BURO HAPPOLD

All Saints Library

Energy and Carbon statement

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Glossary

Term	Definition
AHU	Air Handling Unit
ASHP	Air Source Heat Pump
BER	Building Emissions Rate (predicted emissions from the proposed building) for Part L
BMS	Building management system
BRE	Building Research Establishment – the scheme administers for NABERS-UK
BRUKL	Building Regulations UK Part L
BH	Buro Happold
CHP	Combined Heat and Power. This is defined as the simultaneous generation of heat and power in a single process.
CHW	Chilled Water
CQHN	Civic Quarter Heat Network
DHN	District Heat Network
DHW	Domestic Hot Water
HVAC	Heating Ventilation Air Conditioning
LTHW	Low Temperature Hot Water
LZC	Low and Zero Carbon technologies
NCM	National Calculation Methodology (for Part L2 Building Regulation Compliance)
Regulated CO_2 emissions	The CO_2 emissions arising from energy used by fixed building services, as defined in Approved Document Part L of the Building Regulations. These include fixed systems for lighting, heating, hot water, air conditioning and mechanical ventilation.
TER	Target Emissions Rate for Part L
UKGBC	UK Green Building Council
Unregulated CO_2 Emissions	The CO2 emissions arising from energy used by non-fixed building services such as those relating to cooking, all electrical appliances and other small power.

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1 Executive Summary

This Energy and Carbon Statement has been prepared in response to Policy JP-S2: Carbon and Energy, and JP-S3: Heat and Energy Networks, of the 'Places for Everyone Joint Development Plan' and Policies EN4 and EN6 of Manchester Local Development Framework Core Strategy Development Plan and applies to the All Saints Library.

The focus has been to develop a library building which is highly energy efficient by following the principles set out in the energy hierarchy to ultimately reduce the carbon emissions associated with operational energy of the development. Passive design measures have been considered to reduce overall energy demand, including the use of high-performing building fabric and optimised glazing ratios. High-efficiency building services shall also be specified to minimise energy consumption once the passive measures have been considered. Available LZC technologies have also been appraised, with the most suitable and feasible technology identified (photovoltaics) to provide further operational CO_2 emission reductions.

The Proposed Development has been subject to dynamic thermal modelling to assess the energy performance of the building and to quantify the CO_2 emissions and how the building performs against the various energy performance metrics. The results indicate that, by following the principles of the energy hierarchy, the proposed development achieves compliance with Policy EN4, EN6 and PfE Policy JP-S2 and JP-S3. The modelling results also indicate that the proposed development is on course to comply with Part L2 2021 of the Building Regulations (2023 amendments) and achieve the required credits under BREEAM ENE01. Based on the modelling, the building is expected to achieve an Energy Use Intensity (EUI) of 107.3 kWh/m^2 GIA per year, while the upfront embodied carbon is estimated at 603 kgCO_2e/m^2 GIA, demonstrating strong alignment with sustainability objectives.

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1.1 Energy and Carbon Proforma

Energy and Carbon Proforma
Non-residential
Major development *(+1,000m²)*
Version 1.0

GMCA GREATER MANCHESTER COMBINED AUTHORITY

Project Name: Manchester Metropolitan University Library Transformation
Application ref:
Date: 20/10/2025

		Ref. name	MMU Library					
		Area (m² GIA)	11709					
		Target values	**Building 1**	**Building 2**	**Building 3**	**Building 4**	**Building 5**	**+**
Minimise energy demand	**Space heating demand (kWh/m²GIA/yr)**	***≤ 15***	6.7					
	Space cooling demand (kWh/m²GIA/yr)	***≤ 15***	6.4					
	Calculation methodology used to calculate space heating demand and confirmation that this covers all homes/blocks	*Predictive energy model*	Dynamic thermal simulation					
	Form factor per building	*≤ 2*	0.51					
	Average external wall U-value (W/m²K)	*≤ 0.15*	0.22					
	Average window U-value (W/m²K)	*≤ 1 (triple)*	1.6					
	Air permeability rate (m³/h/m² @ 50 Pa)	*≤ 1*	2.5					
Maximise energy efficiency	**BREEAM Ene 01 rating**	***Excellent***	Excellent					
	Energy use intensity (kWh/m²GIA/yr)	-	107.3					
	Calculation methodology used to calculate energy use intensity and confirmation that this covers all homes/blocks	*Predictive energy model*	Dynamic thermal simulation					
Use renewable energy	**PV footprint area (% of ground floor space)**	**-**	32%					
	Annual renewable energy generation (kWh/m² building footprint/yr)	-	8.2					
	Renewable energy balance (%)	-	8%					
	Total energy used (kWh/yr)	-	1230682					
	Total energy generated on-site (kWh/yr)	-	98638					
Use low carbon energy	**Fossil fuel free (yes/no)**	***Yes***	Yes					
	Heat source	*Electric*	Electric					
	Low Carbon Heat Appraisal completed	*Yes*	Yes					
	Heat network suitability	-	No					
	Exemption requested	-	Yes					
	Efficiency of heating system (SCOP)	*≥ 3.5*	2					
	Carbon content of heat (gCO_2/kWh)	*≤ 100*	47					
Reduce overheating risk	**Has CIBSE TM52 been used to calculate overheating and does the building pass?**	***Yes***	No					
	What percentage of spaces are cooled? (% of GIA)	-	80%					
	Has a CIBSE TM52 assessment been carried out using DSY2 and DSY3 weather files? Have any additional passive measures been included as a result?	*Yes*	No					
Minimise embodied carbon	**Upfront embodied carbon ($kgCO_2e/m^2GIA$)**	**-**	603					
	List top three materials with the highest upfront embodied carbon emissions ($kgCO_2e/m^2GIA$): Material 1	-	Concrete	176				
	Material 2	-	Rebar	60				
	Material 3		Glass	29				
	Lifecycle embodied carbon ($kgCO_2e/m^2GIA$) - *for large major developments only*	-	1184					
Offsets	**Offset contribution (£)**	**-**						

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1.2 Project Overview

This Energy and Carbon Statement has been prepared in response to Policy JP-S2: Carbon and Energy, and JP-S3: Heat and Energy Networks, of the 'Places for Everyone Joint Development Plan' and Policies EN4 and EN6 of Manchester Local Development Framework Core Strategy Development Plan and applies to the All Saints Library.

The proposals comprise the development of a nine-storey library building (Use Class F1 - Learning and non-residential institutions), public realm, access and servicing arrangements and other associated works.

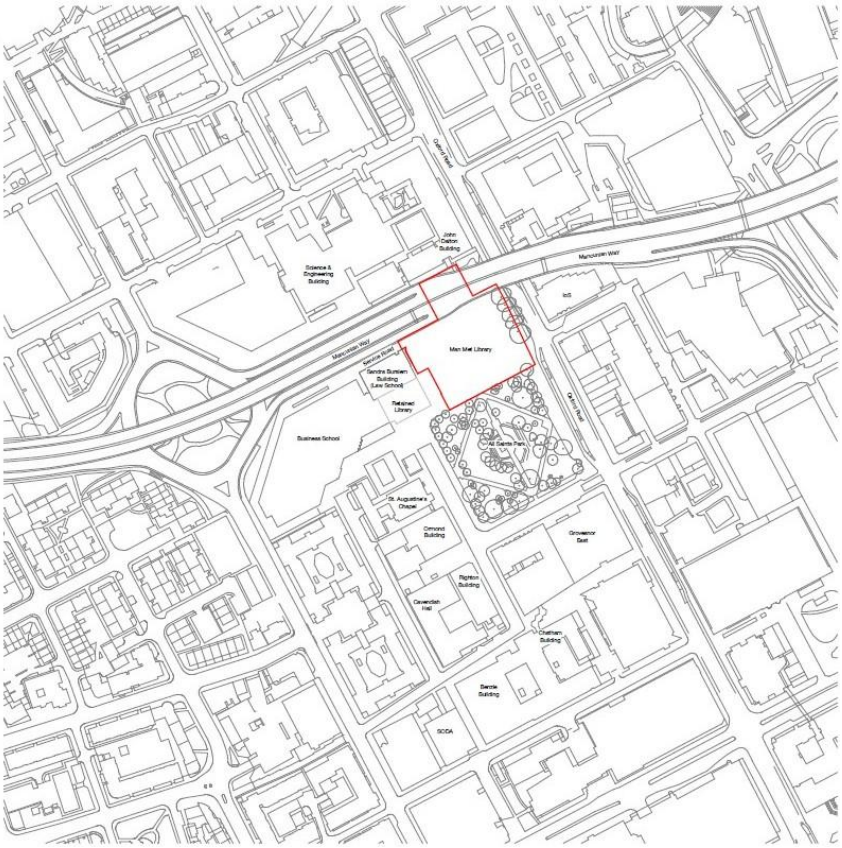


Figure 1—1 The Proposed Development, All Saints Library

This site is within Manchester City Centre and is bounded by Oxford Road to the east, by the Mancunian Way to the north, Manchester Metropolitan University's faculty of Business and Law to the west, and All Saints Park to the south. The Site currently comprises the vacant All saints Library Building – a nine storey brick building. The building on site is considered no longer fit for purpose and has been vacant since summer 2024. The site is subject to a planning application (submitted August 2025) for demolition – due to be determined early December 2025.

The focus has been to develop a library building which is as energy efficient as possible by following the principles set out in the energy hierarchy to ultimately reduce the carbon emissions associated with operational energy of the development. Passive design measures have been considered to reduce overall energy demand, including the use of high performing building fabric and optimised glazing ratio. High efficiency building services shall also be specified to minimise energy consumption once the passive measures have been taken into account. Available LZC technologies have also be appraised, with the most suitable and feasible technology identified (photovoltaics) to provide further operational CO2 emission reductions.

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The Proposed Development has been subject to a dynamic thermal model in order to assess the energy performance of the building and to quantify the CO_2 emissions and how the building performs against the various energy performance metrics. The results indicate that, by following the principles of the energy hierarchy, the proposed development achieves compliance with Policy EN 4, EN 6 and PfE Policy JP-S2 and JP-S3. The modelling results also indicate that the proposed development is on course to comply with Part L2 2021 of the Building Regulations (2023 amendments), and achieve the required 4 credits under BREEAM ENE01.

Table 1—1 Summary of proposed development's responses against planning policies

Policy	Response
Ore Strategy: EN4: Reducing CO2 emissions by enabling low and zero carbon development	The proposed development is designed to be "all-electric", with no reliance on gas or fossil fuel for the heating of the premises. The use of heat-pump heating and cooling will take advantage of the advancing decarbonisation of the electricity grid. In addition, in line with Policy JP-S2, 500 m^2 roof mounted photovoltaic (PV) panels will be installed.
Core Strategy: EN5: Strategic areas for low and zero carbon decentralised energy infrastructure Places for Everyone: JP-S3: Heat and energy networks	The proposed development is designed to be 'all-electric'. Connecting to the nearby Civic Quarter Heat Network (CQHN) is concluded to be not economically or practically viable. The energy centre of CQHN contains fossil fuels which is against the university's sustainable construction tracker.
Core Strategy EN6: Target Framework for CO_2 reductions from low or zero carbon energy supplies Places for Everyone: JP-S2: Carbon and energy	The proposed development is better than building regulations Part L 2021 notional building by 6.1%. This is achieved by following the energy hierarchy: • A passive-first approach with optimised glazing ratio and low g-value glazing to minimise energy demand • Energy efficient HVAC systems including air-source heat pumps for heating and cooling and LED lighting with daylight dimming control • On-site renewables with 500 m^2 roof mounted photovoltaics It also achieves BREEAM 'Excellent' for the 'Ene 01 – reduction of energy use and carbon emissions. Offsetting payments are not required with this planning application as Manchester City Council has not yet set standards locally for carbon offsetting payments.

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2 Building Fabric and Ventilation

2.1 Building Form, and Heat Loss Envelope

The building is a university library located in Manchester, it will comprise mostly of open plan study spaces but will also include smaller bookable rooms, dedicated IT suites as well as spaces for the storage and reading of special collection items.

The library comprises of six principal floors plus a mezzanine level (between the ground and first floor), and an additional mechanical and electrical (MEP) floor at the top (Level 7), which is not occupied. The overall form is relatively simple, with a flat roof incorporating enclosed and screened plant areas.

The façade design includes:

- Large double-height curtain wall glazing on the southern ground floor, extending toward the north-eastern ground floor
- Simple glazing on all other facades, with some areas of double-height glazing
- Two vertical cores located on the eastern and western facades.

The building footprint also contains unheated spaces including staircases, storerooms, MEP spaces (electrical switch rooms, life safety systems), risers, smoke shafts, lift and lobbies.

The following form factor was calculated from the Part L IES model dated 15/09/2025.

Table 2—1 Form factor calculation

GIA	External wall area	Form factor
12,021 m^2	5,938 m^2	0.51

2.2 Elevation Design and Window Proportions

The building facade has been developed in a way that the solar gains have been minimised in the south and west façade and at the same time the amount of daylight through the north and east facade has been maximised. This design allows for the cooling demand from the solar gains to be low and the energy use from artificial lighting to be minimum due to the daylighting dimming control across the perimeter zones of the building.

Table 2—2 Window to wall ratios

Façade	Window-to-wall ratio %
North	33%
East	25%
South	30%
West	19%

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2.3 Heated and Unheated Spaces

Unheated spaces within the building footprint have been identified and are shown in the zonal layouts of the MEP strategy. These drawings illustrate the thermal envelope in both plan and section, clearly distinguishing between heated and unheated zones. The layouts are included in the Appendix A and provide a spatial overview of thermal boundaries in relation to the building services strategy.

Unheated spaces:

- Staircases
- Lifts
- Storerooms
- Risers
- Lobbies
- MEP spaces.

2.4 Building Fabric Specifications and Airtightness

Table 2—3 Building fabric performance

Specification	Unit / element
Airtightness	2.5 m^3/m^2.hr @ 50 Pa
Average U-values	Ground floor: 0.10 W/m^2.K External wall: 0.22 (Inc. non-repeating bridges) W/m^2.K Curtain wall: 1.6 (10% frame) W/m^2.K Roof: 0.10 W/m^2.K
Window U-value	1.3 (10% frame) W/m^2.K
Door U-value	1.3 W/m^2.K
Glazing g-value	0.25 (LT 60%)
Thermal bridging	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.

2.5 Ventilation System

The building will utilise a mechanical ventilation system with heat recovery (MVHR) to provide background ventilation throughout all internal spaces. This strategy is based on a displacement ventilation and comfort cooling approach, designed to maintain thermal comfort across the building. Mechanical ventilation will be delivered via rooftop air handling units (AHUs), located within a covered plant area to facilitate maintenance during adverse weather conditions. Each AHU will be equipped with filters, heat recovery, cooling coils, and heating coils, and will supply fresh air while extracting stale air in accordance with Building Regulations Part F and the All Saints Library Design Criteria. Fresh air provision will meet a rate of 12 l/s/person per floor, with an 80% occupancy diversity factor applied to avoid oversizing of mechanical plant.

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2.6 Space Heating Demand

The space heating demand for the building has been calculated using predictive energy modelling in IES Virtual Environment (version 2024.1.1.0). The computational building energy simulation provides an estimate of building energy performance based on a simplified and idealised model of the building and its control.

Based on this analysis, the predicted space heating demand is 6.7 kWh/m^2/year, delivered via air source heat pumps (ASHP) operating on an air-to-water configuration. This figure reflects the efficiency of ASHP technology and the impact of design measures to minimise heating loads.

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3 Maximise Energy Efficiency

3.1 Energy Use Intensity

The operational energy performance modelling work carried out for this building is as per CIBSE TM54 methodology. The predicted gross energy estimate is between 107 kWh/m^2 and 134 kWh/m^2 representing the range that could be expected when operating the building varying usage.

Based on the simulation results and supplementary calculations, the building is projected to consume approximately 107.3 kWh/m^2 annually, excluding contributions from photovoltaic (PV) systems. However, recognising that the building is unlikely to operate under ideal conditions, a 25% contingency margin has been applied to the estimate. This adjustment places the expected energy use within the range of 107 to 134 kWh/m^2. Adding the contribution from PV, the energy use intensity reduces between 99 kWh/m^2 to 126 kWh/m^2.

