades is 30% as per the in-built parameters within IES.

Figure A-4 below illustrates how the surrounding buildings have been represented in the energy model.

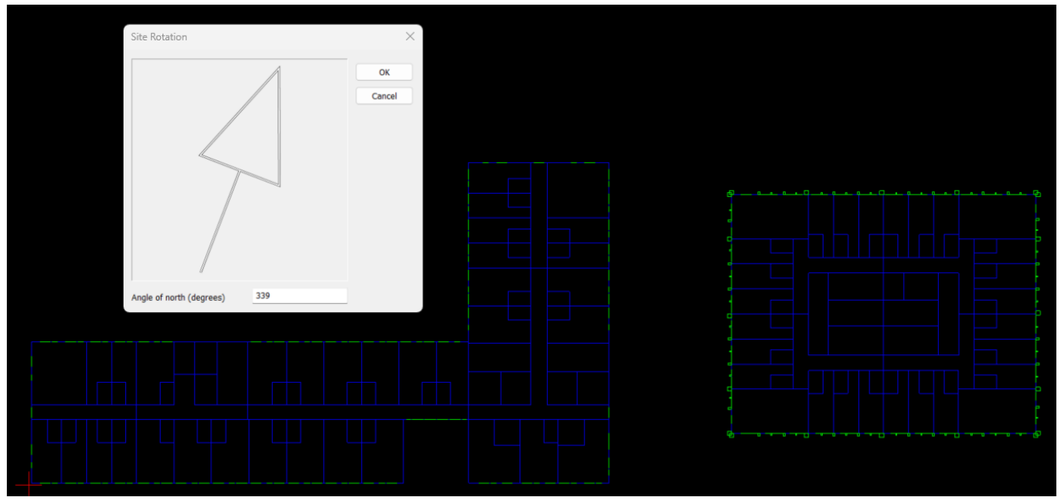


Figure A—3 Typical floor in IES model

A.4 Form

A.4.1 Vertical zoning

All floors of the proposed building have been modelled as per the Stage 2 documentation. Floor to floor height is typically 2,850mm with the ground floor to be 5,000mm.

A.4.2 Windows and shading

A visual representation of the building model is shown in and shows the external shading features included in the following forms:

- Adjacent buildings have been incorporated as simplified geometric blocks
- Glazing modelled includes the frame with thermal properties assigned to glass and frame to represent the whole unit.
- Building façade U-values have been set based on the stage 2 design.
- Shading elements have been modelled physically in the model

Copyright © 1976 - 2026 Buro Happold. All rights reserved

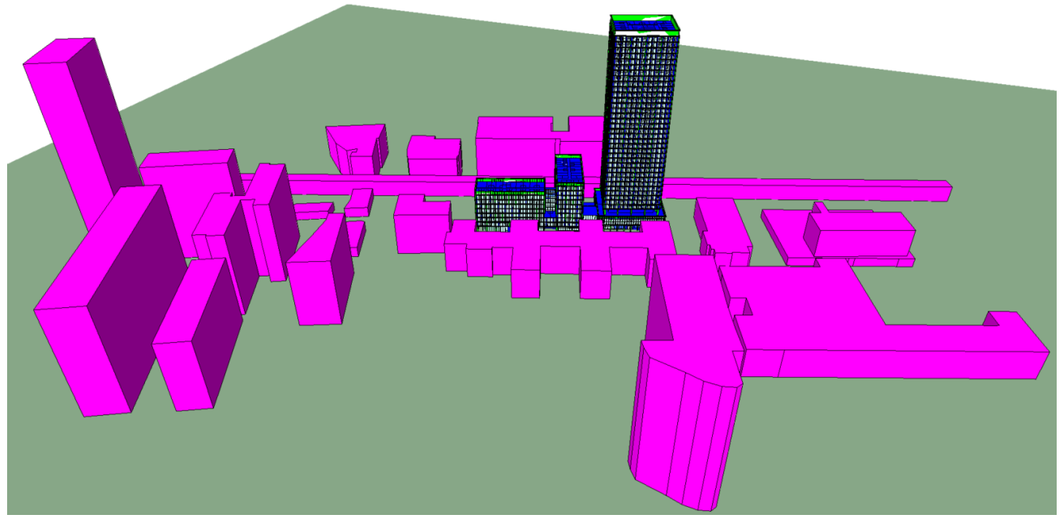


Figure A—4 Model of building and surroundings

A.4.3 Areas

The building's measured Gross Internal Area (GIA) in design was 34,618m^2 GIA.

The IES model's area is 37,243m^2 GIA.

