BURO HAPPOLD

Sister Manchester, Plot H

Whole Life Carbon Report

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Glossary

Term	Definition
BREEAM	Building Research Establishment Environmental Assessment Method
BSRIA	Building Services Research and Information Association
CWCT	Centre for Window and Cladding Technology
DfMA	Design for Manufacture and Assembly
EAF	Electric Arc Furnace
EIA	Environmental Impact Assessment
EPD	Environmental Product Declaration
FF&E	Furniture, Fixtures and Equipment
GEA	Gross External Area
GGBS	Ground Granulated Blast-furnace Slag
GHG	Greenhouse Gas
GIA	Gross Internal Area
GLA	Greater London Authority
HVAC	HVAC
ISO	International Organization for Standardization
IStructE	Institute of Structural Engineers
LCA	Life-Cycle Assessment
LEED	Leadership in Energy and Environmental Design Building Certification
LETI	London Energy Transformation Initiative
MEP	Mechanical, Electrical, Public Health
MVHR	Mechanical Ventilation with Heat Recovery
NIA	Net Internal Area
NLA	Net Lettable Area
NZCBS	Net Zero Carbon Buildings Standard
O&M	Operation & Maintenance
PBSA	Purpose Built Student Accommodation
PV	Photovoltaic (solar panels)
RC	Reinforced Concrete
RIBA	Royal Institution of British Architects
RICS	Royal Institution of Chartered Surveyors
TM54	CIBSE TM54: Evaluating Operational Energy Use at the Design Stage
T&D	Transmission and distribution
WLCA	Whole Life Carbon Assessment
WTT	Well-to-tank

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1 Executive Summary

This Whole Life Carbon Assessment (WLCA) is submitted in support of the full planning application for the Sister – Plot H development, brought forward by the applicant team comprising RGRE Ltd, ID Manchester Ltd and The University of Manchester, 'The Applicant'. The WLCA forms part of the Energy and Carbon Statement and has also been written to comply with the *GMCA Design Guidance for Net Zero*.

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

This report presents a whole life carbon assessment of construction materials, as well as site works and expected operational demands of the proposed building. During RIBA Stage 2, certain design interventions were specified as part of design development in order to reduce the environmental impact of the building. This was followed by final data collation from all the consultants and assessing life cycle environmental impact of all building materials in One Click LCA. To ensure a complete assessment of building, material quantities from consultants were also aligned with the cost plan from the cost consultants.

We note that the GMCA *Design Guidance for Net Zero* references LETI targets but asks for the RICS 2nd edition (2023) methodology to be undertaken. Therefore, whilst the assessment has been carried out in accordance with the latest 2023 methodology, we have highlighted where this will have produced a higher result than the 1st edition – most notably with demolition included, increased transport emissions associated with the need to account for return empty journeys and explicit contingency factors.

Currently the assessment has been modelled assuming industry standard carbon factors in line with RICS 2nd edition and its referenced discipline specific documents (e.g. CWCT, IStructE) but the team has already begun to explore potential paths to embodied carbon reduction, which are outlined in Section 7. Further betterment of material carbon performance will continue to be explored in future stages.

The upfront embodied carbon intensity of the whole development is **765 kgCO_2e/m^2**. Life cycle embodied carbon, (A-C excluding B6 & B7) is **1,273 kgCO_2e/m^2** for a decarbonised scenario. Please see Table 1—1 below for a detailed breakdown.

For the decarbonised scenario, the following apply:

- **Grid decarbonisation:** Represents a scenario in which there is a gradual reduction in the energy and carbon intensity of electricity production.
- **Material decarbonisation:** Accounts for the expected decarbonisation transition related to the extraction, transportation and manufacturing processes of materials.

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Table 1—1 Whole life carbon summary

	WLCA Module	Non-decarbonised scenario		Decarbonised scenario	
		Total ($kgCO_2e$)	**Embodied carbon intensity** ($kgCO_2e/m^2$)	**Total** ($kgCO_2e$)	**Embodied carbon intensity** ($kgCo_2e/m^2$)
Plot H	**Upfront embodied carbon (A1-A5**)	**26,488,460**	**765**	**26,488,460**	**765**
	Module B1-B5	31,588,950	912	15,821,115	457
	Module B6-B7 *(operational energy + water)*	59,066,231	1,706	12,989,210	375
	Module C1-C4	2,604,425	75	1,753,377	51
	Module D	-15,252,465	-441	-7,645,291	-221
	Cradle-to-grave (A-C) *excluding B6&B7*	**60,681,835**	**1,753**	**44,062,951**	**1,273**

Please note these results include an added 15% contingency, in line with RICS 2nd edition guidelines for Early-Stage Design.

Industry benchmarks, such as the LETI/RIBA target, or the NZCBS limits report against a limited scope that excludes demolition and facilitation works, loose FF&E, PV and external works to compare building level performance. For this scope, the upfront carbon reduces to **712 $kgCO_2e/m^2$**.

The NZCBS upfront carbon limits have been based on the most complete data set of any UK industry benchmarking to date. It is notable how the limit is higher for commercial residential than for flats, which stems from the reasons outlined in Section 6.1.1. Due to this, and the challenges with using RICS 1st edition-based LETI/RIBA targets (discussed in Section 5), we urge caution against comparing the building to the GMCA residential benchmark. Having said that, should the embodied carbon savings that have already been considered (detailed in Section 7) be realised, and the uncertainty factor be conservative, which is expected given the comprehensive modelling undertaken, then the building could deliver against this GMCA benchmark in future stages.

Detail on how the team will continue to aim to reduce the embodied carbon emissions is available in Section 8. Measures include:

- Procuring local materials
- Minimising fuel consumption and waste on site with clear guidance in ER documentation to contractors
- Reviewing service lives of materials procured.