3.2 Efforts to Reduce Energy Use of Equipment

The 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 ratio to limit unwanted solar gains. Glazing with optimum g-value (0.25) 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 – Air handling units (AHU) have been designed to minimise system pressures and maximise fan wire to air efficiencies. Outdoor air is supplied to the zones at a maximum rate of 12 L/s/m2 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.
- 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.). For example, lift lobby, toilets and stair areas will be switched on motion sensors. Stair areas will maintain a minimum illumination for safety purposes.
- Renewable Energy Systems – A 115 kWp photovoltaic (PV) array has been included on the rooftop of the development.
- Cooling Plant – Space cooling is delivered to the offices by a chilled water (CHW) air-source heat pump (ASHP) feeding the trench units, fan coil units and slab cooling. DX cooling is provided to comms rooms.
- Heating Plant – Heating hot water is delivered to the building by a lot temperature hot water (LTHW) air-source heat pump (ASHP) feeding the AHUs as well as the trench units and fan coil units.
- Domestic Hot Water (DHW) Plant – DHW is provided by a dedicated CO2 air-source heat pump.

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4 Renewable Energy Generation

4.1 Proposed Renewable Energy Generation System

Table 4—1 PV panels specification

Description	Solar PV
Orientation	140° from N (SE)
Tilt	30° (Horizontal)
Peak output (kWp)	115
PV area as a percentage of ground floor area	32%
Expected annual renewable energy generation	98,638 kWh/yr
Annual renewable energy generation per m^2 GIA	8.2 kWh/yr/m^2.GIA
Balance between total energy use and renewable energy generation	8%

The image below shows the area on the roof where the 500 m^2 of PV will be placed (shaded in yellow). To the North lie the two roof plant spaces, either fully enclosed or screened.

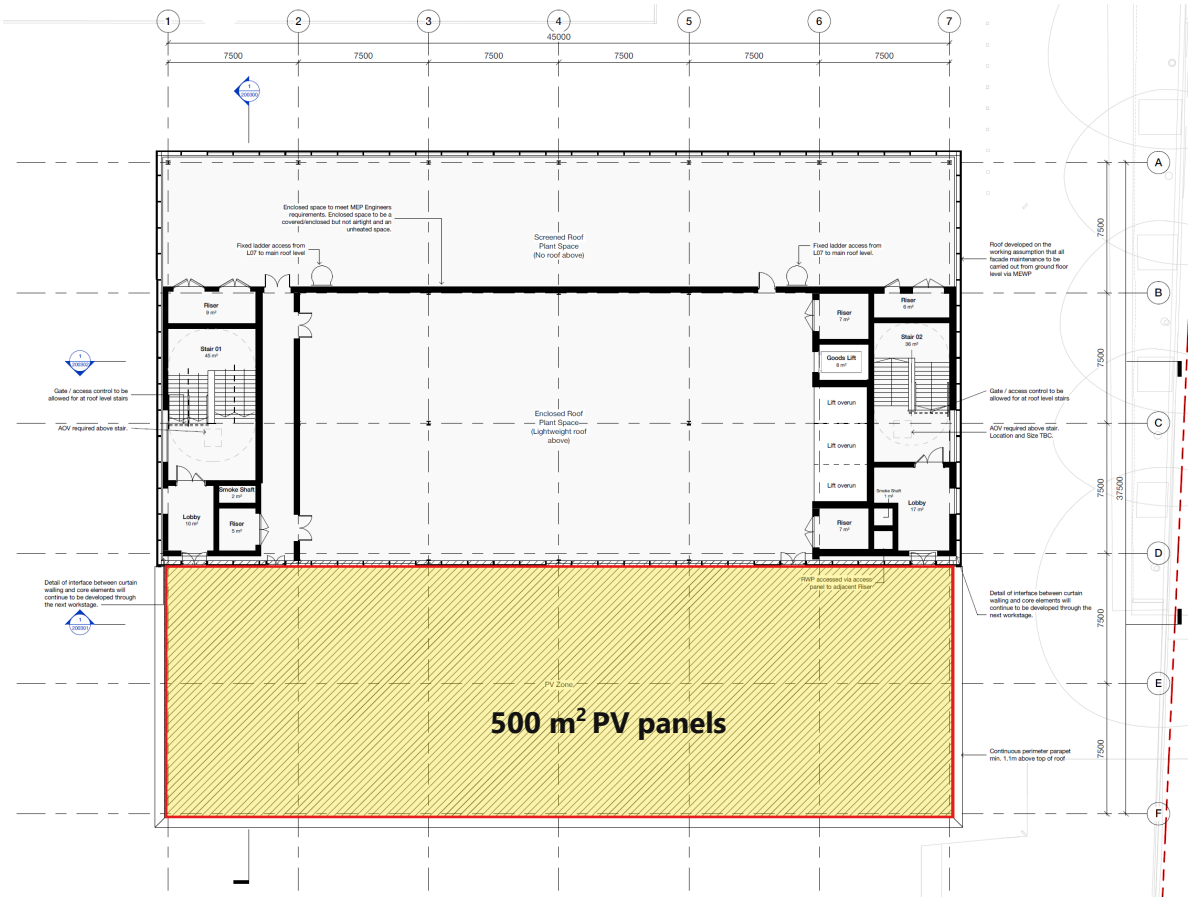


Figure 4—1 Roof layout

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4.2 Renewable Energy Balance

The libraries total energy usage has been calculated to be 1,230,682 kWh/year as outlined in section 2.1. The expected annual renewable energy generation is 98,638 kWh/year. The table below summarises the calculated renewable energy balance.

Table 4—2 Renewable energy balance

Total energy usage (kWh/yr)	PV energy generation (kWh/yr)	Energy balance
1,230,682	98,638	8%

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5 Low Carbon Heating

5.1 Fossil Fuel Free

The proposed development is designed to be "all-electric", with no reliance on gas or fossil fuel for the heating of the premises. The use of heat-pump heating and cooling will take advantage of the advancing decarbonisation of the electricity grid. In addition, in line with Policy JP-S2, 500 m2 roof mounted photovoltaic (PV) panels will be installed on the roof.

5.2 Proposed Systems for Heating and Hot Water

The building will be cooled using air source heat pumps (ASHPs) configured for reverse cycle operation, allowing them to provide both heating and cooling. The ASHPs will be sized to meet the building's cooling loads with extra capacity for resilience, and each unit will be capable of operating independently with a low turndown ratio of 20% to maintain efficiency during low-load periods.

Domestic hot water is generated via dedicated high temperature CO2 air-source heat pump. There are also two cylinders for the hot water storage along with a secondary circulation loop and a pump.

5.3 Summary of Comparison with Other Systems from Low Carbon Heat Appraisal (Including Low Carbon Heat Networks)

A Low and Zero Carbon (LZC) feasibility study has been undertaken for the proposed development. The feasibility study has been undertaken to assess each potential LZC technology and understand how feasible it would be to implement the technologies across the site, and to discount any unsuitable options at an early stage. A summary of the LZC technology appraisal is shown in Appendix B.

The Proposed Development is in proximity to the Civic Quarter Heat Network. The energy centre features a combined heat and power engine along with two gas boilers serving buildings like Manchester Central, Town Hall and the Central Library. A feasibility study was carried out to assess the potential connection and viability for All Saints Library. It has been concluded that a heat network approach for the Proposed Development is not economically or practically viable. In addition, the University's Sustainable Construction Tracker states that the use of fossil fuels is precluded and therefore the building has been designed to be 'all-electric'.

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5.4 Proposed System for Cooling

The building will be cooled using air source heat pumps (ASHPs) configured for reverse cycle operation, allowing them to provide both heating and cooling. These units are highly efficient and will use refrigerants equivalent to or better than R32, in line with sustainability requirements. The ASHPs will be sized to meet the building's cooling loads with extra capacity for resilience, and each unit will be capable of operating independently with a low turndown ratio of 20% to maintain efficiency during low-load periods.

Thermal buffer vessels will be included to improve part-load performance and prevent short cycling of the compressors. The chilled water temperature produced by the ASHPs will vary throughout the year based on outdoor conditions and the need to dehumidify incoming air, helping to prevent condensation on chilled slabs. The ASHP units will be located externally, such as on the roof or in a designated plant area, while the thermal buffer vessels will be housed internally within the plant room.

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6 Overheating Risk

6.1 Overheating Risk Assessment

Initial design measures to reduce overheating risk and limit solar gains were developed in line with the cooling hierarchy, prioritising passive strategies. These measures are summarised in the table below.

As the development will be comfort cooled, the risk of overheating will be mitigated, ensuring a comfortable indoor environment for occupants. Approximately 80% of the spaces will be mechanically cooled.

A detailed thermal comfort assessment will be carried out at Stage 4 against the present and future weather scenarios (DSY2 and DSY3 weather files). It is anticipated that operative temperatures during summer will comply with the CIBSE Guide A recommended operative temperature range.

Table 6—1 Cooling hierarchy

Cooling hierarchy measure	Recommendation
Minimise internal heat generation through energy efficient design	
High efficiency lighting installations (LED)	LED lighting fittings will be installed in all spaces minimising the heat gains and the cooling demand from lighting.
Low temperature hot water (LTHW) pipework design and installations (location, configuration and insulation) to minimise heat losses.	Primary distribution within the block is recommended to be vertical rather than horizontal to reduce pipe lengths. The design team have also worked to minimise pipe run lengths.
Reduce the amount of heat entering the building	
Solar control	Glazing ratios have been carefully selected to minimize overheating risk, without compromising energy or daylight. Solar control glazing on all windows to achieve g-value = 0.25
Use of thermal mass to cool the building	
Exposed concrete slab	Chilled water is running thought pipes within slab. This method utilises the large thermal mass of concrete as a buffer for the changing cooling or heating loads during the day.
Heat recovery	
Mechanical ventilation with heat recovery	All occupied spaces will be provided with mechanical ventilation with heat recovery to reduce the energy use for heating.
Active/comfort cooling	
Provision of cooling	Following the implementation of passive measures to reduce the risk of overheating and high cooling demand on the hottest days of the year and the more extreme weather scenarios, active mechanical cooling is provided to all occupied spaces.

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7 Materials

7.1 Upfront Embodied Carbon

The Stage 3 Whole Life Carbon Assessment (WLCA) for the All Saints Library estimates upfront embodied carbon (A1–A5) at 603 $kgCO_2e/m^2$ GIA, equating to 7,246 tCO_2e overall. This is approximately 5% above the UK Net Zero Carbon Building Standard (UKNZCBS) 2027 target of 575 $kgCO_2e/m^2$, but within a manageable margin for improvement through Stage 4 procurement and specification refinement.

The elemental breakdown shows:

- Superstructure: 223 $kgCO_2e/m^2$ (40% of A1–A5)
- Building envelope: 127 $kgCO_2e/m^2$
- MEP systems: 94 $kgCO_2e/m^2$
- Substructure: 50 $kgCO_2e/m^2$

Structural lean design:

- Concrete mix optimisation: Substructure and superstructure concrete specified with ≥50% GGBS replacement and UK CARES certified rebar (97% recycled content), reducing cement-related emissions.
- Structural steel reuse: 20% reused steel sections incorporated into the frame.
- Grid and depth efficiency: Structural grid and slab depths rationalised to minimise material volume while maintaining performance.
- Reduced foundations: Lighter superstructure allowed for smaller pile caps and optimised ground slab thickness.
- Slab type: In-situ reinforced concrete slabs retained for thermal mass benefits, but with SCM optimisation.

Architectural lean design:

- Façade rationalisation: Glazed terracotta rainscreen and aluminium sub-framing systems reviewed to reduce layering and bracket density.
- Recycled aluminium: Targeting ≥75% recycled content for extrusions and louvres (e.g. Hydro Circal, Purso Greenline).
- Window-to-wall ratio: Optimised to balance daylighting and thermal performance without excessive glazing.
- Multi-purpose components: Integrated shading and ventilation features within façade elements to avoid additional metal components.

Building services lean design:

- Passive measures: High-performance envelope and thermal mass reduce reliance on active cooling.
- Ductwork optimisation: Early coordination to minimise steel duct lengths and diameters.
- Refrigerant specification: Low-GWP refrigerants selected for DX units and heat pumps.
- Circular approach: Future-proofing through modular plant design and potential supplier take-back schemes.

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7.2 Life cycle carbon analysis

The life cycle embodied carbon assessment for the All Saints Library has been carried out in accordance with RICS Whole Life Carbon Assessment for the Built Environment (2023), covering modules A-C over a 60-year reference study period. Two scenarios were modelled:

- Non-decarbonised grid
- Decarbonised grid (FES 2021 trajectory)

Results:

Life-cycle embodied carbon (A-C, excl. B6 & B7):

- Non-decarbonised: 1,184 $kgCO_2e/m^2$ (14,236 tCO_2e)
- Decarbonised: 898 $kgCO_2e/m^2$ (10,797 tCO_2e)

Whole life-cycle carbon (A-C incl. operational energy & water):

- Non-decarbonised: 3,268 $kgCO_2e/m^2$ (39,286 tCO_2e)
- Decarbonised: 1,571 $kgCO_2e/m^2$ (18,887 tCO_2e)

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8 Offsets

8.1 Offsetting

From the latest GMCA Net Zero Guidance, the decision to include offsetting is to be determined by each local authority in Greater Manchester. It is our understanding the Manchester City Council have not yet set standards locally for carbon offsetting payments. Therefore, on this basis, offsetting payments are not required with this planning application.

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9 Building Regulations Compliance Part L

This section intents to inform the energy strategy for reducing CO_2 emissions for the New All Saints Library for Manchester Metropolitan University to comply with the Building Regulation Part L2A 2021 and Manchester City Council relevant planning policies. A snapshot of the BRUKL document can be found in Appendix E.

It is demonstrated that the proposed building meets all the requirements as below:

Table 9—1 Summary of the outcome

Element	Project Requirement	Stage 3 Results	Notes
Building Regulations Part L Compliance	Compliance	Compliance	6.1% pass margin
EPC Rating	"A" rating	"A" rating	Rating of 12 achieved at RIBA Stage 3, comfortably within the 0-25 rating required to achieve an EPC "A" rating
BREEAM Ene01 Credits	Minimum of 4	4	
On site renewable energy contribution (kWh/m^{2}footprint/yr)	Minimum of 40	60	Initial estimate based upon RIBA Stage 3 proposed PV areas (500 m^2) and building massing