Table A—2 Architectural area schedule

Floor	Architectural GIA schedule (m2)	IES Model area
Basement	946	1003
Ground	1,697	1662
1	2,074	2090
2	1,033	990
3	1,365	1376
4	1,611	1627
5	1,611	1627
6	1,568	1588
7	1,568	1588
8	1,082	1093
9	1,082	1093
10-37	18,984	18905
Total	34,618	34,642

A.5 Constructions

A.5.1 Thermal performance

Table A—4 Opaque elements thermal performance

Type	Building Element	Target U-Value (W/m^{2}K)
External Walls	External solid walls	0.14
Ground and exposed floors	Ground floor any floor of space overhanging	0.15
Roof	Roof	0.10

Table A—5 Glazing and curtain walling performance

Element	U-Value (W/m^{2}K)	G-value	Light Transmittance (%)
Windows (generally)	1.0	0.32	60
Windows (North elevation)	1.0	0.42	70
Windows (amenity spaces)	1.0	0.25	58
Rooflights	2.2	0.55	60

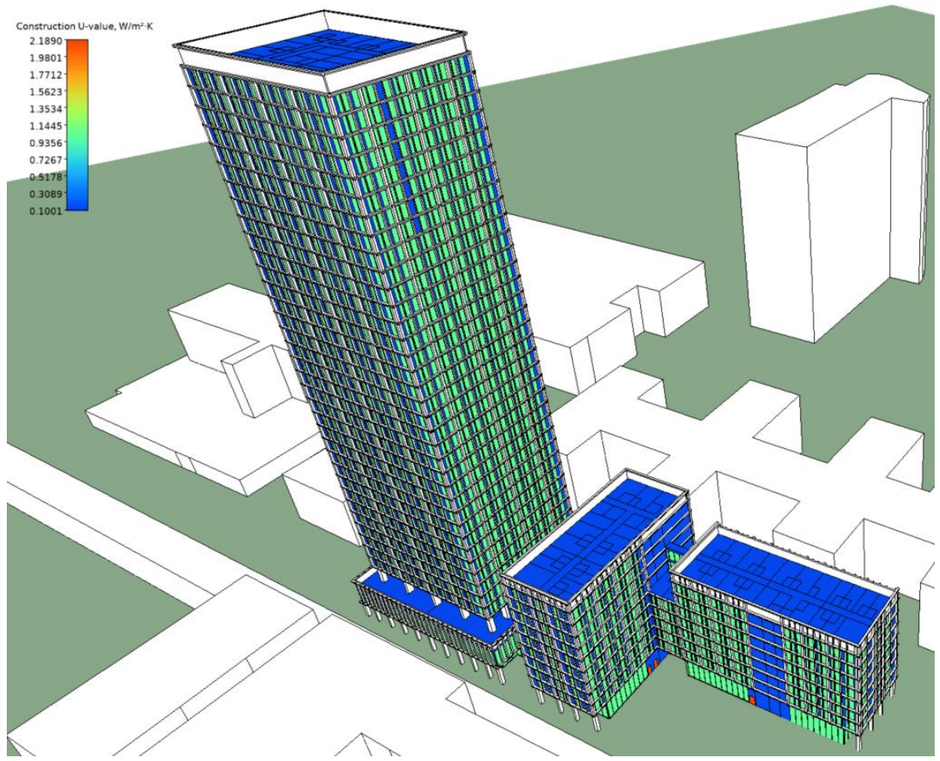


Figure A—5 U-values markup for the building. Windows have the highest U-value and are shown in green.

Copyright © 1976 - 2026 Buro Happold. All rights reserved

Note the U-value targets include all repeating thermal bridges. Non-repeating (linear) thermal bridge heat losses are accounted by adding 25% to the target U-value in the energy model. Low

A.5.2 Infiltration

Building air permeability has been assumed to achieve an average 3.0 m^3/hr per m^2 of façade @ 50 Pa. To represent this air permeability in the energy model, the infiltration rate has been set at an overall air change rate of 0.15 ach. These values are not dependent on the local wind conditions and are therefore constant within the simulation. This is considered a conservative assumption as infiltration will be lower at typical wind conditions.

A.6 Internal loads

Internal heat loads are summarised in the table below. The heat gains associated with this energy use directly impact the space heating and cooling loads. Both the design density (i.e. system capacity) and the operational density (i.e. assumption in the model) are included. Controls and profiles applied are detailed in the next sections for each internal heat load.

Table A—6 Internal heat gains

	Lighting (W/m^2)		Equipment (W/m^2)		Occupancy (m^2person)	
	Operation	**Sizing**	**Operation**	**Sizing**	**Operation**	**Sizing**
Studio	2	2	450 W	450 W	1 person	1 person
Cluster	2	2	80 W	80 W	1 person	1 person
Communal kitchen	2	2	450 W	450 W	6 persons	6 persons
Gym	6	6	12	12	10	10
Lounge	6	6	12	12	10	10
Co-working	6	6	12	12	10	10
Private Dining	6	6	12	12	10	10
Health/Wellbeing	6	6	12	12	10	10
Library	6	6	12	12	5	5
Management Suite	6	6	12	12	12	12
Commercial Unit	General: 6 Display: 10	6	12	12	5	5
Entrance reception	6	6	12	12	25	25
Store	1.1	1.1	-	-	-	-
Circulation	1.4	1.4	-	-	-	-
Plant	6	6	-	-	-	-
WC	2.7	2.7	-	-	-	-
Refuse	1.1	1.1	-	-	-	-
Cycle store	1.1	1.1	-	-	-	-
Comms	6	6	5 kW	5 kW	-	-

A.6.1 Lighting

Internal lighting

The energy use from lighting has been calculated based on the RIBA Stage 2 basis of design provided by MEP.