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2 Introduction

2.1 Scope of the Document

Buro Happold have prepared this Whole Life Carbon Assessment (WLCA) report to present the findings from whole life carbon assessment of construction materials, as well as site works and expected operational demands of Sister – Plot H Development referred to hereafter as "the Site". The Site is to be developed by RGRE Ltd, ID Manchester Ltd and The University of Manchester. The WLCA forms part of the Energy and Carbon Statement and has also been written to comply with the *GMCA Design Guidance for Net Zero*.

Section 3: Outlines the delivery of the Whole Life Carbon Assessment against the Planning Policy requirements.

Section 4: Details the methodology of the assessment in accordance with RICS 2nd edition.

Section 5: Describes the project embodied carbon targets, noting there is no explicit target for student residential buildings in the GMCA guidance. It also outlines why RICS 2nd edition results will be increased in comparison to RICS 1st edition results and the associated LETI/RIBA targets that are referenced in GMCA documentation.

Section 6: Presents the project whole life carbon results for the project, split between upfront carbon (A1-A5) and whole life carbon (A-C).

Section 7: Outlines the reduction measures that have already been implemented on the project to aim to reduce the environmental impact of the building.

Section 8: Outlines potential further opportunities that could be explored for the building in future stages.

2.2 Existing Site

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

Although not within a conservation area, the site is located adjacent to the boundary of the Whitworth Street Conservation Area and there are listed buildings immediately to the north of the site, and within its vicinity, including the Grade II Listed Manchester South Junction & Altrincham Viaduct, Orient House, and Granby House.

The site is split across Flood Zone 1 (low probability of flooding) to the east and Flood Zone 2 (medium probability of flooding) to the west. The existing car park structure exhibits evidence of flooding in the basement and ground floor areas.

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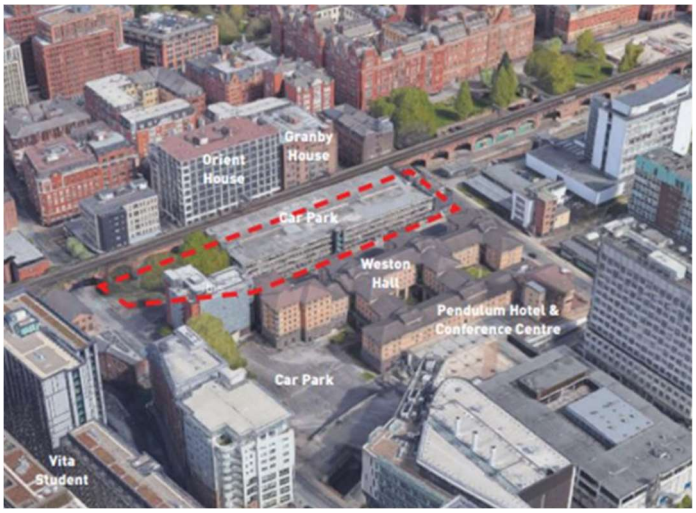


Figure 2—1 Existing Site Boundary

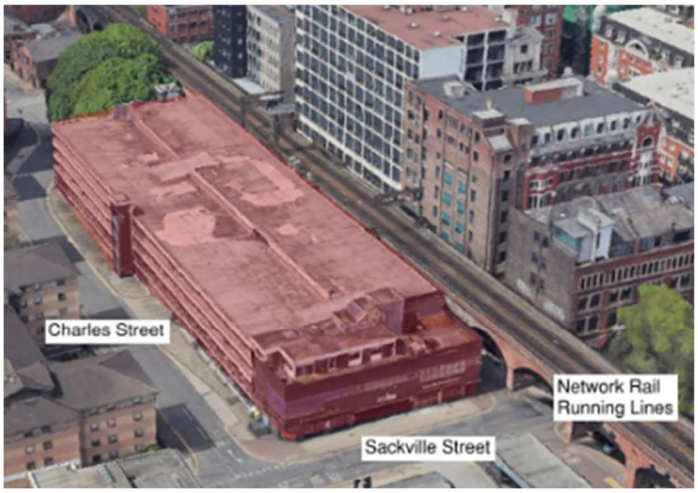


Figure 2—2 Existing Car Park block to be demolished, (Subject to separate planning application submitted August 2025)

2.3 Description of the Development

The proposals comprise the demolition of the existing multi-storey car park and associated retail units, and the construction of a Purpose Built Student Accommodation (PBSA) development (Use Class Sui Generis) comprising three towers of 8, 10, and 38 storeys, connected by a two-storey podium providing flexible commercial floorspace (Use Class E). The proposed PBSA will deliver a total of 1,041 student bedspaces, arranged as 720 cluster bedrooms and 321 studios, supported by internal amenity space, cycle parking, and associated servicing facilities.

At ground level, the podium will accommodate three commercial units (totalling 659 m^2 GEA), providing opportunities for a variety of flexible retail, food, and beverage uses that will activate the street frontage and contribute to the wider Sister neighbourhood. The development also includes high-quality public realm and landscaping proposals along Charles Street, with improved pedestrian connectivity and the introduction of new planting, seating areas, and active frontages.

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The scheme has been designed to respond to its city-centre context, with the podium and tower arrangement stepping in height from east to west to create a varied and contextual skyline. The architectural approach will complement the evolving Sister masterplan, while delivering a distinctive, high-quality addition to Manchester's skyline. Supporting facilities include 64 secure cycle spaces within the basement (including six accessible spaces), 13 Sheffield stands for visitors, and two DDA-compliant car parking spaces and two servicing bays located along Charles Street. Construction of Plot H is anticipated to commence in Summer 2027 and will be delivered as a single phase of development.