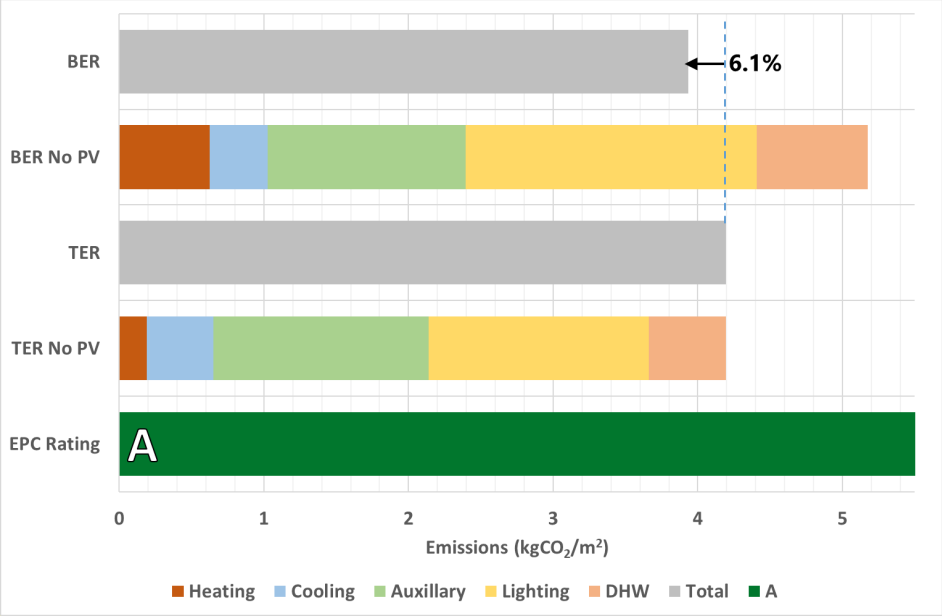
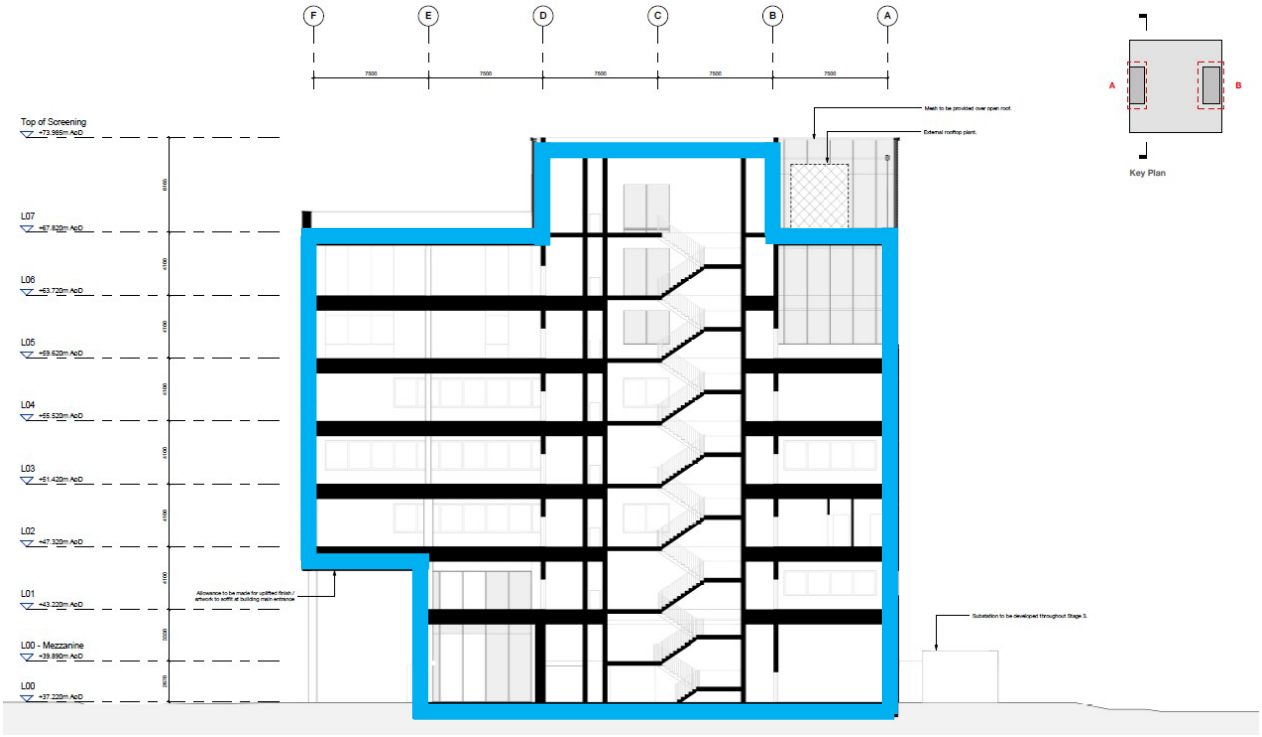
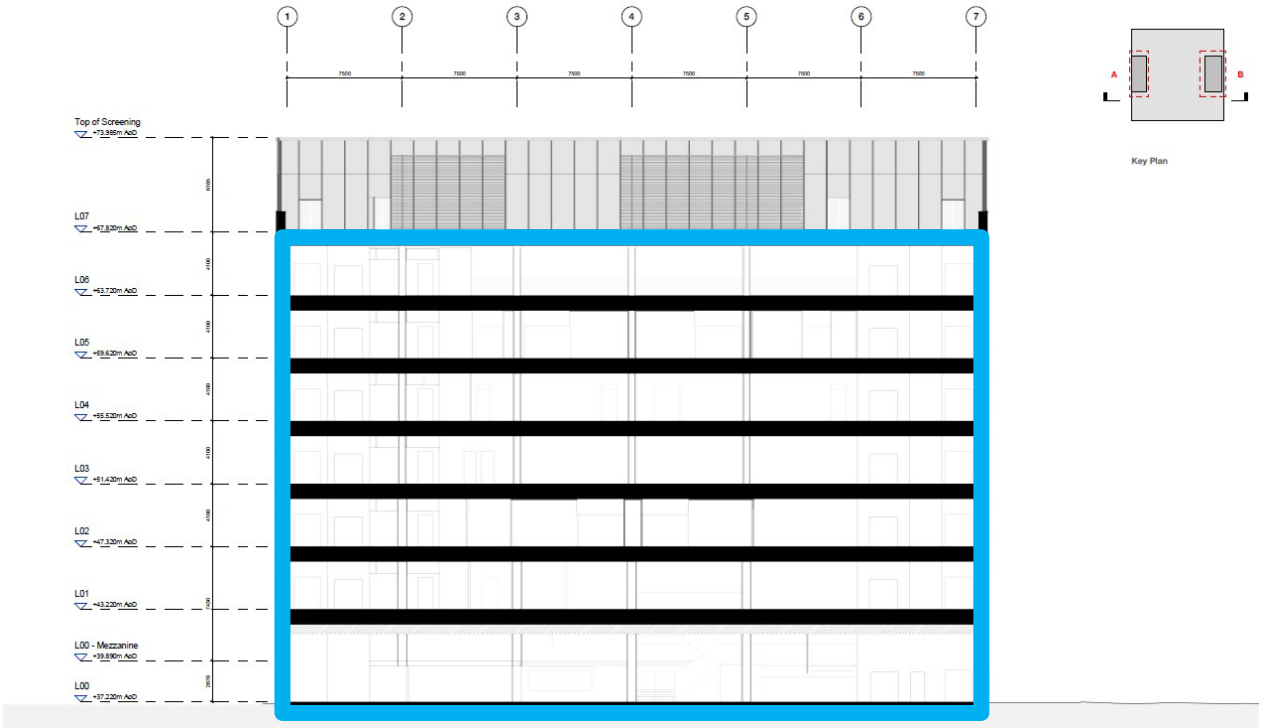


Figure 9—1 Carbon emissions breakdown for each energy use category, actual and notional building

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Appendix A Thermal Line Strategy





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Appendix B Low Carbon Heat Appraisal

Table B—1 Low zero carbon heat appraisal

Technology	Functionality	Cost Effectiveness	Potential CO_2 Savings	Potential Suitability
Solar Thermal – generation of hot water from the sun	Energy generation would be modest, however solar collectors and hot water storage could be coordinated close to each other to reduce circulation losses. Hot water demand is not likely to be consistent throughout the day however so its effectiveness would be limited.	Generally a lower capital cost compared to other LZC technologies	Low – this will depend on whether it displaces an electric or gas based systems, and the demand for hot water. Either way, it is likely to have a modest impact on carbon emissions.	**No** – the lack of steady hot water demand and modest energy generation mean the roof space required for solar collectors would be better used for an alternative technology such as PV.
Photovoltaics – generation of electricity from the sun	The proposed development has south facing roof areas where PV could be located. Once installed, maintenance is minimal and reliability is high. A wide range of installation options are available.	Electricity bill reductions will depend on the size of the systems installed.	Low/Medium – however depends on the size of the system used. The larger the system, the lower the net carbon emissions.	**Yes** – this technology is feasible as it can be physically coordinated, is reliable and can offer good carbon emission reductions.
Combined Heat & Power (CHP) – generation of electricity on site and use of heat by product	Considered as a low carbon rather than a zero carbon technology, unless it is fuelled on a renewable fuel. Requires a predictable and relatively constant load, however this cannot be guaranteed in this case.	Payback could be low for a fully utilised system, but where it cannot run for long periods and is poorly sized it can lead to 'heat dumping' in summer.	Medium - the overall system can have a big effect on emissions. Although the heating side is generally less efficient than say a gas system, the electricity generated is then carbon 'free'. However, if the CHP is only sized for the base load, the benefits can be greatly reduced as it may not command a large part of the peak load.	**No** - the lack of a guaranteed constant load and the potential need to 'dump' excess heat from what is a low heat loss building would make CHP plant impractical and unviable. CO_2 Emissions from gas CHP will be increase to higher than that of a gas boiler over the lifetime of the building due to the decarbonisation of the electricity grid.
Ground Source Heat Pumps (GSHPs) – generation of heat from the ground	Can be a very efficient way of heating a building, using the ground as a heat source. An efficient system can produce 3 to 4 units of heat for every unit of electricity used. Closed loop horizontal or vertical pipework systems	A medium sized system with an overall COP of 3 could be expected to achieve a payback of about 20 years. The ground works are the most expensive part of the system, while the heat pumps can be of a	Medium/High – high COPs are dependent on relatively low supply temperatures.	**No** - there is insufficient accessible ground space around the building to install a closed loop system. Also, given the city centre location of the site, the ground is unlikely to be free from obstructions, such as sewers and other services.

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Technology	Functionality	Cost Effectiveness	Potential CO_2 Savings	Potential Suitability
	required within the ground to utilise the ground as a heat source.	comparable price to conventional boilers.		
Air Source Heat Pumps (ASHPs) – generation of heat from external air	COPs are inferior to that of GSHPs due to varying air temperatures. Also generate low grade heat typically used to serve LTHW systems. ASHPs work best when serving a steady base load and at a constant output. Both buildings have suitable external roof space to locate ASHPs.	Capital cost is lower when compared to GSHP installations with similar capacities. A medium sized system with an overall COP of 2.5 could be expected to achieve a reasonable payback period.	Medium/High – depends on the size of system and COPs that can be achieved.	**Yes** – this technology would be feasible as there is suitable plant space and can offer reasonable carbon savings.
Wind – generation of electricity from wind	Best performance in open, non-urban locations. Can be installed on or integrated into a building.	Generally the small scale units generate only modest levels of power, which lead to extremely high payback periods.	Low/Medium – Large sized turbines in non-urban or off-shore locations will be more effective.	**No** - given that the project is in an urban area, it is expected that obstacles will be present and wind patterns will be poor.
Biomass – generation of heat from burning biological material	Considered a zero carbon technology because it uses the closed loop of the carbon cycle. Can replace gas boilers, however requires a large fuel storage facility.	More expensive than conventional gas fired boilers.	Medium/High – this can have a significant impact on the carbon emission of the heating system, but since electricity commands the larger share of a buildings' overall emissions, the impact will be somewhat limited.	**No** – there is no suitable location to site a silo and sourcing a consistent and reliable supply in an urban area is likely to be difficult. It will also affect negatively the local air quality.

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Appendix C Embodied Carbon Calculations

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New Library
Whole life cycle assessment

Hawkins\
Brown

Document history & authorisation

Version	Status	Date	Description
P01	S3 – For Review & Comment	31.10.25	Stage 3 Issue

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Project description
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Benchmarks

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Embodied carbon
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Embodied carbon
Operational carbon
Whole life carbon
Conclusion

Appendices
A RICS table
B Operational water

Audit sheet

Asset-related technical characteristics		
Project name	Manchester Metropolitan University New Library	
Asset type	New-build	
Sector and subsector	High education, Library	
Project phase	RIBA Stage 3	
Project description	New library design for Manchester Metropolitan University	
Location	Manchester	
Date of completion of construction	n/a	
Primary normalisation / functional unit	Sub asset 1: New Library GIA (m^2)	Sub asset 2: External works External area excl. building footprint
Breakdown of GIA by use type	12,021 m^2	4,322 m^2
Building height above ground	36.7m	
Number of storeys above ground	7	
Types of main materials / technologies used in building elements	Reinforced concrete structure, ceramic rainscreen, handset brick cladding, raised access floor, carpet flooring, rubber flooring	
Types of main building services	ASHP, in slab cooling, fan coil units, trench heating, central AHU	

Assessment information	
Goal and scope of the assessment	Inform the client on the embodied carbon emissions of the development and identify the carbon hotspots to help improve the carbon impact leading into the next stage of the project.
Project phase of the assessment	RIBA Stage 3
Name/company of the assessor	Ben Gur, Hawkins\Brown
Date of assessment	31.10.2025
Internal QA	Julia Galves, Hawkins\Brown
Assessment scope/type	Full RICS PSv2 2023
Date of completion of construction	n/a
Key material quantities with associated carbon factors and data sources	See 'Results – embodied carbon' section
Key assumptions and scenarios	See 'Methodology – embodied carbon' section
Exclusions and variations from RICS PS v2 standard	n/a
Conclusions and recommendations	See 'Results – next steps and recommendations' section

Audit sheet

Results summary - Sub asset 1 MMU New Library Building	**Overall carbon** (tCO_2e)	**Carbon per m² GIA** ($kgCO_2e/m^2$)
Upfront carbon (A1-A5); incl. uncertainty	7,246	603
Life-cycle embodied carbon (A-C exc. B6&B7) No decarbonisation scenario; incl. uncertainty	14,236	1,184
Life-cycle embodied carbon (A-C exc. B6&B7) Decarbonisation scenario FES 2021; incl. uncertainty	10,797	898
Whole life-cycle embodied carbon (A-C) No decarbonisation scenario; incl. uncertainty	39,286	3,268
Whole life-cycle embodied carbon (A-C) Decarbonisation scenario FES 2021; incl. uncertainty	18,887	1,571

Results summary - Sub asset 2 External works	**Overall carbon** (tCO_2e)	**Carbon per m² GIA** ($kgCO_2e/m^2$)
Upfront carbon (A1-A5); incl. uncertainty	296	68
Life-cycle embodied carbon (A-C exc. B6&B7) No decarbonisation scenario; incl. uncertainty	566	131
Life-cycle embodied carbon (A-C exc. B6&B7) Decarbonisation scenario FES 2021; incl. uncertainty	433	100
Whole life-cycle embodied carbon (A-C) No decarbonisation scenario; incl. uncertainty	1,031	239
Whole life-cycle embodied carbon (A-C) Decarbonisation scenario FES 2021; incl. uncertainty	531	122

Executive summary

This whole life-cycle carbon assessment has been prepared by Hawkins\Brown and provides an updated estimate of the carbon impact at Stage 3 of the MMU Library Redesign project.

Purpose of document

This report displays the results of the whole life-cycle analysis (WLCA), based on Stage 3 design information. The study estimates the embodied and operational carbon emissions of the proposed development and offers reduction strategies. The primary aim is to inform the design team about the project's carbon at practical completion and over the building's reference study period of 60-year life cycle.

Methodology

The analysis is based on BS EN 15978:2011 and relevant professional guidance from the RICS PS v2. It includes all relevant life cycle stages. OneClick LCA software was used to conduct the analysis of consultants' design information.

Where consultant models were not available, assumptions have been applied. A further 6% contingency and additional relevant uncertainty factors have been applied to reflect the project's RIBA stage.

Results overview

The upfront carbon (A1-A5) results for the library building currently sit at **603 kgCO_2e/m²** Over the full life cycle, total emissions are estimated at: ~**1,184 kgCO_2e/m²** (A-C, non-decarbonised) & ~**898 kgCO_2e/m²** (A-C, decarbonised).

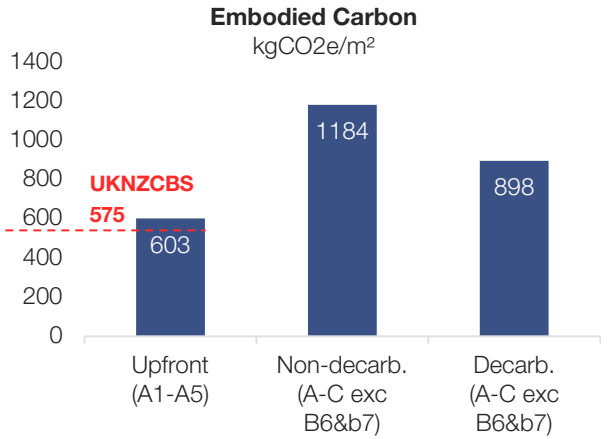
These results demonstrate that the current design is close to alignment with the UKNZCBS trajectory for higher-education buildings, however this is provided that Stage 4 procurement embeds verified low-carbon materials and supplier data.

The building's superstructure accounts for around 380 kgCO_2e/m², or 63% of total upfront carbon. In-situ concrete and reinforcement steel are the key drivers in the structural frame and upper flows. Build-envelope related emissions have seen a notable increase due to the refinement of several aspects of the façade design, with aluminium secondary framing, glazed elements, and the glazed terracotta façade systems adding a significant contribution.