Table A—7 Base building lighting

Space	Load range (W/m2)	Diversity factor	Control
Studio	2	90%	
Cluster	2	90%	
Communal kitchen	2	90%	
Gym	6	90%	Absence detection
Lounge	6	90%	Absence detection
Co-working	6	90%	Absence detection
Private Dining	6	90%	Absence detection
Health/Wellbeing	6	90%	Absence detection
Library	6	90%	Absence detection
Management Suite	6	90%	Absence detection
Commercial Unit	6	100%	Absence detection
Entrance reception	6	100%	Manually switched
Store	1.1	50%	Absence detection
Circulation	1.4	90%	Presence detection
Plant	6	20%	Manually switched
WC	2.7	90%	Presence detection
Refuse	1.1	50%	Absence detection
Cycle store	1.1	50%	Absence detection
Comms	6	20%	Manually switched

External Lighting

Electricity use from the external lighting has been estimated based on 5kW total installed capacity.

Table A—8 External lighting energy consumption

Month	Actual Sunrise	Actual Sunset	Morning Hours	Evening Hours	Total external lighting (kWh)
Jan	08:11	16:02	08:11	07:58	104
Feb	07:21	17:04	07:21	06:56	83
March	06:21	17:56	06:21	06:04	80
April	06:12	19:50	06:12	04:10	65
May	05:17	20:39	05:17	03:21	56
June	04:50	21:11	04:50	02:49	48
July	05:09	21:04	05:09	02:56	52
August	05:54	20:15	05:54	03:45	62
Sept	06:43	19:06	06:43	04:54	73
Oct	07:31	17:57	07:31	06:03	88
Nov	07:30	15:53	07:30	08:07	98
Dec	08:12	15:36	08:12	08:24	107
Total					916

A.6.2 Equipment

The MEP design uses 12 W/m² for sizing of all spaces cooling and electrical services.

Copyright © 1976 - 2026 Buro Happold. All rights reserved

A blanket equipment power density of 2,5 W/m^2 has been applied to the toilets to account for the usage of the hand driers.

An allowance has been made for the comms room containing IT equipment. The operational profile was estimated to be 80% 19:00-07:00, and 30% otherwise.

Table A—9 Equipment load

Space	Load (W/m^2)	Diversity factor
Studio	450 W	90%
Cluster	80 W	90%
Communal kitchen	450 W	90%
Gym	12	100%
Lounge	12	100%
Co-working	12	100%
Private Dining	12	100%
Health/Wellbeing	12	100%
Library	12	100%
Management Suite	12	100%
Commercial Unit	12	100%
Entrance reception	12	100%
Store	-	
Circulation	-	
Plant	-	
WC	2.5	100%
Refuse	-	
Cycle store	-	
Comms	5 kW	

A.7 Operational profiles

As the development is a student accommodation building, the typical academic calendar (see Appendix C) was used to account for the Christmas and Spring breaks as well as the summer holidays whereas universities are closed. Public holidays have also been included. NCM profiles have been used for the amenities and commercial units. The core hours for the amenities are from 8am until 11pm and for the commercial units from 9am until 6pm.

A.8 Air distribution

In line with the mechanical design, the IES HVAC airside model contains the following key systems:

- 1 No local mechanical ventilation unit serving the studios, clusters and communal kitchens. This represents all the individual units serving the student bedrooms.
- 1 No air handling unit serving the student amenities
- 1 No local mechanical ventilation unit serving the commercial units. This represents all the individual units serving the commercial units.

The fan, coil and heat recovery inputs for IES were developed from the mechanical design documentation. Representative internal unit pressures and efficiencies were assumed to match the minimum specific fan powers specified as outlined in the following table. In line with the mechanical design, the local mechanical ventilation units provide air tempering only as they are not fitted with heating coil.