The following figures show the proposed development layout and indicative massing.



Figure 2—3 Proposed Ground Floor Plan (hodder+partners)

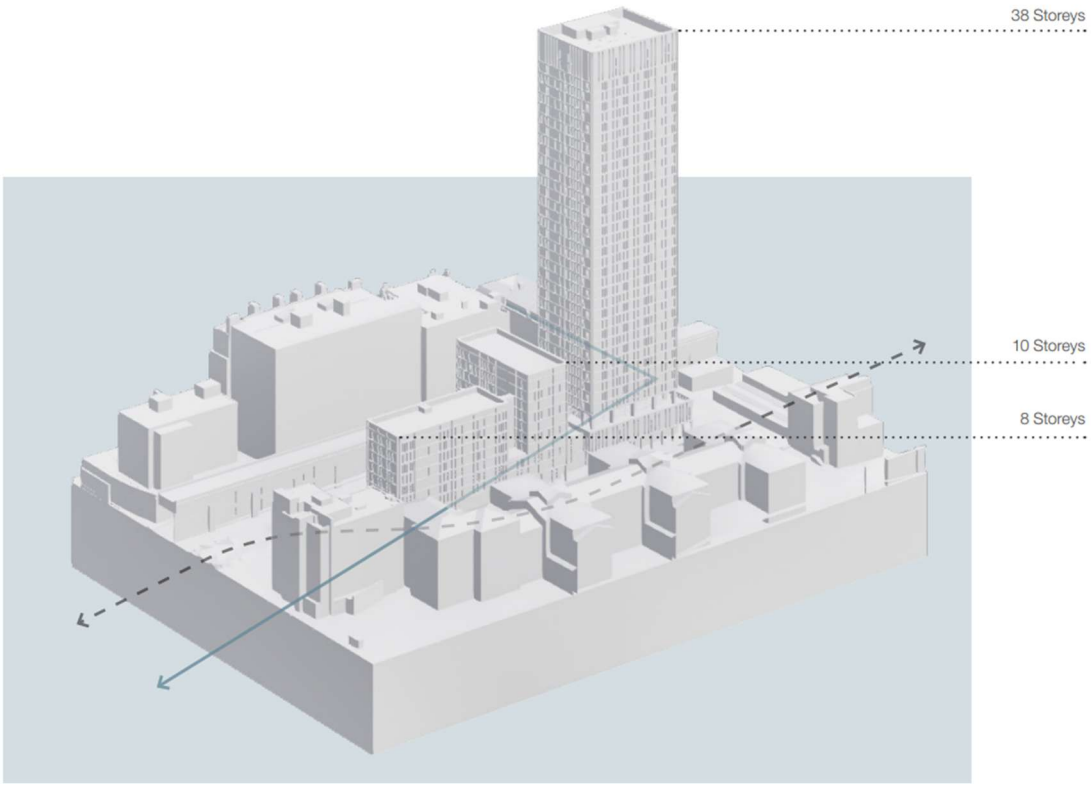


Figure 2—4 Indicative Massing (hodder+partners)

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3 Planning Policy Context

This Whole Life Carbon Assessment should be read alongside the Energy and Carbon Statement. This report has also been written to comply with the *GMCA Design Guidance for Net Zero*.

3.1 Design Guidance for Net Zero Guidance for applicants on how to design to achieve Net Zero Carbon buildings

In March 2025 the GMCA issued *Design Guidance for Net Zero: Guidance for applicants on how to design to achieve Net Zero Carbon buildings*. This document is part of a suite of three documents regarding Net Zero, and focusses on building design to achieve Net Zero targets. This report details how the development has designed for low embodied carbon at early design stages, including reporting against the specific measures outlined in Chapter 4 of that document.

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4 Methodology

4.1 Whole Life Cycle Assessment background

Whole life-cycle carbon emissions are the total greenhouse gas emissions arising from a development over its lifetime, ranging from the emissions associated with raw material extraction, the manufacture and transport of building materials, to installation/construction, operation, maintenance and eventual material disposal. This report covers a 'cradle-to-grave' Whole Life Carbon Assessment (WLCA) which includes modules A-C. Note that Module A0 which covers non physical pre-construction activities such as surveys is considered negligible for buildings. Additionally, inclusion of Module B8 which covers user activities such as commuting to a building is optional and has not been encompassed in this assessment. Modules D1 and D2 are reported separately.