Internal finishes and MEP systems contribute ~170 kgCO_2e/m², reflecting both the density of building services and the premium interior specification and requirements for high acoustic insulation performance in certain rooms. Within the MEP systems, carbon intensive steel ductwork and pipework systems have been identified as a major driver of embodied carbon, presenting further opportunities to reduce the building's impact through material and supplier selection.

The substructure represents the remaining 50 kgCO_2e/m², demonstrating a ~38% saving largely from foundations and pile caps where GGBS and mix optimisation offer clear saving potential.

Overall, the building performs within an achievable margin of the 2027 benchmark and provides a robust baseline for low-carbon procurement.

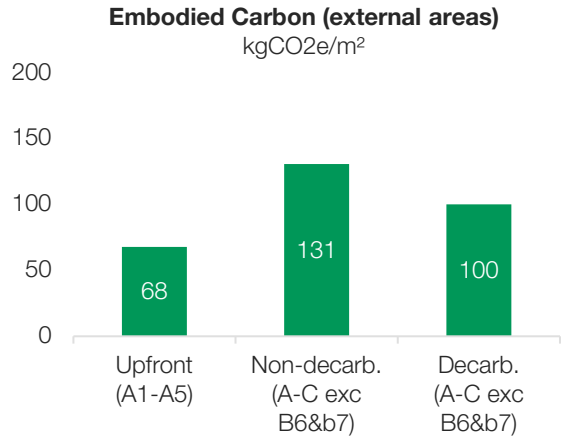


External works (Asset 3)

The additional upfront carbon intensity (A1-A5) associated with the project's exteternal works is 68 kgCO_2e/m². Over its 60 year expected service life, Whole Life-cycle Carbon (A-C inc B6&B7) increases to 131kgCO_2e/m² for non-decarbonised scenario, and 100 kgCO2e/m² for decarbonised scenario.

The materials inputs used in the analysis were based on cost plan information and landscape drawings, and include refined buildups for the following elements;

- 8.1.1.Roads, paths, pavings, surfaces
- 8.1.2.Fencing, railings, walls, and
- 8.1.3 External fixtures



Executive summary
Priority actions for Stage 3

Priority actions to minimise Upfront Carbon

The Stage 3 WLCA for the MMU New Library confirms that a number of low-carbon design measures have already been embedded, but there remains clear scope for further reduction. These opportunities will be realised through a combination of material efficiency, supply-chain engagement, and verified low-carbon procurement.

Structural engineering

Most of the project's upfront carbon arises from the structural frame and building envelope, which together account for over 60 % of A1-A5 emissions. Continued optimisation of the concrete specification will therefore be essential.

Collaboration with the appointed contractor should focus on testing and verifying mixes with 50% or greater SCM replacement, ensuring curing times and strength performance remain acceptable.

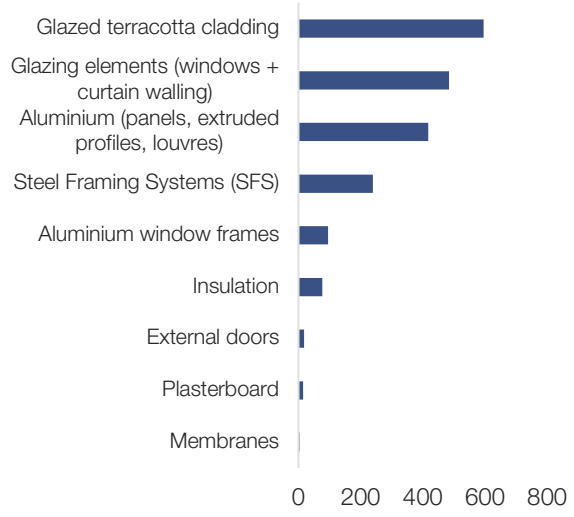
Building envelope (cladding panels)

The façade system represents the next most significant contributor. Further work is recommended to rationalise the build-ups and sub-framing systems while maintaining the design's civic quality and daylight performance.

Direct engagement with terracotta and glazing manufacturers should target reductions in the carbon-intensive firing and extrusion stages of ceramic production and identify opportunities for recycled or lower-temperature manufacturing.

The EPD used to represent the ceramic tiles was chosen as the closest fit, however it may not account for the carbon uplift associated with the additional firing processes to achieve the desired pearlescent finish. It is important to highlight that there is a sizeable range in terms of carbon impact from products within this category, highlighting the importance of material specification here.

A1-A5 impact by façade element (tCO2e)



Building envelope (aluminium sub-framing)

For the aluminium support systems, specifying extrusions with ≥ 75 % recycled content and rationalised bracket geometries can deliver meaningful Stage 4 reductions. Systems such as Purso Greenline or Hydro's Circal range, offer recycled aluminium profiles suitable for façade sub-framing and bracketry applications.

The current specification information for the building's aluminium louvres do not mention demountable fixings, which will likely lead to these elements becoming sealed into curtain-wall rebates. As such, pursue mechanical fixing that allows for their future removal/reuse. The associated cost-based implications of alternative systems will be assessed at the next work stage.

Internal assemblies & finishes

The carbon impact associated with internal assemblies has remained relatively low on the project, largely due to the prominent use of open plan spaces.

The internal finishes to the ceilings, floors and walls, however, remain a key source of upfront carbon. This is primarily associated with the specialised acoustic insulation panels, bespoke MDF-lined 'shrouds', and the baffle systems used in the ceiling finishes. Identifying low carbon, EPD-verified products for these applications should therefore be prioritised.

Building services (MEP)

For building services,, the focus should shift toward product-specific data and circular design. A full CIBSE TM65 assessment is recommended in collaboration with the services engineer to quantify the embodied carbon of mechanical and electrical systems, verify manufacturer EPDs, and identify high-impact components such as ductwork, cabling and plant housings

Introduction

Introduction
Project description

Project description
The new Library will be focal point on the Manchester Metropolitan University. It is part of it's Road to 2030 vision aims to establish itself as a global university, anchored in Manchester with an integrated and vibrant relationship with the city.

The proposed building presents itself to the City on the Oxford Road corridor and in wider views from the civic heart of Manchester and beyond. The design has the potential to put Manchester Metropolitan University front and centre on Manchester's map and on the global stage with design progress and academic excellence.

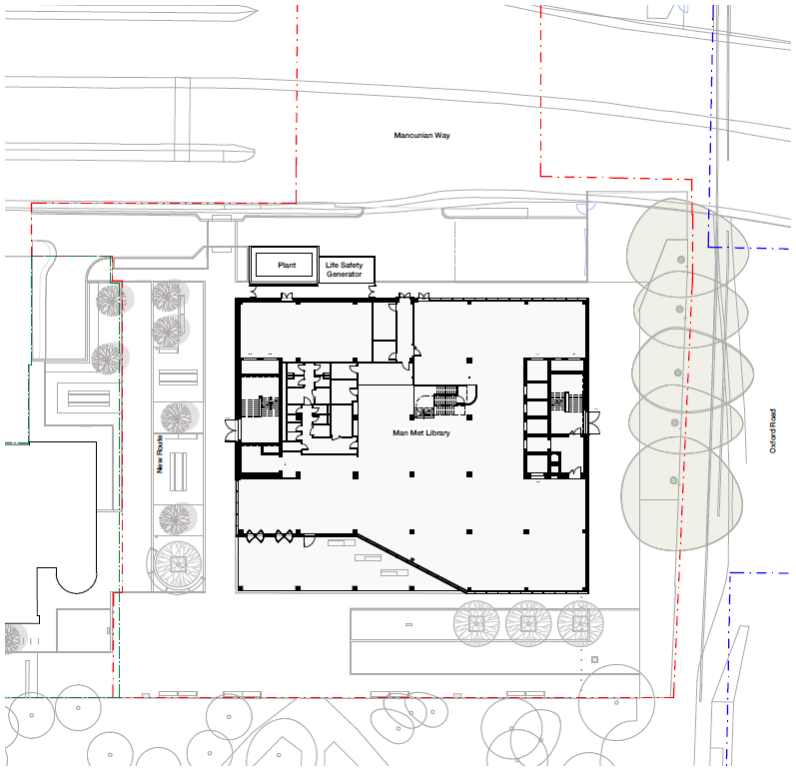
Purpose of document
The aim of this report is to assess the embodied carbon and whole-life carbon associated with the Stage 3 design of the proposed development and to outline opportunities for further carbon reduction as the project progresses toward detailed design and construction. This will be achieved through the following means;

- Quantify the embodied carbon associated with the Stage 3 design at practical completion (modules A1-A5) and over the building's reference study period of 60 years (modules A-C);
- Identify the building elements and material systems with the highest contribution to embodied carbon ($kgCO_2e/m^2$ GIA); and
- Evaluate project specific design, specification, and procurement strategies that could achieve further carbon savings ahead of Stage 4, including benchmarking against the UKNZCBS embodied carbon limit for buildings 2027 (575 $kgCO_2e/m^2$ GIA) and the operational energy intensity target (95 kWh/m^2 GIA/yr).

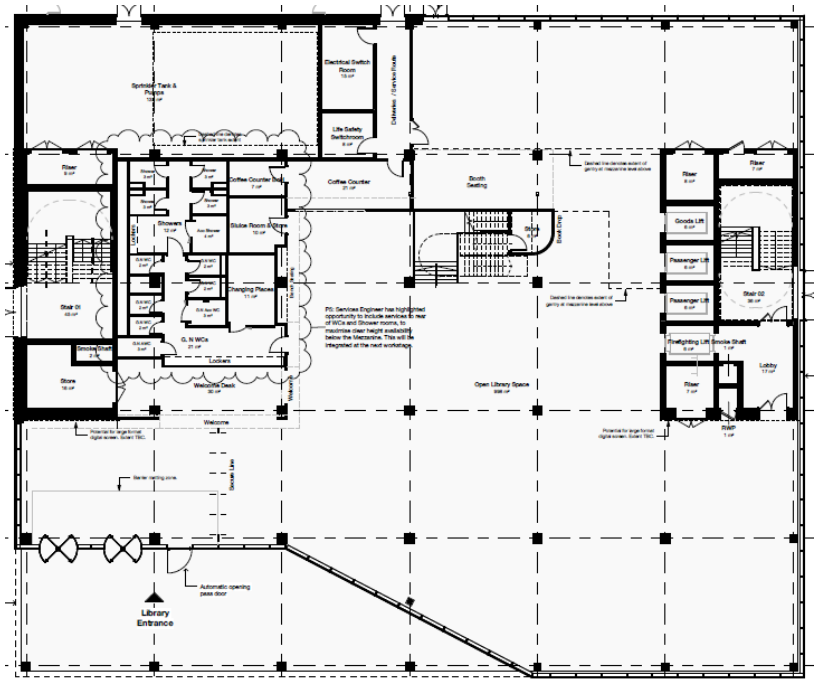
Assessment type
New build
GIA
12,021 m^2
Location
Manchester