Table A—10 AHUs specification

AHU Ref	Air volume (l/s)	Specific Fan Power (W/l/s)	Heat Recovery Efficiency (%)	Speed control
Student bedrooms	21,339 (when in minimum)	0.84	88%	EDR Typical VSD Fan
Student amenities	1,701	1.5	80%	EDR Typical VSD Fan
Commercial units	1,215	1.5	80%	EDR Typical VSD Fan

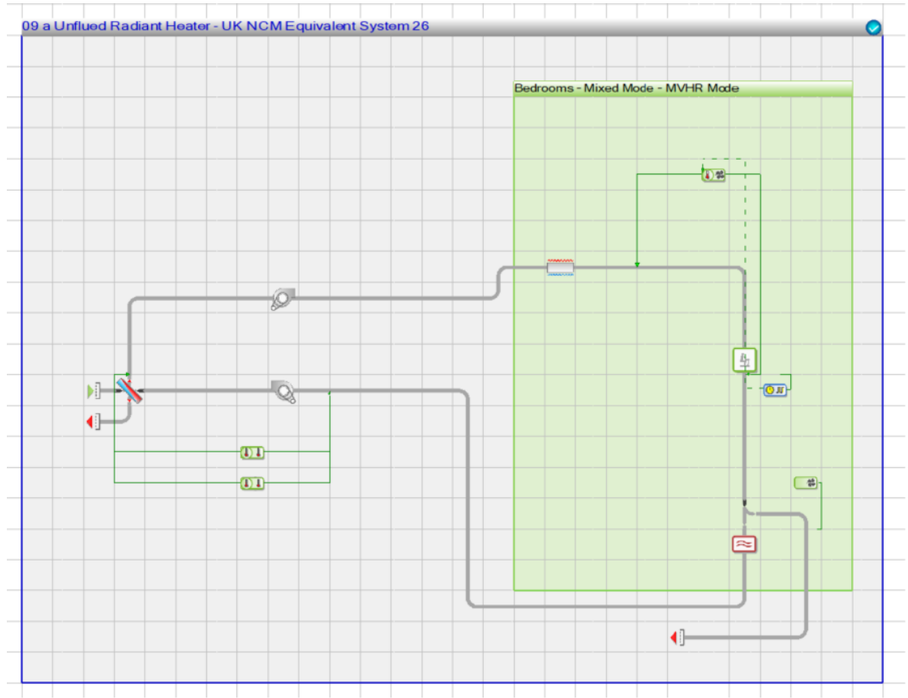


Figure A—6 Airside HVAC network for the student studios and clusters

A.8.1 Ventilation systems losses

All heat gains from fan motors are assumed to enter the air streams and will increase cooling coil loads accordingly. No ductwork thermal losses are modelled.

A.8.2 Control Sequences

Control sequences for the simulation have been based on assumptions and design information as description of operations is not available yet . The general logic modelled for the base case is summarised below.

A.8.3 Outdoor air systems

Studios and clusters

Outdoor air control

Copyright © 1976 - 2026 Buro Happold. All rights reserved

Outdoor air controls have been set up as follows:

- Minimum fresh air to satisfy part F requirements when room temperature is below 22ºC.
  - Bathroom: 8 l/s
  - Studio/Cluster: 11 l/s
  - Communal kitchen: 13 l/s
- Ventilation is boosted up to 4ach when room temperature reaches 26ºC to mitigate overheating.
- In the naturally ventilated bedrooms mechanical ventilation is switched off when the room temperature is between 23ºC-25ºC.

Student amenities and commercial units

Demand controlled ventilation has been set to maintain between 800 and 1000ppm of CO_2 by varying the fresh air supply volume in each zone. Minimum fresh air rate was 30% of the maximum flow rate.

A.8.4 Miscellaneous fans

An allowance has been made for the energy consumption from the extract fans serving the refuse and cycle stores, toilets and the laundry.

Table A—11 Miscellaneous fans energy consumption

Area serving	Estimated Power (kW)	Number of Working Hours	Annual Energy Consumption (kWh)
Refuse and Cycle store	0.5	8760	4,380
WC	0.5	5475	2,737.5
Laundry	0.75	5475	4,106.3