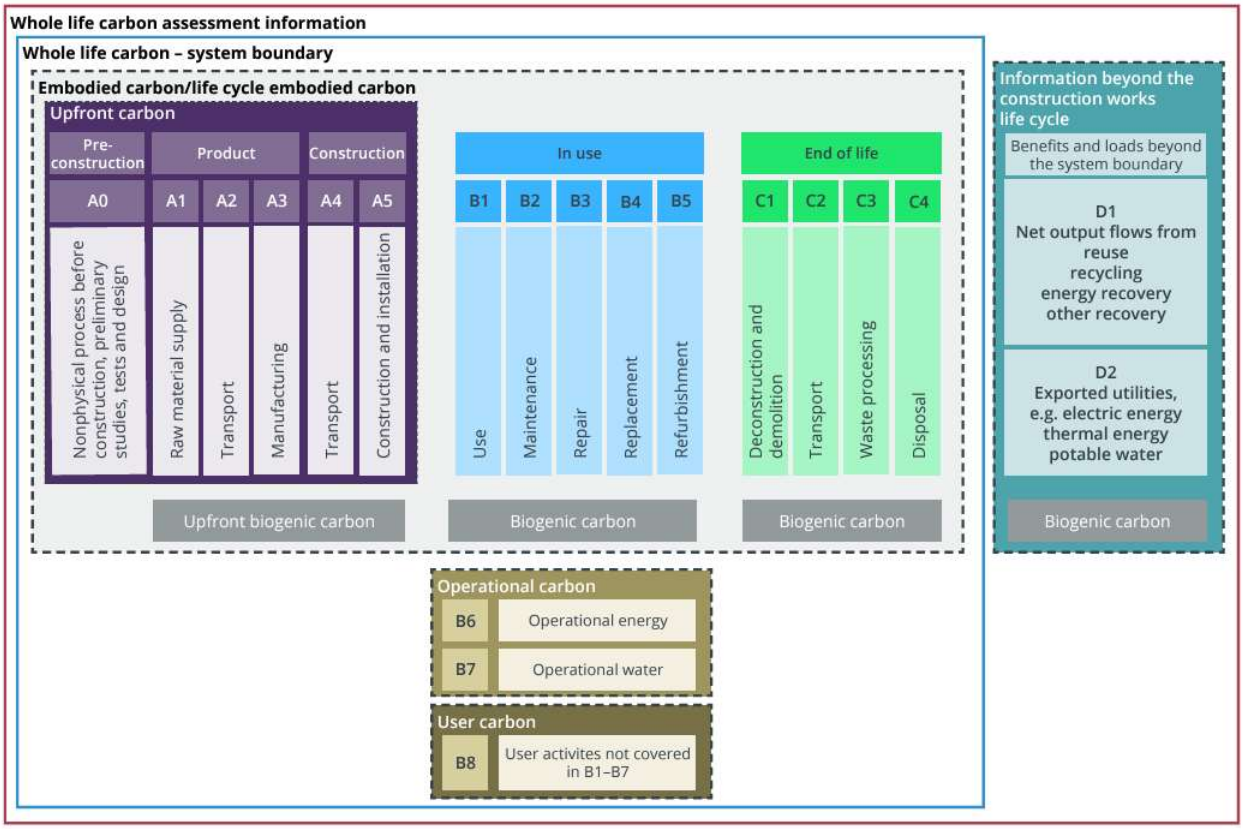


Figure 4—1 Building and infrastructure life cycle stages and information modules (RICS Whole Life Carbon Assessment 2023)

4.2 Scope of assessment

Table 4—1 demonstrates which building elements from the development have been included across the embodied carbon assessments for the Whole Life Carbon Assessment.

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Table 4—1 Elements included within scope of LCA assessments

Building element	Element sub-category	Included
Facilitating works and demolition	a) Demolition works	Y
	b) Facilitating works	Y
Substructure	a) Foundations and piling	Y
	b) Basement and lowest floor	Y
Superstructure	a) Frame	Y
	b) Upper floors and roof	Y
	c) Stairs, ramps	Y
	d) External envelope	Y
	e) Windows and external doors	Y
	f) Internal walls	Y
	g) Internal doors	Y
Finishes	a) Wall finishes	Y
	b) Floor finishes	Y
	c) Ceiling finishes	Y
FF&E	a) FF&E	Y (loose FF&E excluded from industry comparison target in accordance with LETI/RIBA/NZCBS)
Core and Local Services	a) Public health	Y
	b) HVAC	Y
	c) Electrical installations	Y
	d) On-site renewable energy generation	Y (On-site renewables excluded from industry comparison target in accordance with LETI/RIBA/NZCBS)
	e) Systems including life safety, life and conveyor etc.	Y
External works	a) External works	Y (External works excluded from industry comparison target in accordance with LETI/RIBA/NZCBS)

4.2.1 Life cycle sequence for a project with demolition

When any full or partial demolition or deconstruction of an existing structure is required, to facilitate the construction of a new asset within the designated site boundary or as an extension to the existing asset, the impacts associated with that demolition or deconstruction must be included in the WLCA in sub-module A5.1.

This requirement is illustrated within the RICS 2nd edition which outlines the lifecycle sequence for such a project, as seen in Figure 4—2, for which this asset is represented by 'Asset 2'. As the detailed processing routes for the demolished materials are unavailable, as is typically the case at early design stages, then **35 kgCO_2/m²** of demolished area has been applied.

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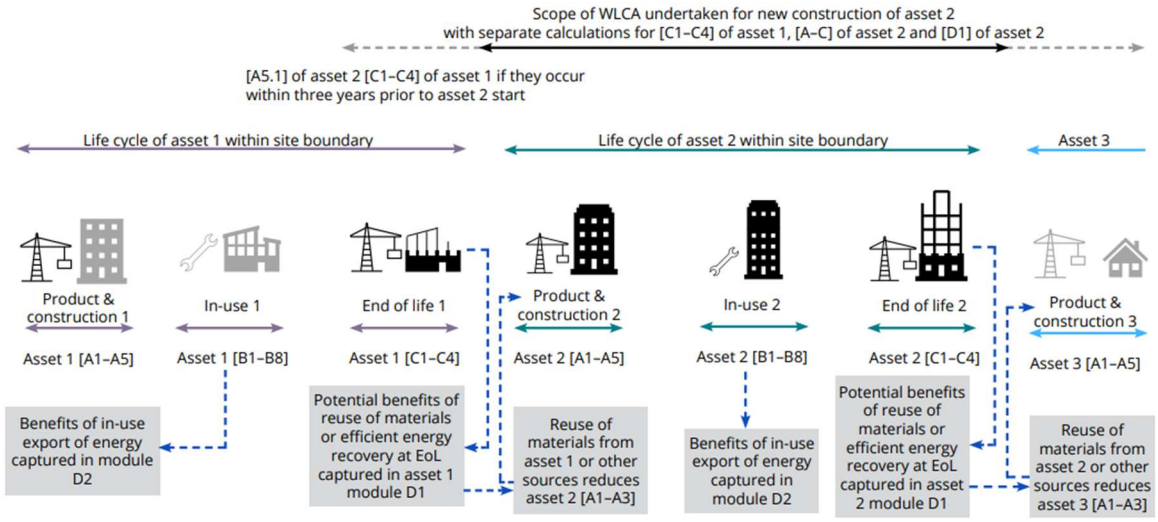