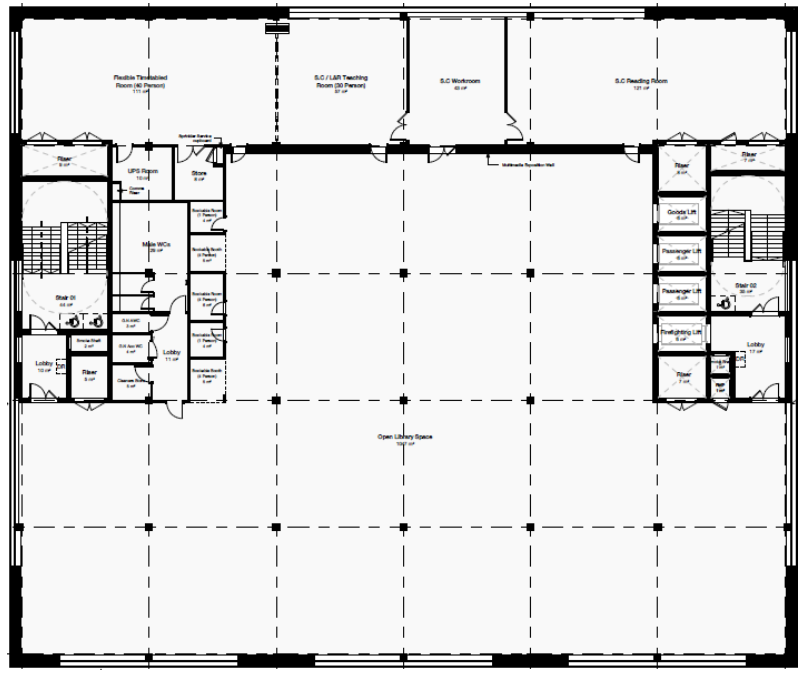
Introduction
Project description



External works boundary area

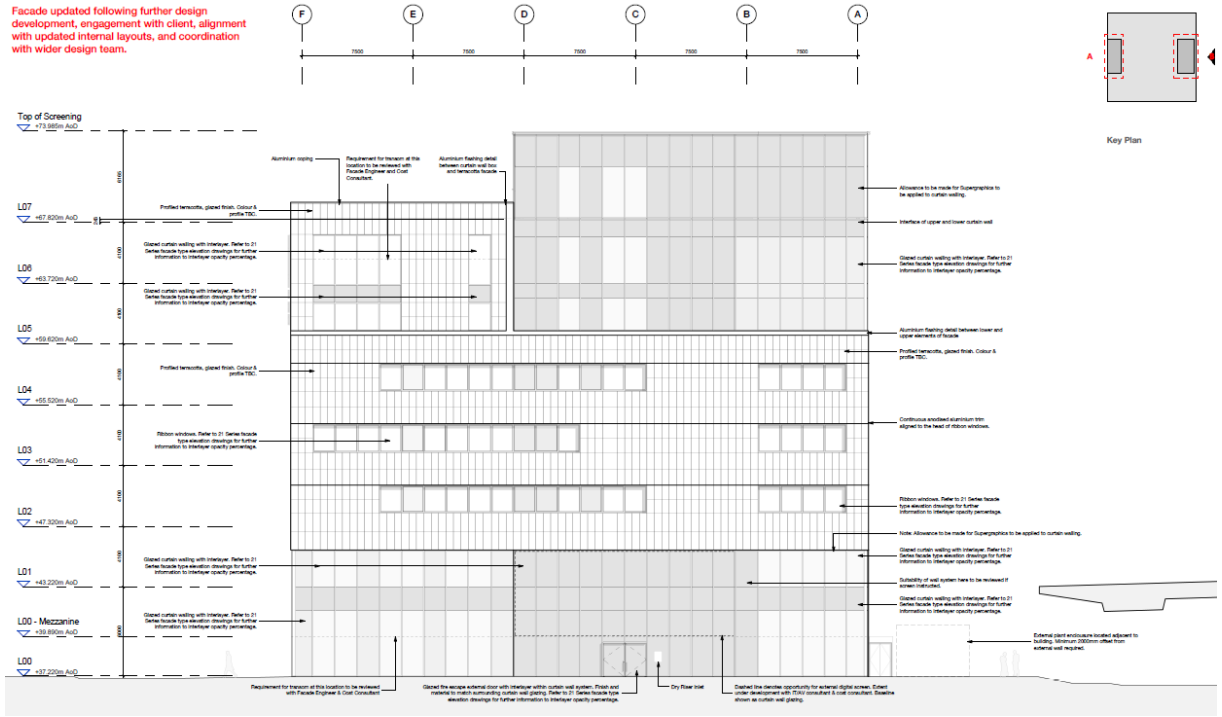


Ground floor plan

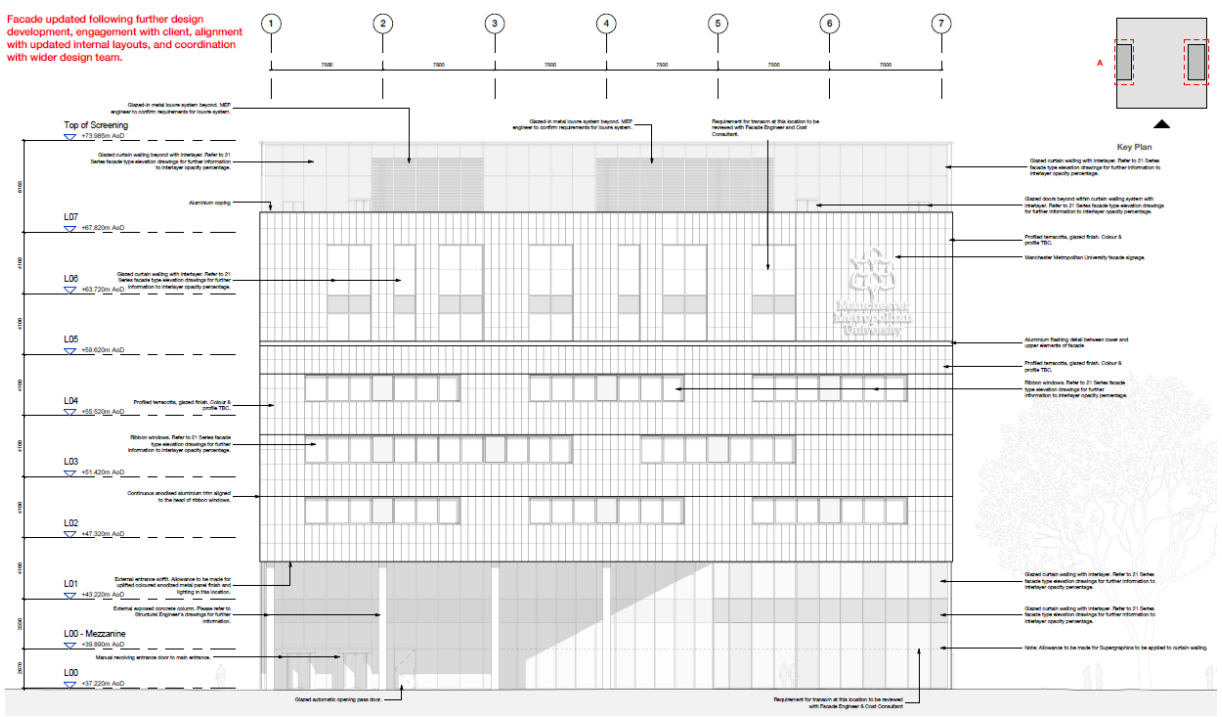


General arrangement first floor

Introduction
Project description



East facade



South facade

Introduction
Benchmarks

UK Net Zero Carbon Building Standard

The UK Net Zero Carbon Buildings Standard (UKNZCBS) is a newly established, industry-wide framework providing a unified approach to designing, constructing, and verifying net-zero carbon buildings across the UK. Launched in September 2024, this standard has been written by major industry organisations, including RIBA, LETI, and the UK Green Building Council (UKGBC). It applies to all building types, encompassing both new constructions and retrofit projects, and sets specific, measurable targets for operational and embodied carbon. To certify a building as “Net Zero Carbon Aligned,” it must meet all specified requirements in the Standard, including limits for both energy use intensity and embodied carbon, verified through performance data.

The embodied carbon and energy in use limits are updated annually, with the relevant target or limit being set by the commencement of on-site works. For this project, this is expected to be in 2027, and the relevant limits are shown in the tables on the right.

UKNZCBS Annex A1, Table EC-1: Upfront carbon limits, New works ($kgCO_2e/m^2$)	
Commencement year on site	Higher education
2027	575

UKNZCBS Annex A1, Table OE-1: Energy use intensity limits, New Building ($kWh/m^2GIA/yr$)	
Commencement year on site	Higher education
2027	95



Methodology

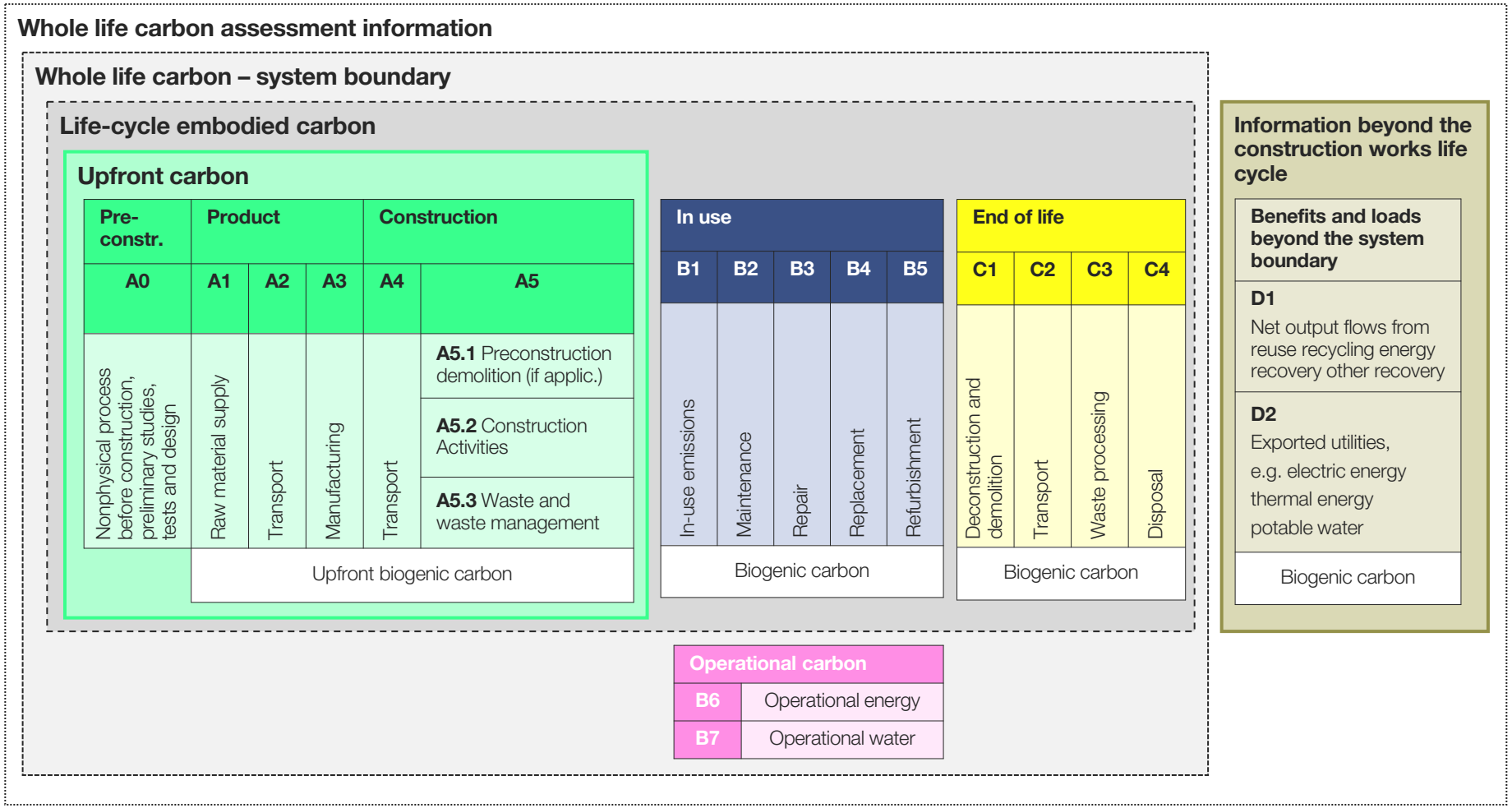
Methodology
Scope of the assessment

The WLCA has been conducted in accordance with BS EN 15978: 2011: (Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method) using the RICS Professional Statement: Whole Life Carbon assessment for the built environment 2nd edition (September 2023), over a 60-year reference study period, covering the entirety of modules A, B and C:

- Module A1 – A5 (Product sourcing and construction stage)
- Module B1 – B7 (Use stage)
- Module C1 – C4 (End of life stage)

The embodied carbon estimates from construction and materials for applicable life-cycle stages A1 – C4, otherwise known as a cradle-to-grave study, are estimated for a reference life-cycle of 60 years. This includes embodied emissions from raw extraction of materials, their processing in a factory or equivalent, transport and construction on site, any replacements assumed over the study period, and finally end of life disposal.

Module D, related to the benefits beyond the system boundary, is reported separately.



Methodology
Scope of the assessment

All the building elements listed in the adjacent table have been included in the WLCA Assessment, in line with the RICS Professional Statement 2nd edition.

Granularity Level 1 Early/ concept design stages		Included in this WLC?
0.1 Treatment and demolition works / Facilitating works		n/a
1 Sub-structure		Yes
2 Super structure	2.1 Frame 2.2 Upper floors 2.3 Roof 2.4 Stairs and ramps	Yes
	2.5 External envelope including roof finishes 2.6 Windows and external doors	Yes
	2.7 Internal walls and partitions 2.8 Internal doors	Yes
3 Finishes		Yes
4 FF&E		Yes
5. Building services (MEP)	5.1 Public health	Yes
	5.2 Heating, Ventilation and Cooling (HVAC)	Yes
	5.3 Electrical installations	Yes
	5.4 On site renewable energy generation	No – not included as not considered in UKNZCBS
	5.5 Systems including Life safety, Fuel installations, Lift and conveyor installations, Services equipment, Disposal installations, Specialist installations, Builders work in connection with services	Yes
6 Pre-fabricated buildings and units		n/a
7 Works to existing buildings		n/a
8 External works (within the project boundary)		Yes
8 External works (associated with the works outside the boundary)		n/a

Methodology
LCA Software and database

The WLCA Assessment has been conducted using the LCA software “One Click LCA” by Bionova.

“One Click LCA” is an industry recognised tool that produces results compliant with the international standards ISO 14044 and EN 159781 and it is certified with Quality System ISO 90012. “One Click LCA” has material life-cycle inventory carbon data that is compliant with EN15804.

The calculation tool used from OneClick was ‘Whole life carbon assessment, RICS - 2nd Edition’. This is aligned with latest RICS PS guidance.

The tool integrates data from nearly all the available EPD platforms around the globe.

Given that this is an early design stage, whenever no material/product specification was defined, a generic dataset (either from ICE, OneClick or IStructE) was used instead.

Methodology
Embodied carbon

Material inventory

The whole life-cycle carbon assessment for the proposed development was conducted using Stage 3 design information received on 10th October 2025. The data was provided by Turner & Towsend (T&T), the cost consultants, in an excel spreadsheet cost plan format.

All material quantities from the different information formats were processed and entered in the OneClick LCA carbon modelling software to generate the embodied carbon results. The most comparable materials available within the software's database were utilised.

The results include all additional modules as exported directly from OneClick LCA.

Additionally, a **6% contingency** was applied to account for the Technical Design Stage.

A further 2% contingency was added to reflect the data quality and uncertainty etc.

Building component	Description of component in proposed building	Source/Format/Date
Sub-structure	**Reinforced Concrete Piles:** Concrete Spec: Ready-mix concrete, RC32/40 with 50% GGBS cement (ICE – generic) Rebar Rate: 200 kg/m³ - 97% Recycled Content (Assumed UK CARES rebar) **Reinforced Concrete Pile caps:** Concrete Spec: Ready-mix concrete, RC32/40 with 50% GGBS cement (ICE – generic) Rebar Rate: 200 kg/m³ - 97% Recycled Content (Assumed UK CARES rebar) **Reinforced Concrete Ground Slab:** Concrete Spec: Ready-mix concrete, RC32/40 with 50% GGBS cement (ICE – generic) Rebar Rate: 140 kg/m³ - 97% Recycled Content (Assumed UK CARES rebar)	T&T Cost plan 10th October 2025 Buro Happold Concrete Specification 29th October
Frame	**Reinforced Concrete columns:** Concrete Spec: Ready-mix concrete, in-situ, UK average, C40/50 (IStructE (2025)))* Rebar Rate: 250 kg/m³ - 97% Recycled Content (Assumed UK CARES rebar) **Reinforced Concrete beams:** Concrete Spec: Ready-mix concrete, in-situ, UK average, C32/40 (IStructE (2025))* Rebar Rate: 220 kg/m³ - 97% Recycled Content (Assumed UK CARES rebar) **Structural steelwork** Structural closed steel sections, UK average (IStructE)* Reused steel sections, UK average (IStructE (2025)) (20% RC)	T&T Cost plan 10th October 2025
Upper floors and roof	**Reinforced Concrete slab:** Concrete Spec: Ready-mix concrete, in-situ, UK average, C32/40 (IStructE (2025)) Rebar Rate: 175 kg/m³ - 97% Recycled Content (Assumed UK CARES rebar)	T&T Cost plan 10th October 2025
Stairs and ramps	**Concrete stairs** Assembly for stairs per one metre height, incl. railing - OneClick LCA generic construction	T&T Cost plan 10th October 2025

* Assumes 25% SCM content

Methodology
Embodied carbon

Material inventory (cont.)

Building component	Description of component in proposed building	Source/Format/Date
External walls	Glazed terracotta rainscreen cladding SFS with Full Fill Insulation 150mm thick Aluminium sheet cladding with deep articulated profile	T&T Cost plan 10th October 2025
Roof coverings	Warm Roof System (Tapered Insulation, Elastoner bitument self-adhesive underlayer, Reinforced Bitument) Tapered Bituminous Warm Roof with Ballast (Screed, Hot bitumen, AP1 Acces, High Performance Rigid Cellular Glass insulation, Polypropylene Layer) Lightweight Uninsulated Roof System - 130mm Steel deck	T&T Cost plan 10th October 2025
Windows and curtain walling	Ribbon Windows - Anodised Aluminium window system, ceramic fritted glass Aluminium stick curtain wall system at upper level	T&T Cost plan 10th October 2025
Internal walls	Plasterboard partitions on metal studs (12.5 mm and 150 mm) Acoustic and fire-rated plasterboard partitions with mineral wool insulation Folding/sliding acoustic partitions	T&T Cost plan 10th October 2025
Finishes	Floors: polished concrete, rubber tiling, carpet (varies), raised access flooring Walls: Emulsion paint Ceilings: Demountable suspended ceilings with exposed soffits within open plan areas, acoustic insulation baffles within multimedia space and podcast rooms Lay-in mesh ceiling to upper-floor WCs	
Heating, Ventilation and Cooling (HVAC)	Fan coil units, direct expansion (DX) units, AHUs, Air/air heat pumps, radiators, smoke extract fans Ductwork, sprinklers, pipework and cable trays	T&T Cost plan 10th October 2025
Hardscaping	Permeable concrete blocks, dense asphalt, bluestone paving slabs MOT Type 1 recycled aggregates for sub-bases Landscaping with topsoil and growing medium	T&T Cost plan 10th October 2025

Methodology
Embodied carbon

Assumptions

Lifecycle module assumptions	
A4, A5.3	Transport distances, wastage rates, service lives and EOL as per RICS PS 2023
A5.2, B2, B3, C1	Calculated in OneClick, following the RICS PS 2023 guidance
Materials spec assumptions	
Recycled contents	Steel sheets: 15% recycled content Rebar: 97.07% recycled content as per UK CARES specification
SFS	Assumed mass within the facade buildup of 16 kg/m²
Elements assumptions	
MEP	As information is not available at this stage for lighting and power distribution and cabling systems, OneClick templates have been used on a GIA basis to account for these elements

Methodology
Operational carbon

Energy in use

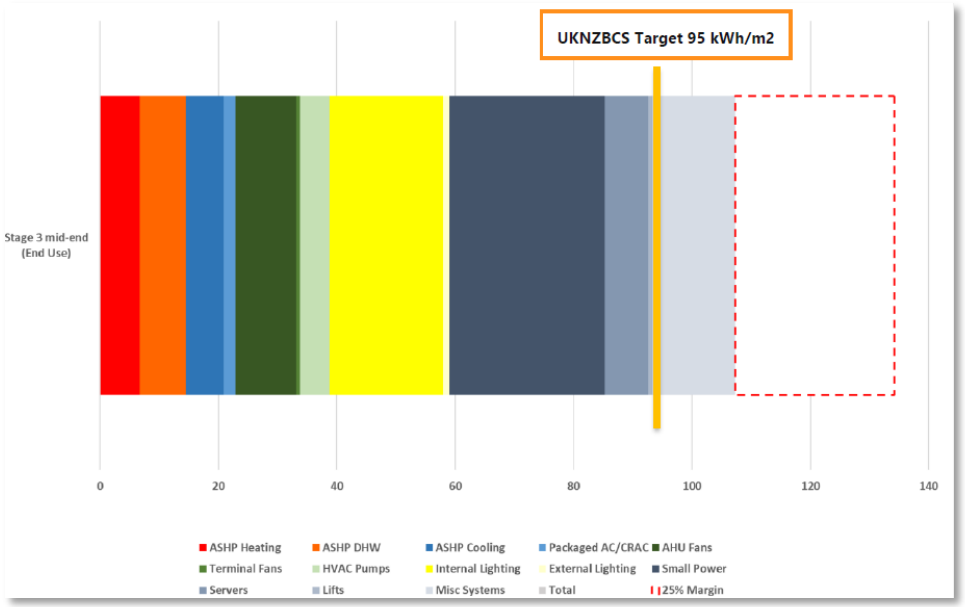
Energy use has been assessed using the TM54 analysis prepared at Stage 3 by Buro Happold, which provides a representative estimate of operational performance.