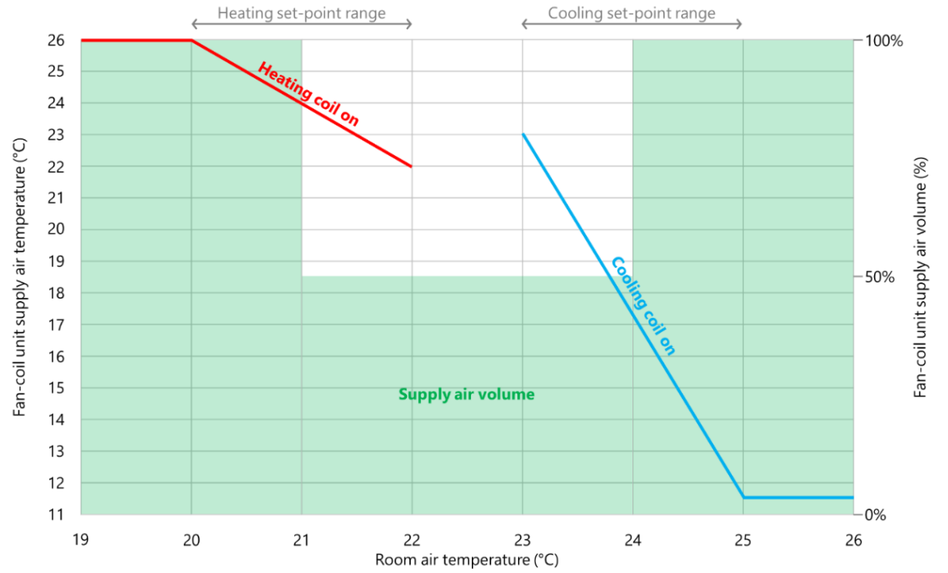
A.9 Room heating/cooling systems

A.9.1 Studios and clusters heating

Studios, clusters and communal kitchens are heated via electric radiant panels. 1 kW of capacity has been assumed for each unit. The heating setpoint has been assumed to be 20ºC when occupied and 16ºC otherwise.

A.9.2 Fan coils (VRF cassettes)

The fan-coil units (FCUs) are equipped with variable speed drives capable of operating with variable air flow. Supply air temperature have been modelled to vary depending on room air temperature. The following diagrams illustrate how the FCUs have been modelled in ApacheHVAC. All fan energy is calculated within Apache HVAC. FCU unit SFPs were modelled as 0.20 W/l/s.



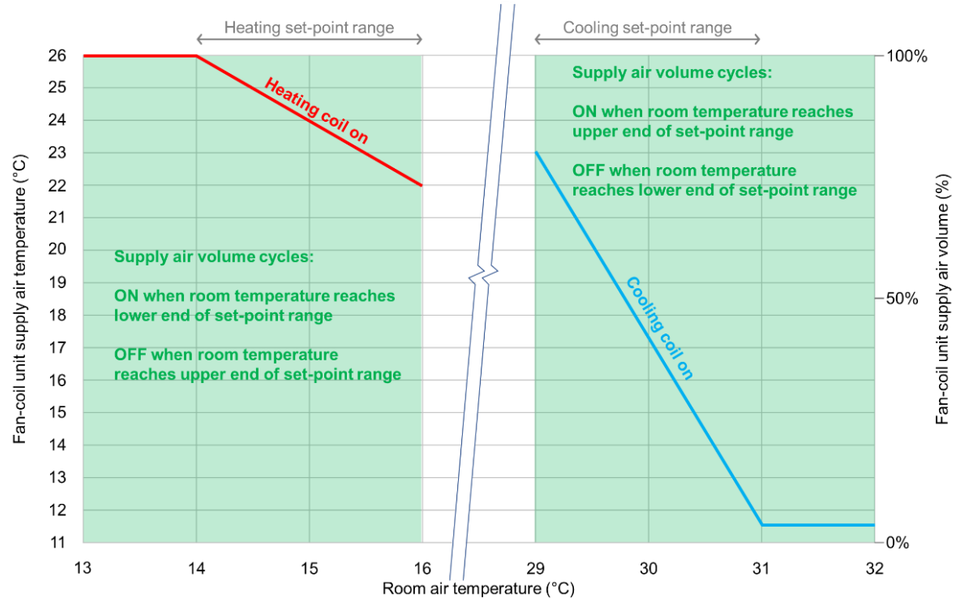


Figure A-7 Fan-coil unit control temperature (left) and air-flow volume (right) in heating mode

A.9.3 Student bedrooms natural ventilation strategy

The studios and clusters use natural ventilation strategy as an endeavour to achieve a low energy consumption as much as possible. This is achieved through window openings in the façade. It should be noted that due to air quality issues, the

Copyright © 1976 - 2026 Buro Happold. All rights reserved

windows in the first until the third floor must be closed, except for those ones facing South. The windows open when the external temperature is lower than the room temperature and their control strategy is described below:

- When a room is occupied during the day (7am to 10am and 7pm to 12am during a weekday), windows open as of the following:.
  - Start to open when room temperature exceeds 23°C
  - Be fully open when the room temperature reaches 26°C
  - Be fully closed when room temperature exceeds 26°C to allow for the boosted mechanical ventilation to switch on

The same control strategy applied during the weekend when the bedrooms are occupied from 8am to 12am.

A.10 Heating and Cooling Plant

A.10.1 VRF plant

In line with the mechanical design, the IES HVAC waterside cooling plant model contains the following key systems:

- 1 No VRF unit providing space cooling to the student amenities
- 1 No VRF unit providing space cooling to the commercial units

All the VRF systems have been defined using the IES Generic air-source VRF part load performance data corrected to account for the refrigerant pipe lengths and drops for each system, scheduled reverse cycle defrost for 5% of the time below 2.5°C outside air temperature. Heat recovery within each system has been assumed when there are simultaneous heating and cooling loads occur.