Figure 4—2 'Illustrative life cycle sequence for a building that evolves through a subsequent refurbishment' (RICS 2nd edition)

4.3 Sourcing of material quantities

The assessment collated the most up-to date and representative data that was available for material quantities for the building and the associated infrastructure on the site. In line with RICS 2nd edition Guidance for WLCA at Early Design Phase, key inputs can be seen in Table 4—2 below:

Table 4—2 WLCA Element Data Sources

WLCA Element	Key input source
Gross Internal Floor Area [GIFA]	Provided by Deloitte (Standard Description Document – Planning and EIA).
Substructure	Concrete and reinforcement quantities provided by Structural & Civils Engineers (Roscoe). Other material information from Cost Plan (RG Group).
Superstructure (Structural – Frame, Upper floors and roof, Stairs)	Concrete and reinforcement quantities provided by Structural Engineers (Roscoe). Other material information from Cost Plan (RG Group).
External envelope (External walls and roof coverings, external windows and doors)	Overall areas from Cost Plan (RG Group). Material build-ups for standard façade and roof coverings from Buro Happold's internal library for early-stage design, adapted to project specific details.
Internal (Internal walls, Internal doors, finishes and FF&E)	Quantities from Cost Plan (RG Group). Allowance for internal walls added from Buro Happold's library to account for additional detail not included in early cost estimate (e.g. wall ties and mastic seals).
Building Services	Modelled using the RICS 2nd edition MEP supplementary table and material provided by MEP consultant (HG-CE).
External Works	External Drainage quantities provided by Structural & Civils Engineers (Roscoe). Hard Landscaping surfaces and areas provided by Landscape Architect (Layer.studio). Generic build-ups for hard landscaping from Buro Happold's internal library for early-stage design.
Energy Consumption	TM54 Operational Energy modelling (Buro Happold)
Water Consumption	Indicative water consumption estimated based on BSRIA Rules of Thumb
Construction Site Emissions	RICS 2nd edition benchmark based on m^2 (see section 4.3.2.2)
Demolition Emissions	Demolished buildings area provided by architect RICS 2nd edition benchmark based on m^2

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4.3.1 MEP modelling

Modelling of MEP is one of the most challenging aspects of any Whole Life Carbon Assessment due to the number and complexity of the elements. In the past there has been a continual underrepresentation of emissions associated with MEP due to systems not being modelled in their entirety.

In the latest version of RICS, a list of supplementary assumptions has been provided to enhance the precision in benchmarking of MEP and services in buildings in lieu of exact material and equipment specification. Through the adoption of the supplementary assumption, the selected MEP strategy can be represented based on the simple building sizing figures such GIA, number of levels and the occupancy. Combining the assumptions with standard industry practise for material selection, it is possible to generate an embodied carbon benchmark specific to the services of the building. In combination with HGCE, this is the process that has been undertaken for this early design stage for the project.

4.3.2 Construction site emissions

RICS 2nd edition stipulates that the carbon impacts arising from any on-site construction-related activities must be considered in module A5. This includes any demolition works associated with refurbishment or redevelopment of existing built assets or sites; temporary works associated with installation processes; any construction activities and installation processes on-site, including energy consumption for site accommodation and use of plant, machinery and equipment; and the impacts associated with any waste generated through the construction process, its treatment and disposal, including the disposal of packaging waste.

For Sister Plot H, Pre-construction demolition (A5.1) of the existing buildings is reported using the RICS benchmark of **35 kgCO_2/m²** of demolished area. Construction activities (A5.2) have been modelled using the RICS 2nd edition benchmark of **40 KgCO_2e/m²**. Waste and waste management (A5.3) are applied as element by element allowances. Worker transport (A5.4) is optional and has not been included in the scope of this assessment.

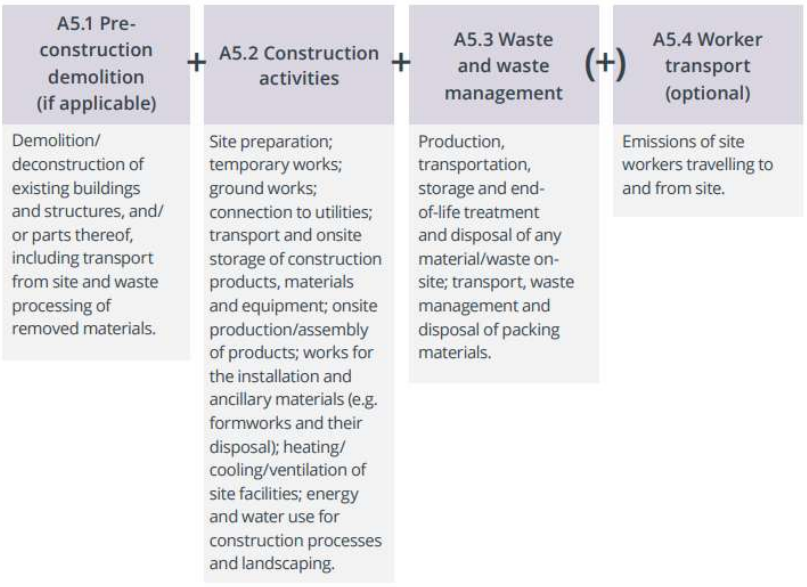


Figure 4—3 Sub-modules of module A5 (RICS 2nd edition)

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4.4 LCA Software

The assessment has been carried out with One Click LCA software. The software holds 11 third party certifications and complies with over 30 certifications and standards for Life Cycle Assessment and Life Cycle Costing, including all versions of LEED and BREEAM. The software includes curated and verified global and local databases. The up-to-date list of integrated databases can be found here: https://www.oneclicklca.com/support/faq-and guidance/documentation/database/.