The TM54 results predict a total building energy use intensity of 107–134 kWh/m² yr, excluding photovoltaic (PV) contributions, and 99–126 kWh/m² yr when on-site generation is included.

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These results were entered into One Click LCA to calculate operational carbon emissions using the dataset ‘Electricity, UK 2023 - based on the energy supplementary table of the RICS Whole Life Carbon Assessment, 2nd Edition’ together with ‘On-site generated renewable electricity, RICS 2nd Edition (energy supplementary table)’.

This approach reflects the project’s current predicted building operation, incorporating the TM54 mid-end scenario as the baseline for energy use and enabling consistency with RICS-aligned whole life carbon reporting.



Water use

The carbon emissions for water have been based on the benchmarks for potable water use of RIBA 2030 Climate Change document.

The water in use assumed was 13 l/p/day, in line with the RIBA 2030 Climate Challenge (V2) ‘2025’ target for a New Build Office. The occupancy per building and total considered can be seen in the table in this page. The working days annual average considered for this calculation was 260 days.

The annual water usage was then entered into ‘OneClick LCA’ to gain a 60-year carbon emission. UK 2023 Water supply and treatment data was used, with a carbon factor of 0.38 kgCO2e/m³.

The irrigation water consumption was calculated using ‘Level(s) indicator 3.1: Use stage water consumption’. Full calculation can be found in the appendix. A conservative approach of manual irrigation system was considered at this stage.

Asset	Potable water demand	Water consumption yearly
New library	3,000 people 260 days	10,140 m³
External works	450m² irrigation area	4 m³
Site wide		**10,144 m³**

Results

Results
Embodied carbon

MMU New Library

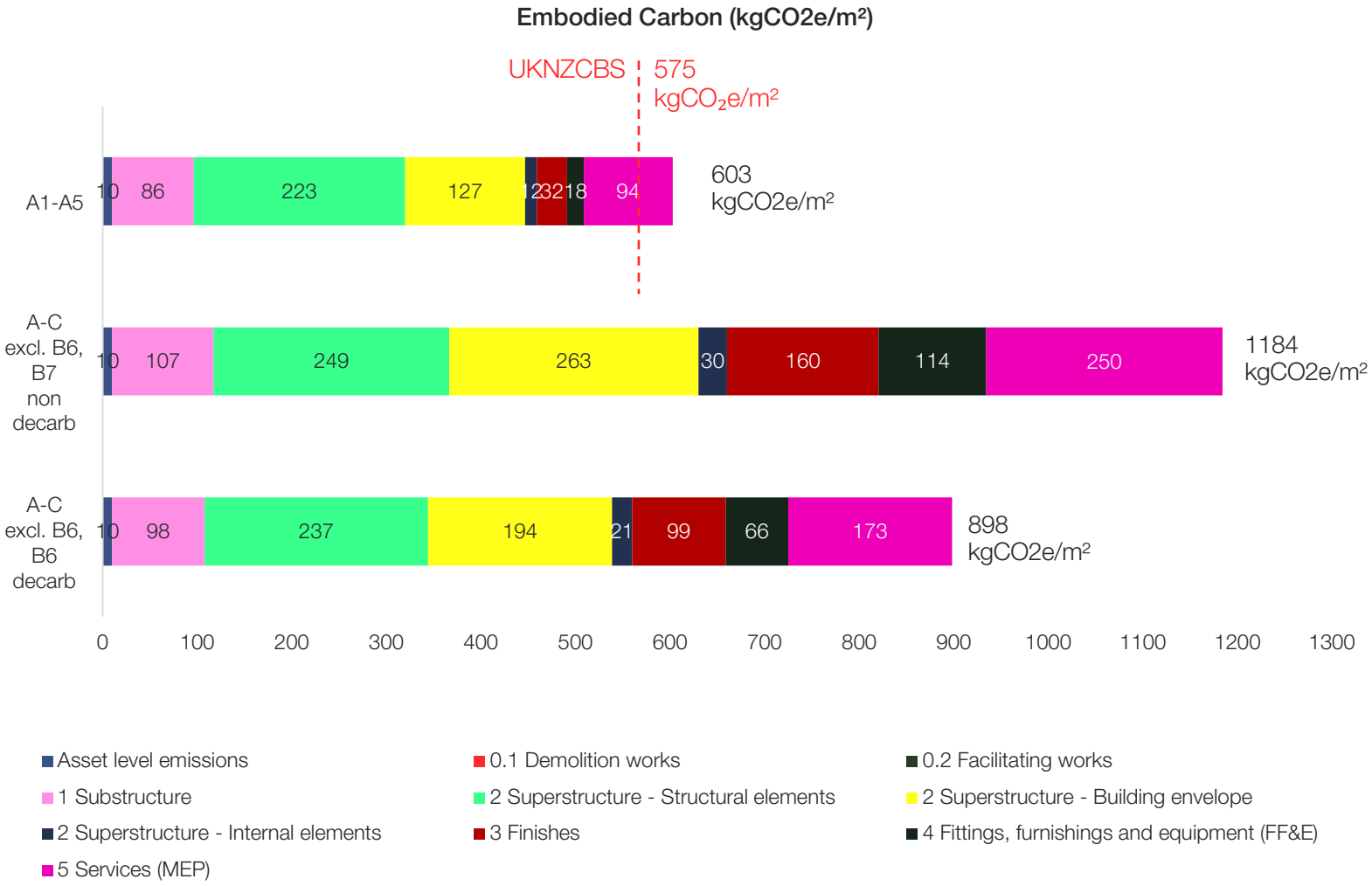
The graph on the right illustrates the embodied carbon results for the MMU New Library, showing upfront emissions (A1–A5) and life-cycle totals both with and without future grid decarbonisation. Red dashed line marks the UKNZCBS upfront carbon target for higher-education projects commencing on site in 2027 (575 $kgCO_2e/m^2$).

Overall, the design marginally exceeds the 2027 benchmark by around 5% at **603 $kgCO_2e/m^2$** (A1–A5), but remains within a manageable margin of improvement. Across the full life cycle, total emissions are estimated at **1,184 $kgCO_2e/m^2$** in the non-decarbonised scenario and **898 $kgCO_2e/m^2$** when projected grid decarbonisation is applied. These results suggest the current scheme is well aligned with emerging UKNZCBS limits, provided that upcoming material specifications and procurement decisions continue to focus on verified low-carbon options.

From an elemental breakdown, the primary embodied include:

- Superstructure (structural elements) contributes around 223 $kgCO_2e/m^2$, or ~40% of upfront emissions.
- Building envelope represents a further 127 $kgCO_2e/m^2$
- MEP systems contribute approximately 94 $kgCO_2e/m^2$ at practical completion but grow to 160 $kgCO_2e/m^2$ over the full life cycle due to component replacement cycles (non decarb. future energy grid scenario).

This distribution highlights the need for continued optimisation of structural and services design, including refinement of material specifications, reduced mechanical system replacement rates, and close coordination with suppliers to secure EPD-verified low-carbon products. Targeted interventions across these key areas would provide the clearest route to achieving full UKNZCBS alignment by the next design stage.



Results
Embodied carbon

MMU New Library: 10 most impactful materials/elements

Material	EPD/Dataset used	Carbon factor (A1-A3)	Impact A1-A3 tCO_2e	% impact A1-A3
Ready-mix concrete	Ready-mix concrete, in-situ, UK average, C40/50 (IStructE (2025))*	0.13 kg CO2e / kg	1,013	**15.80%**
Rebar	Reinforcement steel bar (rebar), UK average (IStructE)**	0.76 kg CO2e / kg	731	**11.40%**
Ready-mix concrete	Ready-mix concrete, RC32/40 with 50% GGBS cement (ICE)	0.11 kg CO2e / kg	722	**11.30%**
Ready-mix concrete	Ready-mix concrete, in-situ, UK average, C32/40 (IStructE (2025))*	204.24 kg CO2e / m3	385	**6.00%**
Glazing (curtain wall system)	Glass façade curtain wall system, 53.5 kg/m2, EF30 UW ENVIRO|FACADES (Erie Architectural Products)	207.0 kg CO2e / m2	349	**5.50%**
Aluminium	Aluminium profiles and brackets for subframe system, NVELOP (SFS) ,	9.59 kg CO2e / kg	339	**5.30%**
Structural steel	Steel hot rolled, I, H, U, L, T and wide flats, S235-S960 (bauforumstahl)	1.74 kg CO2e / kg	225	**3.50%**
Ceramic	Ceramic facade panel, unglazed, 40 mm, 57 kg/m2, 2125 kg/m3, TERRART®-Large 40 (NBK Keramik GmbH)	69.8 kg CO2e / m2	165	**2.60%**
Structural steel	Structural closed steel sections, UK average (IStructE) – 60% scrap content	2.5 kg CO2e / kg	156	**2.40%**
Electrical equipment	Direct expansion units, 14 449.13 kg/unit, 50-140 Kw, LDAV LUAV LDEV LDWV (SCHNEIDER ELECTRIC)	15540.7 kg CO2e / unit	156	**2.40%**

* Assumes 97% recycled EAF production

** Assumes 25% SCM content

Results
Embodied carbon

Upfront carbon by material type

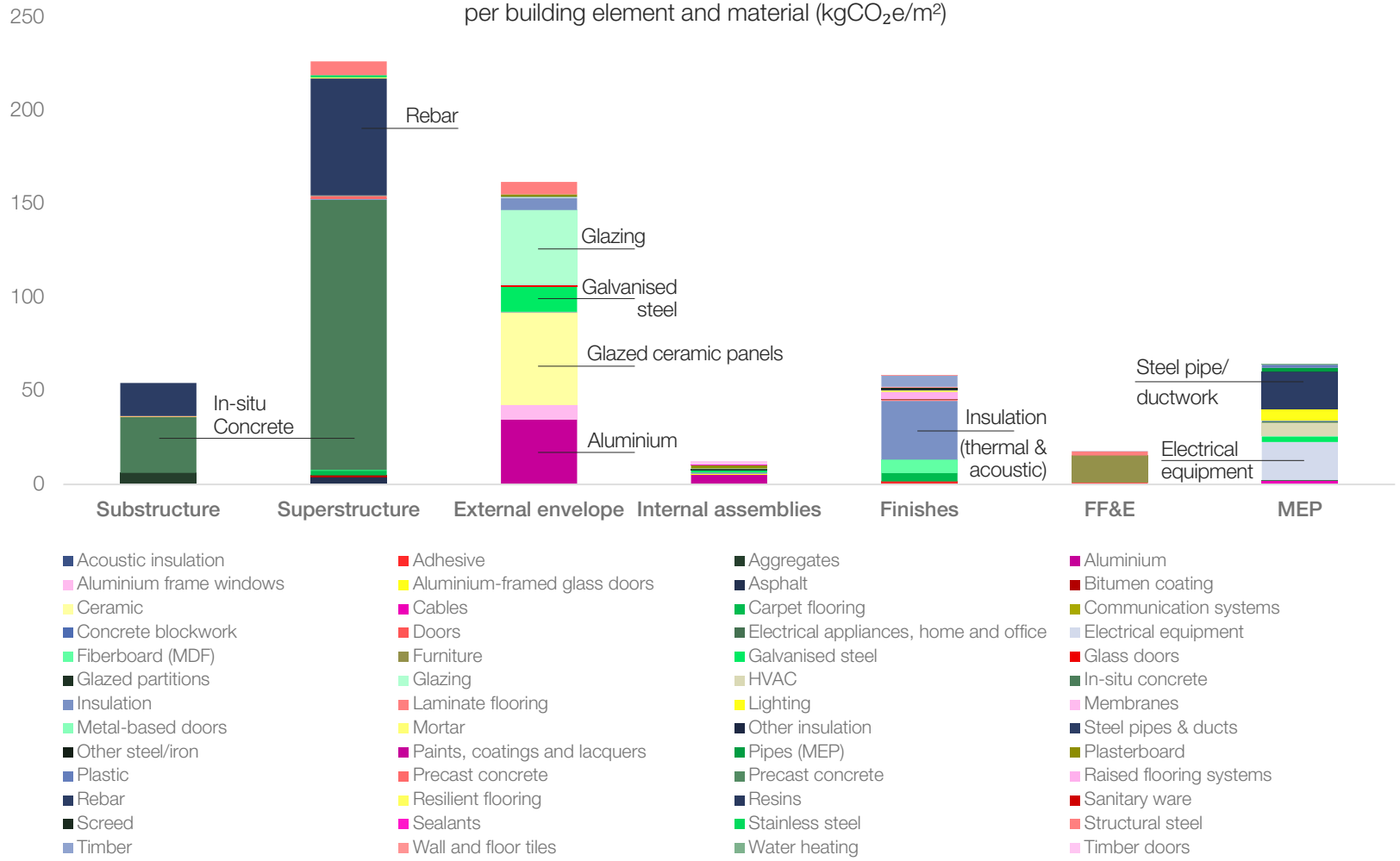
The Stage 3 results confirm that the superstructure remains the dominant source of upfront embodied carbon, with in-situ concrete and reinforcement steel together representing the largest share of total impacts. These materials account for much of the improvement potential at this stage, where design refinement and mix optimisation can yield substantial savings.

The external envelope is the next most significant contributor, driven by aluminium framing, glazing, and glazed ceramic panels. These elements reflect both the architectural intent and the carbon intensity of processed materials. Priorities now include increasing recycled aluminium content, exploring alternative glazing specifications, and rationalising panel systems to reduce sub-framing demand.

MEP systems also feature prominently, particularly steel ductwork, pipework, and electrical equipment, highlighting the importance of coordinated plant design and efficient distribution strategies. Smaller contributions arise from insulation and finishes, though these remain relevant given their replacement frequency over the building's life.

Overall, the Stage 3 results indicate that reductions will hinge on targeted interventions across concrete, steel, aluminium, and glazing, supported by careful MEP rationalisation. These areas now provide a clear basis for design-stage carbon reduction actions before procurement begins.

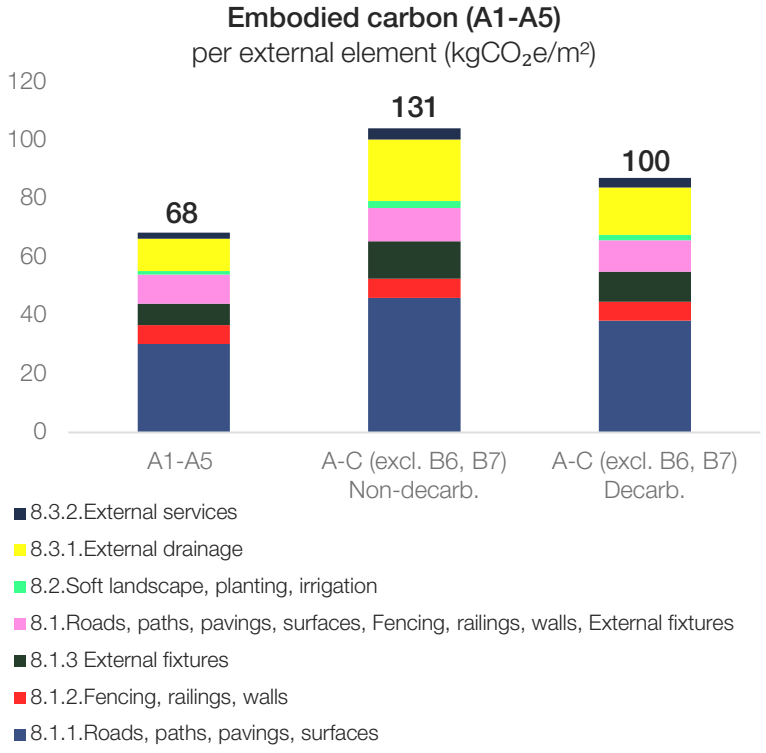
Upfront embodied carbon (A1-A5)
per building element and material ($kgCO_2e/m^2$)



Results
Embodied carbon

Asset 2 - External works

The bar chart below sets out the embodied carbon results for the project's external works, broken down into the main carbon hotspots within this category. The legend highlights the types of features included, providing clarity on the scope of these results, which are not covered in the preceding sections.