Table A—12 VRF heating and cooling

VRF System	Performance curve set	Refrigerant pipe length (m)	Refrigerant pipe drop (m)	EER	COP	Modelled SCOP	Modelled SEER
Amenities	Generic air-source VRF	50	30	3.3	2.6	2.4	2.0
Commercial units	Generic air-source VRF	50	30	3.3	2.6	2.2	3.0

A.10.2 Split DX Cooling

DX cooling system has been modelled to serve the comms room located in the basement. 5 kW have been allowed in line with the mechanical design with an assumed SEER of 3.7.

A.11 Domestic Hot Water

Domestic hot water for the student bedrooms is generated via dedicated high temperature CO_2 air-source heat pump. There are also six cylinders for the hot water storage along with a secondary circulation loop and a pump. Local electric water heaters have assumed to serve the toilets located in the ground and first floor as well as the commercial units. A diversity factor of 73% has been applied for the student accommodation to account for the students absences due to holidays across the year.

The daily weekday hot-water demand for the student accommodation has been estimated for the ensuites and handwashing and cleaning within the communal toilets. An average of 66,388 litres/ per day with a weekend weighting factor of 100% have been allowed for the student accommodation and 272 litres/per day with a weekend weighting factor of 100% have been allowed for the commercial units.

The volume of water at the shower outlet temperature of 40°C has been calculated based on taking a shower each day with hot water flow rate of 5 l/min per shower with a duration of 7 minutes. Water usage was spread over the day with the maximum at the start of the day, some usage around lunchtime, and minimal consumption at the end of the day, see Table A-13.

Table A—13 DHW usage profiles

Time period	Bedrooms Profile Weekday	Toilets Profile Weekday
0000-0100	0%	0%
0100-0200	0%	0%
0200-0300	0%	0%
0300-0400	0%	0%
0400-0500	0%	0%
0500-0600	0%	0%
0600-0700	10%	0%
0700-0800	15%	0%
0800-0900	15%	10%
0900-1000	10%	10%
1000-1100	10%	10%
1100-1200	0%	10%
1200-1300	10%	10%
1300-1400	10%	10%
1400-1500	0%	10%
1500-1600	0%	10%
1600-1700	0%	10%
1700-1800	5%	10%
1800-1900	5%	0%
1900-2000	10%	0%
2000-2100	10%	0%
2100-2200	10%	0%
2200-2300	5%	0%
2300-2400	0%	0%

The following input parameters for the DHW were included.

Table A—14 DHW system parameters (student accommodation)

DHW	Units	
Fuel		Electricity
Generator		Heat pump delivering water at 60°C (bedrooms) Electric water heaters (amenities)
Storage Capacity	Litres	6 x 1500 (bedrooms) 40 (amenities)
Storage loss factor	kWh/day	0.0035 (bedrooms) 0.07 (amenities)
Secondary circulation pipe losses	W/m	6
Loop length – supply and return	m	4000
Delivery efficiency	%	Bedrooms: 270 Amenities: 100

Copyright © 1976 - 2026 Buro Happold. All rights reserved

Table 7—15 DHW system parameters (commercial units)

DHW	Units	
Fuel		Electricity
Generator		Electric water heaters
Storage Capacity	Litres	40
Storage loss factor	kWh/day	0.07
Delivery efficiency	%	100