One Click LCA has been third party verified by ITB for compliancy with the following LCA standards: EN 15978, ISO 21931–1 and ISO 21929, and data requirements of ISO 14040 and EN 15804. The full compliancy documentation is available at https://www.oneclicklca.com/support/faq-and-guidance/documentation/compliancy-and-certifications/.

The analysis is carried out using the *Whole life carbon assessment, RICS - 2nd Edition' tool* developed by One Click LCA. The tool has been updated to align with Professional Standard Whole life carbon assessment for the built environment, 2nd edition.

4.5 Key material carbon factors (A1-A3)

Unless development-specific information is given within the RIBA Stage 2 material or provided directly by the design team, the following assumptions have been made relating to key materials to provide the most accurate representation of construction emissions within the UK as is possible during early-stage design. This is based off the *IStructE How to calculate embodied carbon* – a source of information directly referenced by RICS 2nd edition guidance.

Table 4—3 Key carbon material carbon factors

Material	A1-A3 Carbon Factor	A1-A3 Carbon Factor Unit
Concrete in-situ C35/45 (unreinforced)	290	$kgCO2e/m^3$
Steel reinforcement bars	0.72	kgCO2e/kg
UK Open Rolled Steel	1.64	kgCO2e/kg
UK Closed Sections Steel	2.59	kgCO2e/kg
UK Plate Steel	2.47	kgCO2e/kg

4.5.1 Whole Life Carbon modelling default scenarios

Any assumptions for the other life cycle modules are detailed in the table below:

Table 4—4 WLCA Modelling default scenarios

Scenario	Default using within WLCA
Transport [A4]	Transport has been assumed in line with RICS 2nd edition guidance Table 17
Waste Processing [A5]	Wastage parameters inputted in line with RICS 2nd edition Guidance Table 18
Maintenance [B2]	RICS 2nd edition assumption used in lieu of detailed maintenance scenario ($10kgCO_2/m^2$)
Repair/year [B3]	RICS 2nd edition assumption used in lieu of detailed maintenance scenario ($2.5kgCO_2/m^2$)
Service life [B4]	Service lives inputted in line with RICS 2nd edition Guidance Table 20
Energy consumption [B6]	Emissions in line with Appendix H of RICS 2nd edition Guidance (Note this is significantly more than RICS 1st edition due to it considering the embodied carbon emissions of the energy infrastructure).
Water consumption [B7]	Water emissions based on RICS 2nd edition Guidance

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End of Life [C]	C1: Modelled based on *Good practice demolition scenario- 30% of A5.2 impacts* in OneClick C2: Transport parameters associated with individual product/ manufacturer information C3: Waste processing parameters associated with individual product/ manufacturer information C4: Disposal parameters associated with individual product/ manufacturer information
Benefits beyond system boundary [D]	Processed within OneClick in accordance with RICS 2nd edition tool

4.5.2 Uncertainty Factor

When costing projects, it is common for contingencies to be used to reflect uncertainties. For WLCAs there are similar uncertainties, particularly during the early design phase when less specific information is available regarding the final design and materials. The RICS 2nd edition guidance introduces a WLCA uncertainty factor. Applying contingency also helps to account for any market unknowns that may become apparent during procurement, and to accommodate carbon creep (increases in carbon across the later RIBA stages of a project as data information improves), which is a problem for many projects. At this stage, a blanket contingency factor of 15% has been applied. See 5.2.2 for more details.

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5 Project Targets

5.1 Project Targets

The GMCA *Design Guidance for Net Zero* references the LETI/RIBA targets which are based on the RICS 1st edition methodology but asks for the RICS 2nd edition (2023) methodology to be undertaken. Therefore, whilst the assessment has been carried out in accordance with the latest methodology, we have highlighted where this will have produced a higher result than the 1st edition – most notably with demolition included, increased transport emissions associated with the need to account for return empty journeys and explicit contingency factors.

It is worth noting that the LETI/RIBA targets, and other industry limits such as the UK Net Zero Carbon Building Standard) have a slightly reduced building element scope (exclude external works, loose FF&E, demolition and renewable electricity generation) and therefore an additional set of results with these exclusions is presented in the next chapter.

LETI and RIBA are part of the Technical Steering Group of the UK Net Zero Carbon Building Standard and have already stated that they will be looking to update their targets going forward to align with the new standard, and the RICS 2nd edition methodology. Whilst LETI is currently 'hibernating', the project team will monitor these updates and align performance against latest industry standards.

5.2 Comparison of targets to RICS 2nd edition

As noted, there are some significant differences between the RICS 1st edition methodology, upon which LETI targets quoted in the GMCA documentation are based, and RICS 2nd edition methodology, which is the expected route outlined in the same guidance document. This chapter outlines some of those key differences. This provides some context to the results presented in the next chapter, as the development would be better performing if assessed against the 1st edition.