10 most impactful materials within the external works

Material	EPD/Dataset used	Carbon factor (A1-A3)	Impact A1-A3 tCO_2e	% impact A1-A3
In-situ Concrete	Ready-mix concrete, RC20/25 with average UK additions cement	160 kg CO_2e/m^3	102	39.3%
In-situ Concrete	Ready-mix concrete, normal-strength, generic, C30/37 (4400/5400 PSI), 10% (typical) recycled binders in cement (300 kg/m3 / 18.72 lbs/ft3)	0.015 kg CO_2e/kg	28	10.8%
Steel fixtures	Steel fence panels with metallic coating, Base Metal Thickness (BMT): 0.42 mm, 3.48 kg/m2, Metallic Coating AM100	0.015 kg CO_2e/kg	23	9.0%
Steel fixtures	Structural steel bollard (Truck Stopper), 2079 kg/unit	0.072 kg CO_2e/kg	23	8.9%
Granite	Paving products, 60 mm, 135.6 kg/m2	0.039 kg CO_2e/kg	19	7.4%
Asphalt	Asphalt concrete for heavy load bearing applications, hot mix, 2 % bitumen, aggregate size 31 mm	0.044 kg CO_2e/kg	10	4.0%
In-situ Concrete	Ready-mix concrete, RC32/40 with average UK additions cement	0.0023 kg CO_2e/kg	9.7	3.8%
Cast iron	Cast iron pipes and fittings, for sewer and rainwater use, 7.41 kg/m	0.003 kg CO_2e/kg	9.1	3.5%
Natural stone	Street slab, from stone, Finnish average, 2700 kg/m3	6.70 kg CO_2e/m	6.3	2.4%
Precast concrete	Surface water drainage channel (excluding concrete bedding), 96.3 kg/m	0.0025 kg CO_2e/kg	4.9	1.9%

Results
Operational carbon

The carbon factors for this section's operational carbon calculations are based on the RICS PS v2 guidance. For the UK, with a reference study period (RSP) of 60 years, the relevant carbon factors are detailed under the 'Carbon conversion sets – UK' tab.

The calculations and carbon factors for each scenario are outlined below:

Non-decarbonised scenario:

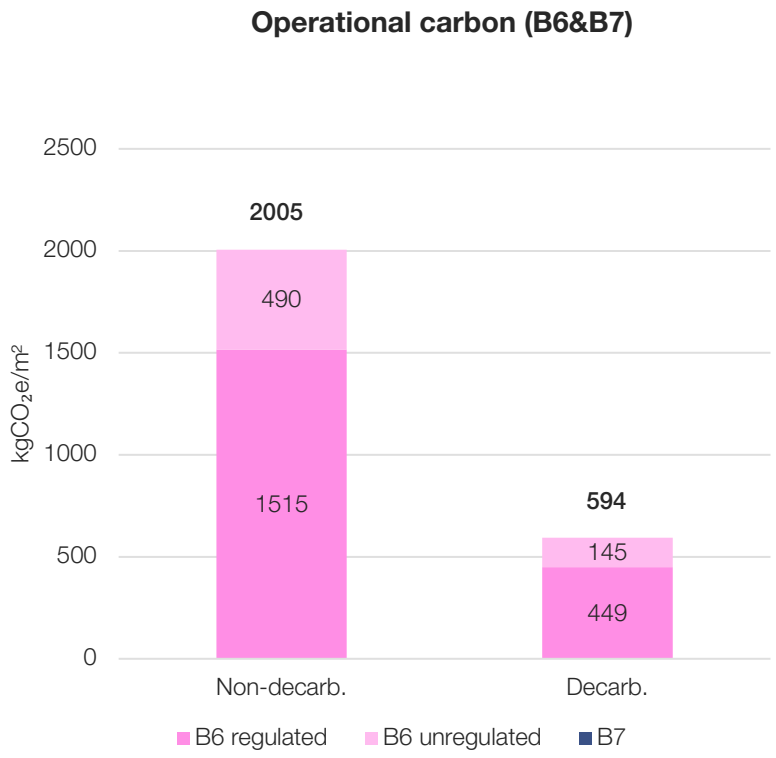
– kWh/yr x 60 x 0.2071 $kgCO_2e/kWh$ (UK government conversion factors for company reporting of greenhouse gas emissions: UK electricity)

Decarbonised scenario:

– kWh/yr x 60 x 0.0413 $kgCO_2e/kWh$ (FES 2023 Falling short excluding BECCS)

The bar chart on the right-hand side shows the operational carbon emissions of the New Library.

The results highlight the significant impact of considering grid decarbonisation in the estimated in-use carbon emissions over the building's life-cycle.



Results
Whole life carbon

Non-decarbonised scenario:

The total whole-life carbon (A–C) for the MMU New Library is estimated at 1,080 $kgCO_2e/m^2$ GIA, or approximately 13,000 tCO_2e overall. Of this total, embodied emissions (A1–A5) represent around 600 $kgCO_2e/m^2$, while use-stage and end-of-life impacts (B–C) contribute the remaining share.

When broken down by life-cycle stage, building operation (B6) remains the dominant source of emissions, accounting for roughly 60 % of total A–C impacts, or about 1,510 $kgCO_2e/m^2$. This reflects the Library's high-intensity mechanical systems, extended occupancy hours, and controlled environmental conditions required for study comfort and equipment operation.

The combined impact from the project's pre-construction, product and construction related modules (A1-A5) accounts for around a quarter pf emissions while maintenance, repair, and replacement (B1–B4) together contribute around 12 %. End-of-life emissions (C1–C4) remain relatively low at 120 $kgCO_2e/m^2$, due to assumptions of material recovery and recycling.

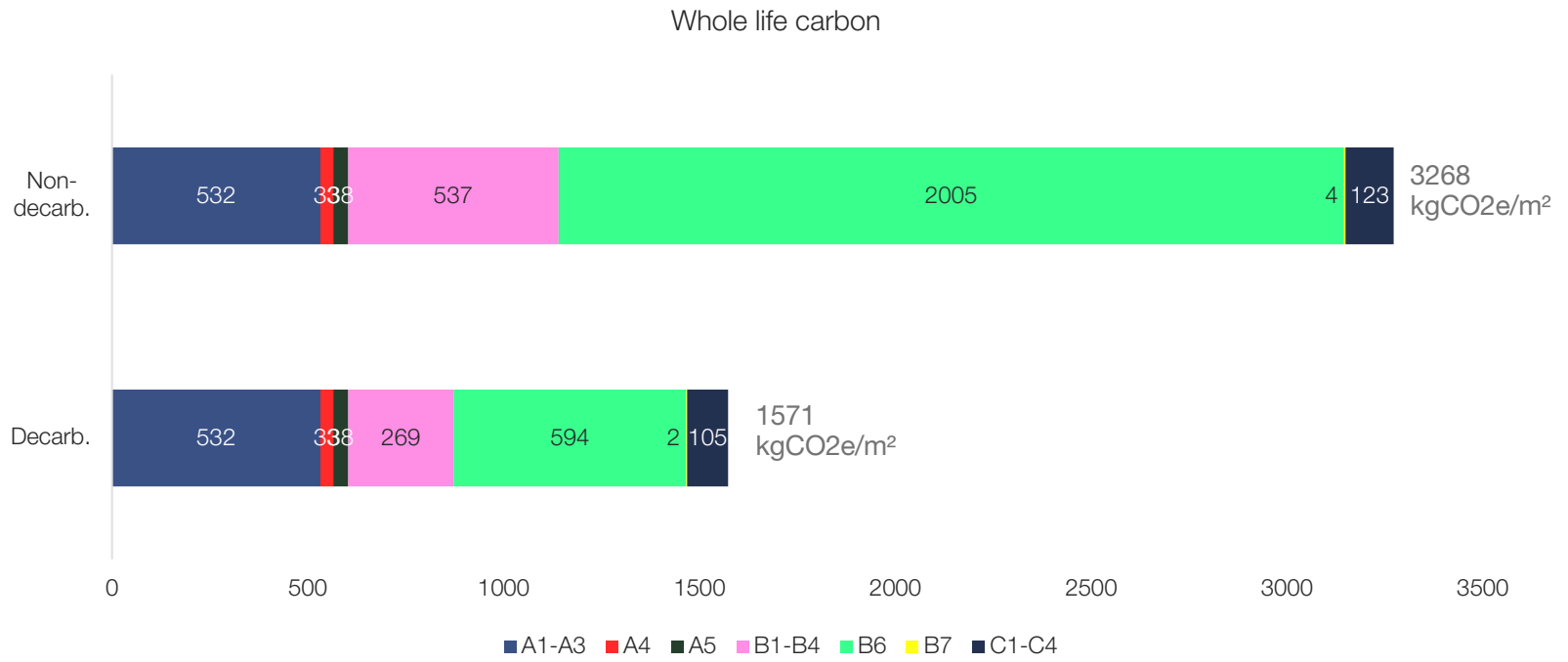
Although operational emissions currently outweigh embodied emissions, the ratio is expected to rebalance as grid electricity decarbonises and embodied carbon becomes the proportionally greater contributor to the Library's long-term footprint.

Decarbonised scenario:

When projected grid decarbonisation and updated UK energy factors are applied, Operational energy emissions (B6) fall substantially to ~450 $kgCO_2e/m^2$. The decarbonised scenario demonstrates that the Library's long-term carbon performance will increasingly depend on the durability of materials, maintenance cycles, and procurement of verified low-carbon products rather than solely operational efficiency.

The results highlight the need to:

- Maintain the focus on demand reduction through passive design and smart building control.
- Embed verified embodied-carbon data within construction procurement to reduce A1–A5 intensity.
- Continue to evaluate renewable energy integration and on-site generation potential to offset residual grid use.



Results
Recommendations and next steps

The recommendations outlined opposite summarise the key opportunities to reduce embodied carbon across the building, from the substructure through to internal finishes and MEP systems. The Stage 3 WLCA for the MMU New Library identifies the superstructure and façade as the dominant sources of upfront carbon, together representing over 60 % of total A1–A5 impacts.

Concrete and reinforcement remain major contributors within the substructure, where ongoing mix optimisation and supply-chain verification will be critical at Stage 4. Above ground, the façade and secondary framing systems drive a substantial share of emissions due to their reliance on aluminium and fired ceramic products. Continued work on simplifying build-ups, maximising recycled content and verifying manufacturer EPDs will therefore be key.

The internal fit-out and services packages, while lower in overall magnitude, still present meaningful reduction potential through the selection of durable, EPD-verified materials and a circular procurement approach for mechanical and electrical systems. A CIBSE TM65 assessment is recommended to capture these impacts in greater detail and to inform Stage 4 design development.

Together, these actions form a targeted roadmap for carbon reduction and data quality improvement ahead of the next reporting stage.

Building Element	Recommendations
Substructure & Superstructure	- Optimise concrete mixes with ≥ 50 % SCM replacement and verify curing and strength performance at Stage 4. Explore the feasibility of utilising SCMs from a range of sources to reduce industry dependence on commonly used materials e.g. GGBS. - Engage suppliers to verify low-carbon concrete and reinforcement EPDs and explore EAF or recycled steel options. - Review formwork and temporary works strategies to increase reuse and reduce waste.
Building envelope	- Rationalise façade build-ups to reduce material layering and sub-framing density while maintaining daylighting and civic quality. - Explore feasibility of targetting ≥ 75 % recycled content aluminium for sub-framing and louvre systems. - Engage with ceramic manufacturers to reduce firing impacts and explore recycled or lower-temperature options (e.g. porcelain), which early EPD data suggests may offer similar finishes at lower A1-A3 carbon factors. - Review fixings and interfaces of façade build-ups to support future disassembly and reuse of façade elements.
Internal Assemblies & Finishes	- Prioritise EPD-verified finishes and low-carbon acoustic or ceiling systems, focusing on high-volume materials such as MDF, mineral fibre, and bespoke metal panels. - Rationalise raised access floor systems by reviewing panel thickness, substructure materials, and recycled steel content to minimise embodied carbon while maintaining serviceability. - Specify durable, long-life finishes that can withstand heavy use and reduce replacement frequency, supporting lower lifecycle carbon and maintenance impacts. - Seek opportunities for simplification and material efficiency in linings, partitions, and suspended systems to reduce overall material intensity.
Building services (MEP)	- Undertake a CIBSE TM65 assessment in coordination with the services engineer to quantify embodied carbon across key systems. - Prioritise high-impact items for detailed review (e.g. ductwork). - Review procurement options for remanufactured or circular-ready equipment, prioritising systems that can be refurbished, upgraded, or re-used at end of life. - Explore potential supplier take-back schemes for HVAC units and lighting. - Specifying components with modular or replaceable parts, and verifying manufacturer commitments to repair, reconditioning, and material recovery.

Appendices

A RICS table
Non decarbonised – Asset 1

Summary of carbon emissions by element and life cycle stage/module (non-decarbonised)

Note: For a refurbishment project the upper rows of this table would be completed twice - for the refubished GIA and new build GIA, the results would then be aggregated when reporting for the overall assete. For a masterplan project complete a version for each individual asset and report the total external works separately.

Columns should be added for each different scenario considered for the asset's use & EoL stages. The scenario name/number should be clearly indicated.
* Headings with asterisk denote modules affected by decarbonisation.

Building elements		Carbon per life cycle stage - non-decarbonised																				
		A0 Pre-construction stage	**[A1-A3]** Product stage excl. sequestered carbon	**[A1-A3]** Sequestered carbon within installed materials/ products	**[A4]** Transport to and from site	**[A5]** [A5.1-A5.3] Pre-construction demolition, construction activities and waste management	[A5.4] Transport of construction workers	**[B1.1]** In-use emissions & removals materials & carbonation	**[B1.2] *** In-use emissions & removals Refrigerant leakage	**[B2-B3]** Maintenance and repair	**[B4] *** Replacement	**[B5] *** Refurbishment/ planned changes excl. sequestration (where relevant)	**[B5]** Sequestered carbon related to refurbishment/ planned changes (where relevant)	**[B6] *** [B6.1-B6.3] Energy use	**[B7] *** [B7.1-B7.3] Water use	**[B8] *** User activities	**[C1] *** Deconstruction/demolition process	**[C2] *** Transport to waste processing or disposal facilities	**[C3]** Waste processing for reuse, recycling and/or energy recovery and	**[C4]** Waste disposal	D1 * Potential net benefits/loads from reuse, recycling, energy recovery and/or other recovery	D2 * Potential benefits/loads from exported utilities
Asset level emissions		0				120000	0		688	0				24100000	0		0					-36600
0.1 Demolition works						0																
0.2 Facilitating works			0	0	0	0		0		0	0						0	0	0	0	0	
1 Substructure			841400	0	124190	72510		0		19803	0						0	210550	20983.8	439.46	-217940	
2 Superstructure - Structural elements			2453800	-21917.4	91184	141071		0		57660	50700						0	198501	25436.2	389.975	-691400	
2 Superstructure - Building envelope			1441000	-33845	26600	59745		0		33970	1620000						0	10008	3313.2	5356.8	-542700	
2 Superstructure - Internal elements			126600	-34100	13370	6300		0		2980	210200						0	2469	29460	6137	-37900	
3 Finishes			307200	-371000	44490	35270		0		7222	1466000						0	5130	431100	2474	-96840	
4 Fittings, furnishings and equipment (FF&E)			182000	-488000	20900	10400		0		4270	1150000						0	1060	486000	905	-16100	
5 Services (MEP)			1040500	-1359	74120	13111		0		128600	1707500						20.8	7021	33780.6	11.6915	-509600	
6 Pre-fabricated buildings and units																						
7 Works to existing buildings			0	0	0	0		0		0	0						0	0	0	0	0	
Sub-total	kgCO2e	0	6392500	-950221.4	394854	458407		0	688	254505	6204400			24100000	0		20.8	434739	1030074	15713.9265	-2112480	-36600
8 External works associated with the project (within boundary)		0	0	0	0	0		0	0	0	0			0	0		0	0	0	0	0	0
8 External works associated with the project (outside of boundary)		0	0	0	0	0																
Total	kgCO2e	0	6392500	-950221.4	394854	458407	0	0	688	254505	6204400			24100000	0		20.8	434739	1030074	15713.9265	-2112480	-36600

A RICS table
Non decarbonised – Asset 1

Summary of carbon emissions by element and life cycle stage/module (decarbonised)

Note: For a refurbishment project the upper rows of this table would be completed twice - for the refubished GIA and new build GIA, the results would then be aggregated when reporting for the overall asset. For a masterplan project complete a version for each individual asset and report the total external works separately.