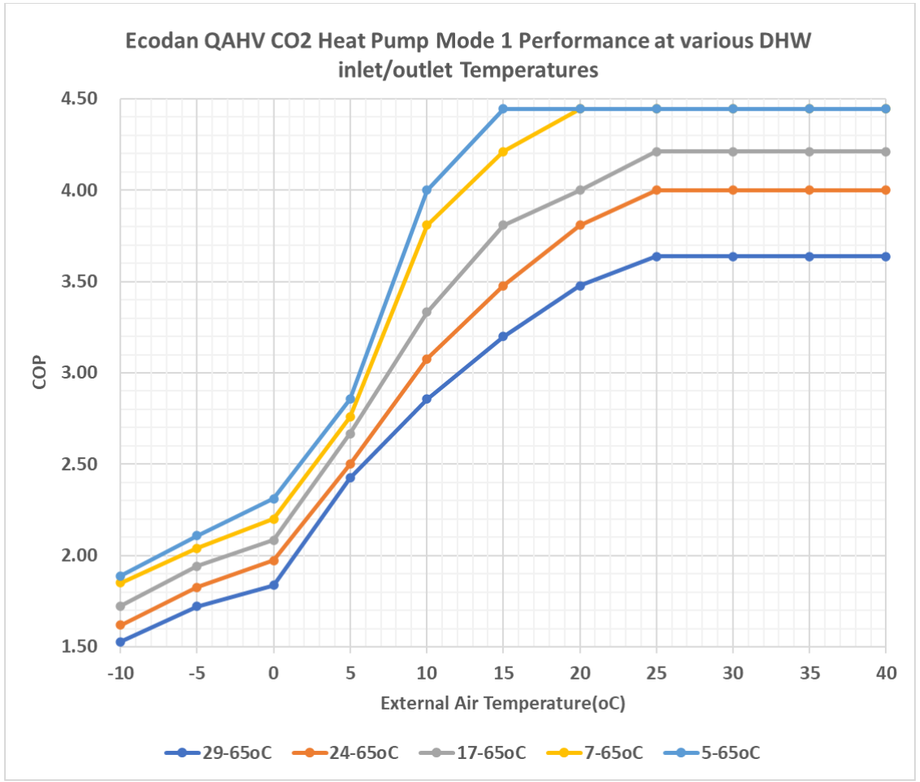


Figure A-8 CO_2 heat pump performance curve

A.11.1 Pumps

For the calculation of pumping energy, the demands predicted by a spreadsheet calculation were used in conjunction with equipment minimum flow rates to determine the pump power for each hour of the year. A minimum turndown of 30% for both primary and secondary pumps with variable speed control has been assumed.

Table A—16 DHW pumps specification

Pump Type	Number of pumps	Rated Pump Power (kW)	Flow rate (l/s)	Pump curve
DHW - Primary	3	2.0	15	Typical VSD
DHW - Secondary	5	1.0	1.25	Typical VSD

A.12 Vertical Transportation

The vertical transportation strategy includes 6 passenger lifts and 1 cycle lift installed in the building. The Lift energy has been calculated using the ISO 25745-2 (2015) method and has been based on the maximum energy consumption for the stated energy efficiency class.

Table A—17 Lift energy consumption input data

Lift reference	Cycle lift	P1	P2	P3	P4	P5	Total
Energy efficiency class	A	A	A	A	A	A	
Number of lifts	1	1	1	1	1	2	7
Specific usage category	2	3	3	3	3	3	
Number of floors	2	9	11	10	39	38	
Travel distance (meters)	3.5	25.5	31.5	28	111.5	107.5	
Nominal load (kg)	2000	1500	1500	1500	1500	1500	
Nominal speed (m/s)	2	2	2	2	2	2	
Lift power consumption (kWh/year)	659	1,888	2,233	2,843	6,839	13,218	27,680

A.13 Switchboard & Reticulation Losses

5% losses have been assumed to account for the LV distribution system losses assuming utility metering will be at LV.

A.14 Photovoltaic panels

PV panels have been included in the design in accordance with the following specification.

Table A—18 PV panels specifications

PV panel area	396 m^2
PV panel efficiency	23%
Peak Output	86.6 kW
Tilt	40° from horizontal
Azimuth	-21°
Annual electricity generation	86,068

Copyright © 1976 - 2026 Buro Happold. All rights reserved

Appendix B Definitions

Table B-1 Energy End use definitions

Energy End Use	Scope
Heating	Space heating consumption (including out-of-hours setback, sometimes called building frost protection). This includes distribution and storage losses. Air heating (e.g. heating coil in an air handling unit (AHU)). Trace heating and frost protection. This includes energy to keep pipework warm, for example to stop a pipe from freezing or to manage legionella risk, as well as frost protection on an AHU. Heat from communal or district heating. Any heat that is exported (generated in the building but used by other buildings) should not be included.
Domestic Hot Water	Domestic hot water heating (including primary and secondary pipework losses, storage losses). Point of use electric water heating and showers
Cooling	Space cooling (including thermal losses). Air cooling (e.g. cooling coil in an AHU). Heat rejection plant: the energy used to reject the heat (fans and condenser pump) where heat rejection is separate from the compressor (e.g. heat rejection fans at roof level reject heat from a water-cooled chiller). Cooling for motor room, plant room, main equipment room, switch room and landlord server room. Tenant server room cooling. Dehumidification plant.
Fans	AHUs and mechanical ventilation with heat recovery (MVHR) units (tenant and landlord). Fan coil unit (or other terminal unit) fans. Exhaust and extract ventilation (landlord). Car park ventilation, lift shaft vent fans if used.
Humidification	Humidification plant.
Pumps	Heating: primary, secondary, tertiary pumps. Cooling: primary, secondary, tertiary pumps. DHW: primary, secondary, tertiary pumps. Boosted cold water services, Cat 5 booster set pump energy. Sewage pumps (for large projects). Rain and grey water, and water treatment pumps.
Lighting - Internal	Internal lighting, lighting controls (parasitic load). Internal car park lighting, Emergency lighting. Other lighting: task lighting, stage/entertainment lighting, display lighting, retail display lighting, architectural lighting.
Lighting - External	External lighting, including external car park lighting, school sports pitch lighting, external signage.
Transportation Systems	Lifts (motor, lighting, ventilation, controls, etc.). Escalators and moving walks.
Receptacle Equipment	Small power, ICT (not server), cleaners' sockets, vending. Washing machines and dryers. Plug-in AV and audio systems.
Specialist Equipment	"Servers (serving the buildings). Datacentre energy (serving other users/companies/customers). Process loads. Laboratory equipment. Specialist medical equipment in hospitals. Pools/spa facilities/hydrotherapy. Other, for example facade access cradle.
Generator	Include compressed air plant
All other uses	Catering Equipment
EV Charging	Refrigeration - cold stores, freezers etc "