5.2.1 Demolition

The new methodology requires the reporting of demolition emissions as part of the A5 module. If the detailed processing routes for the demolished materials are unavailable, as is the case at early design stages, then 35kgCO_2/m^2 of demolished area is to be applied. Due to the area of the existing buildings on the site (car park and retail units) the change is relatively significant for this project contributing **17 kgCO_2/m^2** towards the new development. RICS 1st edition explicitly states that this would not be reported as part of the results, whilst some Planning Policy, such as the current GLA methodology would ask for this to be reported separately.

Please refer to the Circular Economy Statement (SISC0-BHE-ZZ-ZZ-RP-SU-00001) for details on how the development aims to minimise non-hazardous demolition, excavation, construction and operational waste sent to landfill.

5.2.2 Uplift factors

Within the modelling for the assessment, a conservative position has been taken to avoid carbon creep later in design or through construction. For example, where the intention is to use high levels of cement replacement, the concrete

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has currently been modelled as industry standard values. However, there were plenty of projects that had previously taken too optimistic an approach at early stage and therefore the RICS 2nd edition introduces contingency factors to account for this.

The RICS 2nd edition is much more specific with regards to uplift factors that must be applied to the results, with a breakdown shown in the following table. **At this stage, a blanket contingency factor of 15% has been applied.**

Table 5—1 Contingency factor calculation

Stage	Contingency factor	Carbon data uncertainty factor	Quantities uncertainty factor
Concept design *Usually, RIBA Stages 2*	**Yes** – 15%	**No**	**No**
Detailed design & Construction *Usually RIBA Stage 3,4 & 5*	**Yes** – 6%	**Yes** – Calculate using *carbon data quality matrix* to find *asset carbon confidence score**	**Yes** – Calculate using *Quantities uncertainty levels table* to find the *asset QUL score**
Post completion	**No**	**Yes** – Calculate using *carbon data quality matrix* to find *asset carbon confidence score**	**Yes** – Calculate using *Quantities uncertainty levels table* to find the *asset QUL score**

** Based on top 10 materials or products contributing to WLC*

5.2.3 Transport calculations

RICS 2nd edition requires the consideration of an empty running factor to be considered in the A4 transport emissions calculations for road freight. As the assumed transport distances have also changed it is not a simple comparison exercise to run, however based on precedent projects of a similar typology this typically leads to an uplift of 15% for this life cycle module.

5.2.4 Whole life carbon changes

5.2.4.1 Decarbonised scenario

One of the most significant changes to the RICS 2nd edition methodology is the reporting of both a decarbonised and non-decarbonised scenario. For operational energy, in the UK, the falling short scenario (excluding negative emissions from BECCS), from the latest Future Energy Scenarios (FES) developed by National Grid, must be used for the decarbonisation scenario. Alongside grid decarbonisation, it is expected that extraction, transportation and manufacturing processes will also decarbonise. To reflect a likely scenario for decarbonisation of the sector to 2050, RICS have provided standard scenarios for material impacts.

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5.2.4.2 Operational energy carbon factor

For RICS 2nd edition, the carbon conversion factors used must account for both direct and indirect GHG emissions: scopes 1, 2 and 3, including well-to-tank (WTT) and transmission and distribution (T&D) impacts, and should account for the embodied carbon of energy infrastructure where applicable and available, as shown in the figure below. This leads to a significant increase in the B6 emissions compared to a typical 1st edition assessment.

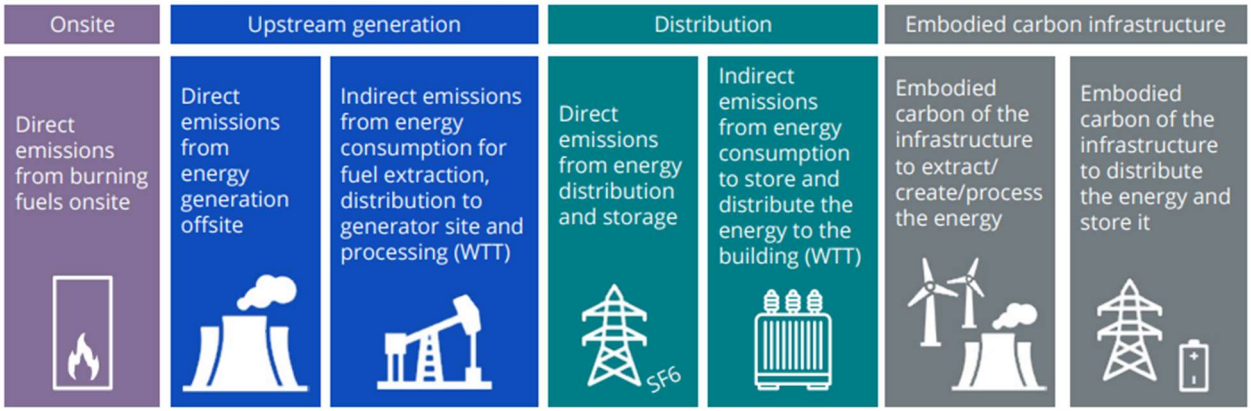


Figure 5—1 Carbon conversion factor inclusions

(https://www.rics.org/content/dam/ricsglobal/documents/standards/Whole_life_carbon_assessment_PS_Sept23.pdf)

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6 Whole Life Carbon Results

6.1 Planning Stage Results

Table 6—1 presents a summary of the Whole Life Carbon Assessment results for Sister – Plot H Development. Results under both a 'decarbonised' and 'non-decarbonised' scenario are presented.

The upfront embodied carbon intensity of the whole development is **765 kgCO_2e/m^2**. Whole Life carbon, Cradle-to-grave (A-C) excluding B6 & B7 is **1,273 kgCO_2e/m^2** under a decarbonised scenario.