Columns should be added for each different scenario considered for the asset's use & EoL stages. The scenario name/number should be clearly indicated.
* Headings with asterisk denote modules affected by decarbonisation.

Building elements		Carbon per life cycle stage - decarbonised																			
		A0 Pre-construction stage	**[A1-A3]** Product stage excl. sequestered carbon	**[A1-A3]** Sequestered carbon within installed materials/ products	**[A4]** Transport to and from site	**[A5]** [A5.1-A5.3] Pre-construction demolition, construction activities and waste management	[A5.4] Transport of construction workers	**[B1.1]** In-use emissions & removals materials & carbonation	**[B1.2] *** In-use emissions & removals Refrigerant leakage	**[B2-B3]** Maintenance and repair	**[B4] *** Replacement	**[B5] *** Refurbishment/ planned changes excl. sequestration (where relevant)	**[B5]** Sequestered carbon related to refurbishment/ planned changes (where relevant)	**[B6] *** [B6.1-B6.3] Energy use	**[B7] *** [B7.1-B7.3] Water use	**[B8] *** User activities	**[C1] *** Deconstruction/demolition process	**[C2] *** Transport to waste processing or disposal facilities	**[C3]** Waste processing for reuse, recycling and/or energy recovery and disposal	**[C4]** Waste disposal	D1 * Potential net benefits/loads from reuse, recycling, energy recovery and/or other recovery	D2 * Potential benefits/loads from exported utilities
Asset level emissions		0				120000	0		344	0				7140000	0		0					-18300
0.1 Demolition works						0																
0.2 Facilitating works			0	0	0	0		0		0	0						0	0	0	0	0	
1 Substructure			841400	0	124190	72510		0		9891	0						0	104770	20983.8	439.46	-108470	
2 Superstructure - Structural elements			2453800	-21917.4	91184	141071		0		28780	25400						0	99151	25436.2	389.975	-346230	
2 Superstructure - Building envelope			1441000	-33845	26600	59745		0		16990	812200						0	5004	3313.2	5356.8	-275200	
2 Superstructure - Internal elements			126600	-34100	13370	6300		0		1488	105200						0	1230	29460	6137	-18990	
3 Finishes			307200	-371000	44490	35270		0		3604	735400						0	2562	431100	2474	-48420	
4 Fittings, furnishings and equipment (FF&E)			182000	-488000	20900	10400		0		2140	579000						0	530	486000	905	-8030	
5 Services (MEP)			1040500	-1359	74120	13111		0		64353	853800						10.4	3509.5	33780.6	11.6915	-255290	
6 Pre-fabricated buildings and units																						
7 Works to existing buildings			0	0	0	0		0		0	0						0	0	0	0	0	
Sub-total	kgCO2e	0	6392500	-950221.4	394854	458407		0	344	127246	3111000			7140000	0		10.4	216756.5	1030074	15713.9265	-1060630	-18300
8 External works associated with the project (within boundary)		0	0	0	0	0		0	0	0	0			0	0		0	0	0	0	0	0
8 External works associated with the project (outside of boundary)		0	0	0	0	0																
Total	kgCO2e	0	6392500	-950221.4	394854	458407	0	0	344	127246	3111000			7140000	0		10.4	216756.5	1030074	15713.9265	-1060630	-18300

A RICS table
Non decarbonised – Asset 2

Summary of carbon emissions by element and life cycle stage/module (non-decarbonised)

Note: For a refurbishment project the upper rows of this table would be completed twice - for the refubished GIA and new build GIA, the results would then be aggregated when reporting for the overall assete. For a masterplan project complete a version for each individual asset and report the total external works separately.

Columns should be added for each different scenario considered for the asset's use & EoL stages. The scenario name/number should be clearly indicated.
* Headings with asterisk denote modules affected by decarbonisation.

Building elements		Carbon per life cycle stage - non-decarbonised																			
		A0 Pre-construction stage	**[A1-A3]** Product stage excl. sequestered carbon	**[A1-A3]** Sequestered carbon within installed materials/ products	**[A4]** Transport to and from site	**[A5]** [A5.1-A5.3] Pre-construction demolition, construction activities and waste management	[A5.4] Transport of construction workers	**[B1.1]** In-use emissions & removals materials & carbonation	**[B1.2] *** In-use emissions & removals Refrigerant leakage	**[B2-B3]** Maintenance and repair	**[B4] *** Replacement	**[B5] *** Refurbishment/ planned changes excl. sequestration (where relevant)	**[B5]** Sequestered carbon related to refurbishment/ planned changes (where relevant)	**[B6] *** [B6.1-B6.3] Energy use	**[B7] *** [B7.1-B7.3] Water use	**[B8] *** User activities	**[C1] *** Deconstruction/demolition process	**[C2] *** Transport to waste processing or disposal facilities	**[C3]** Waste processing for reuse, recycling and/or energy recovery and	**[C4]** Waste disposal	D1 * Potential net benefits/loads from reuse, recycling, energy recovery and/ or other recovery	D2 * Potential benefits/loads from exported utilities
Asset level emissions		0				584000	0		2010	0				235000	230000		0					0
0.1 Demolition works						0																
0.2 Facilitating works			0	0	0	0		0		0	0						0	0	0	0	0	
1 Substructure			0	0	0	0		0		0	0						0	0	0	0	0	
2 Superstructure - Structural elements			0	0	0	0		0		0	0						0	0	0	0	0	
2 Superstructure - Building envelope			0	0	0	0		0		0	0						0	0	0	0	0	
2 Superstructure - Internal elements			0	0	0	0		0		0	0						0	0	0	0	0	
3 Finishes			0	0	0	0		0		0	0						0	0	0	0	0	
4 Fittings, furnishings and equipment (FF&E)			0	0	0	0		0		0	0						0	0	0	0	0	
5 Services (MEP)			0	0	0	0		0		0	0						60.9	0	0	0	0	
6 Pre-fabricated buildings and units																						
7 Works to existing buildings			0	0	0	0		0		0	0						0	0	0	0	0	
Sub-total	kgCO2e	0	0	0	0	584000		0	2010	0	0			235000	230000		60.9	0	0	0	0	0
8 External works associated with the project (within boundary)		0	258679	-3271	22280	15078		0	0	118913	115400			0	0		0	32110	7145	86.7	-68700	0
8 External works associated with the project (outside of boundary)		0	0	0	0	0																
Total	kgCO2e	0	258679	-3271	22280	599078	0	0	2010	118913	115400			235000	230000		60.9	32110	7145	86.7	-68700	0

A RICS table
Decarbonised – Asset 2

Summary of carbon emissions by element and life cycle stage/module (decarbonised)

Note: For a refurbishment project the upper rows of this table would be completed twice - for the refubished GIA and new build GIA, the results would then be aggregated when reporting for the overall asset. For a masterplan project complete a version for each individual asset and report the total external works separately.

Columns should be added for each different scenario considered for the asset's use & EoL stages. The scenario name/number should be clearly indicated.
* Headings with asterisk denote modules affected by decarbonisation.

Building elements		Carbon per life cycle stage - decarbonised																		
		A0 Pre-construction stage	**[A1-A3]** Product stage excl. sequestered carbon	**[A1-A3]** Sequestered carbon within installed materials/ products	**[A4]** Transport to and from site	**[A5]** [A5.1-A5.3] Pre-construction demolition, construction activities and waste management	[A5.4] Transport of construction workers	**[B1.1]** In-use emissions & removals materials & carbonation	**[B1.2] *** In-use emissions & removals Refrigerant leakage	**[B2-B3]** Maintenance and repair	**[B4] *** Replacement	**[B5] *** Refurbishment/ planned changes excl. sequestration (where relevant)	**[B5]** Sequestered carbon related to refurbishment/ planned changes (where relevant)	**[B6] *** [B6.1-B6.3] Energy use	**[B7] *** [B7.1-B7.3] Water use	**[B8] *** User activities	**[C1] *** Deconstruction/demolition process	**[C2] *** Transport to waste processing or disposal facilities	**[C3]** Waste processing for reuse, recycling and/or energy recovery and disposal	**[C4]** Waste disposal	D1 * Potential net benefits/loads from reuse, recycling, energy recovery and/ or other recovery	D2 * Potential benefits/loads from exported utilities
Asset level emissions		0				584000	0		1000	0				51800	46000		0					0
0.1 Demolition works						0																
0.2 Facilitating works			0	0	0	0		0		0	0						0	0	0	0	0	
1 Substructure			0	0	0	0		0		0	0						0	0	0	0	0	
2 Superstructure - Structural elements			0	0	0	0		0		0	0						0	0	0	0	0	
2 Superstructure - Building envelope			0	0	0	0		0		0	0						0	0	0	0	0	
2 Superstructure - Internal elements			0	0	0	0		0		0	0						0	0	0	0	0	
3 Finishes			0	0	0	0		0		0	0						0	0	0	0	0	
4 Fittings, furnishings and equipment (FF&E)			0	0	0	0		0		0	0						0	0	0	0	0	
5 Services (MEP)			0	0	0	0		0		0	0						30.4	0	0	0	0	
6 Pre-fabricated buildings and units																						
7 Works to existing buildings			0	0	0	0		0		0	0						0	0	0	0	0	
Sub-total	kgCO2e	0	0	0	0	584000		0	1000	0	0			51800	46000		30.4	0	0	0	0	0
8 External works associated with the project (within boundary)		0	258679	-3271	22280	15078		0	0	59456	57700			0	0		0	16060	7145	86.7	-34410	0
8 External works associated with the project (outside of boundary)		0	0	0	0	0																
Total	kgCO2e	0	258679	-3271	22280	599078	0	0	1000	59456	57700			51800	46000		30.4	16060	7145	86.7	-34410	0

C Operational inputs
Water irrigation

Country: United_Kingdom_UK
River basin: WFD26_North_West

	Rain (mm/month)	Actual ET (mm/month)	Balance (mm/month)
January	107.2	28.2	79.0
February	78.6	34.9	43.7
March	61.7	55.1	6.6
April	56.4	65.9	-9.5
May	72.4	70.0	2.5
June	71.2	61.1	10.2
July	86.5	49.0	37.4
August	91.9	33.3	58.6
September	82.4	23.0	59.4
October	110.1	18.1	92.0
November	105.2	17.5	87.7
December	114.4	21.9	92.5
Total	**1038.0**		**-9.5**

	Area		Vegetation type	Water demand	K_{sp}	Microclimate / Heat island effect	K_M	Density of vegetation	Density (shading) factor (K_d)	Vegetated area coeffieicnt K_{VA}	Net water balance without irrigation (mm/month)												Total			Irrigation system	Irrigation system efficiency
											Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	mm/yr	$m^3/m^2/yr$	m^3/yr		
											0.0	**0.0**	**0.0**	**-9.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**					
planting bed	175	m2	Lawn grass	Low water demand	0.6	Medium	1	Low density	1.00	**0.6**	0.0	0.0	0.0	-5.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-5.7	0.010	**1.7**	**Manual or other**	0.60
Ornamental planting	275	m2	Mixed planting	High water demand	0.9	Medium	1	High density	0.60	**0.54**	0.0	0.0	0.0	-5.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-5.1	0.009	**2.4**	**Manual or other**	0.60
		m2																					0.0	#N/A			#N/A
		m2																					0.0	#N/A			#N/A
Total vegetated area	**450**	**m2**																						**Total**	**4.0**		

Appendix D BRUKL Document

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2021

Project name

MMU_STAGE_3 As designed

Date: Wed Sep 10 12:22:42 2025

Administrative information

Building Details

Address: Address 1, City, Postcode

Certifier details

Name: Buro Happold

Telephone number: Phone

Address: Street Address, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.28

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.28

BRUKL compliance module version: v6.1.e.1

Foundation area [m²]: 1313.29

The CO_2 emission and primary energy rates of the building must not exceed the targets

Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	4.19	
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	3.93	
Target primary energy rate (TPER), $kWh_{PE}/m^2.annum$	45.83	
Building primary energy rate (BPER), $kWh_{PE}/m^2.annum$	42.16	
Do the building's emission and primary energy rates exceed the targets?	BER =< TER	BPER =< TPER

The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Fabric element	$U_{a\text{-Limit}}$	$U_{a\text{-Calc}}$	$U_{i\text{-Calc}}$	First surface with maximum value
Walls*	0.26	0.22	0.22	00000001:Surf[1]
Floors	0.18	0.1	0.1	00000000:Surf[0]
Pitched roofs	0.16	-	-	No pitched roofs in building
Flat roofs	0.18	0.1	0.1	0600000C:Surf[0]
Windows** and roof windows	1.6	1.42	1.55	00000000:Surf[2]
Rooflights***	2.2	-	-	No roof lights in building
Personnel doors^	1.6	1.27	1.27	00000000:Surf[1]
Vehicle access & similar large doors	1.3	-	-	No vehicle access doors in building
High usage entrance doors	3	-	-	No high usage entrance doors in building

$U_{a\text{-Limit}}$ = Limiting area-weighted average U-values [W/(m²K)] $U_{i\text{-Calc}}$ = Calculated maximum individual element U-values [W/(m²K)]

$U_{a\text{-Calc}}$ = Calculated area-weighted average U-values [W/(m²K)]

* Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

** Display windows and similar glazing are excluded from the U-value check. *** Values for rooflights refer to the horizontal position.

^ For fire doors, limiting U-value is 1.8 W/m²K

NB: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air permeability	Limiting standard	This building
$m^3/(h.m^2)$ at 50 Pa	8	2.5

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Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Floor area [m²]	11597.1	11597.1
External area [m²]	9564.8	9388.2
Weather	MAN	MAN
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	9089.61	3708.1
Average U-value [W/m²K]	0.95	0.39
Alpha value* [%]	14.17	10

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

Building Use

% Area	Building Type
	Retail/Financial and Professional Services
	Restaurants and Cafes/Drinking Establishments/Takeaways
	Offices and Workshop Businesses
	General Industrial and Special Industrial Groups
	Storage or Distribution
	Hotels
	Residential Institutions: Hospitals and Care Homes
	Residential Institutions: Residential Schools
99	**Residential Institutions: Universities and Colleges**
	Secure Residential Institutions
	Residential Spaces
	Non-residential Institutions: Community/Day Centre
	Non-residential Institutions: Libraries, Museums, and Galleries
	Non-residential Institutions: Education
	Non-residential Institutions: Primary Health Care Building
	Non-residential Institutions: Crown and County Courts
	General Assembly and Leisure, Night Clubs, and Theatres
	Others: Passenger Terminals
	Others: Emergency Services
1	**Others: Miscellaneous 24hr Activities**
	Others: Car Parks 24 hrs
	Others: Stand Alone Utility Block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	4.04	1.6
Cooling	3.33	3.32
Auxiliary	9.84	10.72
Lighting	14.3	10.98
Hot water	5.52	4.49
Equipment*	30.12	30.12
TOTAL**	**37.02**	**31.11**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	8.51	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0
Displaced electricity	*8.51*	*0*

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	95.18	71.36
Primary energy [kWh_{PE}/m²]	42.16	45.83
Total emissions [kg/m²]	3.93	4.19

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