Copyright © 1976 - 2026 Buro Happold. All rights reserved

Appendix C Occupancy profiles – student accommodation

Table C—1 Simulation calendar

Start date	End date	Occupancy profile
Jan 1st	Jan 5th	Christmas break
Jan 6th	April 13th	University Term
Apr 14th	April 21st	Spring break
April 22nd	June 11th	University Term
June 12th	Sep 28th	Summer break
Sep 29th	Dec 24th	University Term
Dec 25th	Dec 31st	Christmas break

Table C—2 Student bedrooms occupancy profiles

Studio/Cluster bedroom				Cluster Kitchen		
Hour	Weekday	Weekend	Holiday	Weekday	Weekend	Holiday
00:00	100%	100%	25%	0%	0%	0%
01:00	100%	100%	25%	0%	0%	0%
02:00	100%	100%	25%	0%	0%	0%
03:00	100%	100%	25%	0%	0%	0%
04:00	100%	100%	25%	0%	0%	0%
05:00	100%	100%	25%	0%	0%	0%
06:00	100%	100%	25%	0%	0%	0%
07:00	100%	100%	25%	0%	0%	0%
08:00	65%	100%	25%	50%	0%	0%
09:00	65%	100%	25%	50%	50%	15%
10:00	65%	100%	25%	50%	50%	15%
11:00	15%	40%	10%	0%	50%	15%
12:00	15%	40%	10%	0%	0%	0%
13:00	15%	40%	10%	0%	0%	0%
14:00	15%	40%	10%	0%	25%	15%
15:00	15%	40%	10%	0%	25%	15%
16:00	15%	40%	10%	0%	0%	0%
17:00	15%	40%	10%	0%	0%	0%
18:00	15%	40%	10%	0%	0%	0%
19:00	15%	40%	10%	0%	0%	0%
20:00	65%	100%	25%	50%	50%	15%
21:00	65%	100%	25%	50%	50%	15%
22:00	65%	65%	25%	50%	25%	15%
23:00	65%	65%	25%	50%	25%	15%

Copyright © 1976 - 2026 Buro Happold. All rights reserved

Appendix D Detailed results – student accommodation

Table D—1 Detailed results for the student accommodation

Energy End Use	Baseline (kWh/year)	Off-axis scenario 1 (kWh/year)	Off-axis scenario 2 (kWh/year)	Off-axis scenario 3 (kWh/year)	Combined Off-axis scenario (kWh/year)
Heating - VRF	11,850	6,509	12,870	12,797	6,583
Heating - Electric	538,040	336,227	543,092	552,625	310,172
Cooling - VRF	37,141	45,437	36,908	36,563	44,913
Cooling – Split AC	6,368	6,368	6,368	6,368	6,368
DHW – Heat Pump	607,985	607,985	607,985	675,407	675,407
DHW - Electric	5,186	5,186	5,186	5,736	5,736
AHU Fans	59,789	59,487	78,962	65,932	95,706
Terminal Fans	1,876	1,961	1,953	1,929	1,937
Misc Fans	11,224	11,224	11,224	11,224	11,224
HVAC Pumps	21,470	21,470	21,470	22,312	22,312
Internal lighting	213,373	213,373	213,373	222,996	222,996
External lighting	916	916	916	916	916
Small power	612,038	612,038	612,038	650,704	650,704
Servers	23,625	23,625	23,625	23,625	23,625
Lifts	27,680	27,680	27,680	27,680	27,680
Miscellaneous systems	217,856	197,949	217,773	231,681	210,628
Total	**2,396,417**	**2,177,435**	**2,421,423**	**2,548,495**	**2,316,907**
25% Margin	577,439	522,688	583,900	615,527	557,715
Total with margin	**2,973,856**	**2,700,123**	**3,005,323**	**3,164,022**	**2,874,622**
PV	86,068	86,068	86,068	86,068	86,068
Total net without margin	**2,310,349**	**2,091,367**	**2,335,355**	**2,462,427**	**2,230,839**
Total net with margin	**2,887,788**	**2,614,055**	**2,919,255**	**3,077,954**	**2,788,554**

Copyright © 1976 - 2026 Buro Happold. All rights reserved

Kostas Doumanoglou
Buro Happold Limited
3 Wellington Place
Leeds
LS1 4AP
UK
[redacted]