Table 6—1 Whole Life Carbon Summary

	WLCA Module	Non-decarbonised scenario		Decarbonised scenario	
		Total (kgCO_2e)	**Embodied carbon intensity** (kgCO_2e/m^2)	**Total** (kgCO_2e)	**Embodied carbon intensity** (kgCo_2e/m^2)
Plot H	**Upfront embodied carbon (A1-A5)**	**26,488,460**	**765**	**26,488,460**	**765**
	Module B1-B5	31,588,950	912	15,821,115	457
	Module B6-B7 *(operational energy + water)*	59,066,231	1,706	12,989,210	375
	Module C1-C4	2,604,425	75	1,753,377	51
	Module D	-15,252,465	-441	-7,645,291	-221
	Cradle-to-grave (A-C) *excluding B6&B7*	**60,681,835**	**1,753**	**44,062,951**	**1,273**

Please note these results include an added 15% contingency, in line with RICS 2nd edition guidelines for Early-Stage Design.

6.1.1 Upfront carbon results (A1-A5) breakdown

This report section breaks down the upfront embodied carbon emissions associated with the development. As shown in Table 6—2, the Embodied carbon intensity of the development is **765 kgCO_2e/m^2**. This includes an additional 100 kgCO_2e/m^2 for the uplift factor.

The FFE is significant compared to a standard residential project as all the white goods, beds and other loose FF&E are provided. This is one of the reasons why the project cannot be fairly compared to the residential targets outlined in the GMCA guidance. Increased partition requirements in commercial residential spaces is also reflected in the internal walls figure, which is higher than might be standard in a residential scheme.

For a long time in the industry the embodied carbon emissions associated with building services have been under-reported, with the original LETI Climate Emergency Guide suggesting MEP was 4% of embodied carbon emissions for residential buildings. It is now understood to be a much larger proportion of the result, which is reflected in the results for this development.

The impact of demolition of the existing buildings is evident in the results, with the remaining facilitating work emissions stemming from the waste from excavation.

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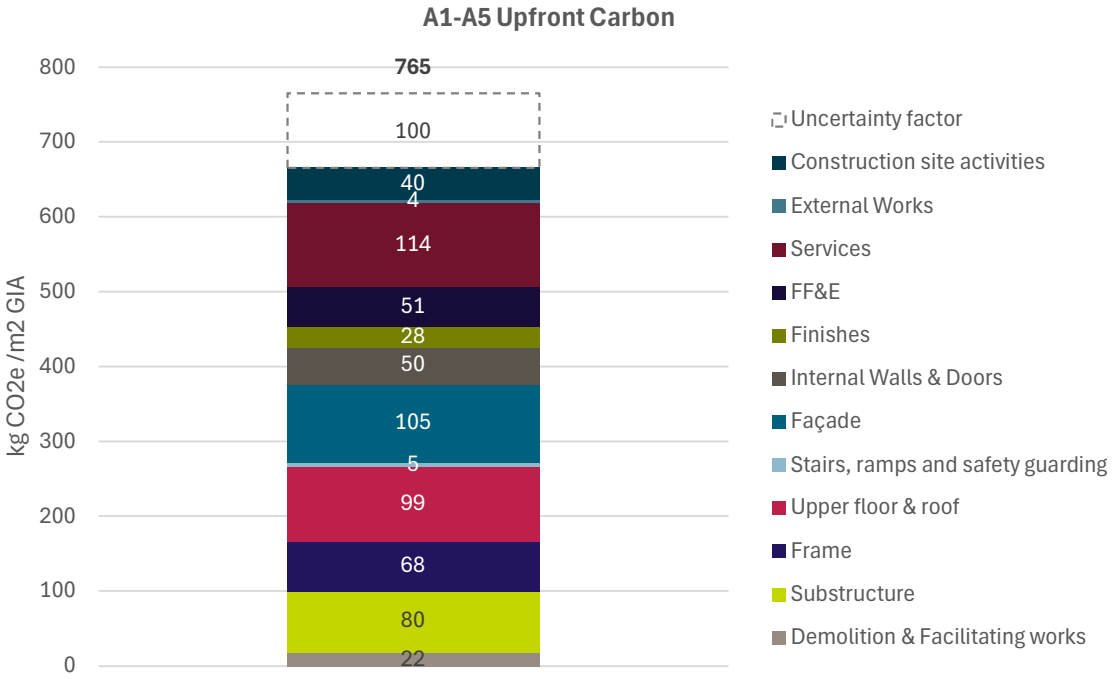


Figure 6—1 Upfront embodied carbon impact (A1-A5)

Table 6—2 Upfront embodied carbon impact (A1-A5)

Building elements	**Total upfront embodied carbon ($kgCO_2e$)**	**Embodied carbon intensity ($kgCO_2e/m^2$)**
Demolition & Facilitating works	750,744	22
Substructure	2,761,130	80
Frame	2,347,932	68
Upper floor & roof	3,442,481	99
Stairs, ramps and safety guarding	176,601	5
Façade	3,635,620	105
Internal Walls & Doors	1,720,711	50
Finishes	971,415	28
FF&E	1,759,173	51
Services	3,932,092	114
External Works	150,800	4
Construction site activities	1,384,744	40
Uncertainty factor	*3,455,016*	*100*
Total	26,488,460	765

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6.1.2 Lifecyle Embodied carbon results (A-C excluding B6 & B7) - Non-Decarbonised scenario

This report section breaks down the whole life carbon emissions associated with the development. As shown in Table 6—3 the whole life carbon intensity of the development is **1,753 kgCO₂e/m²** for a Non-Decarbonised scenario. The results highlight the impact of those building element categories such as FF&E and building services that require multiple replacement cycles across the lifetime of the building. Recommendations for this are discussed in Section 8.

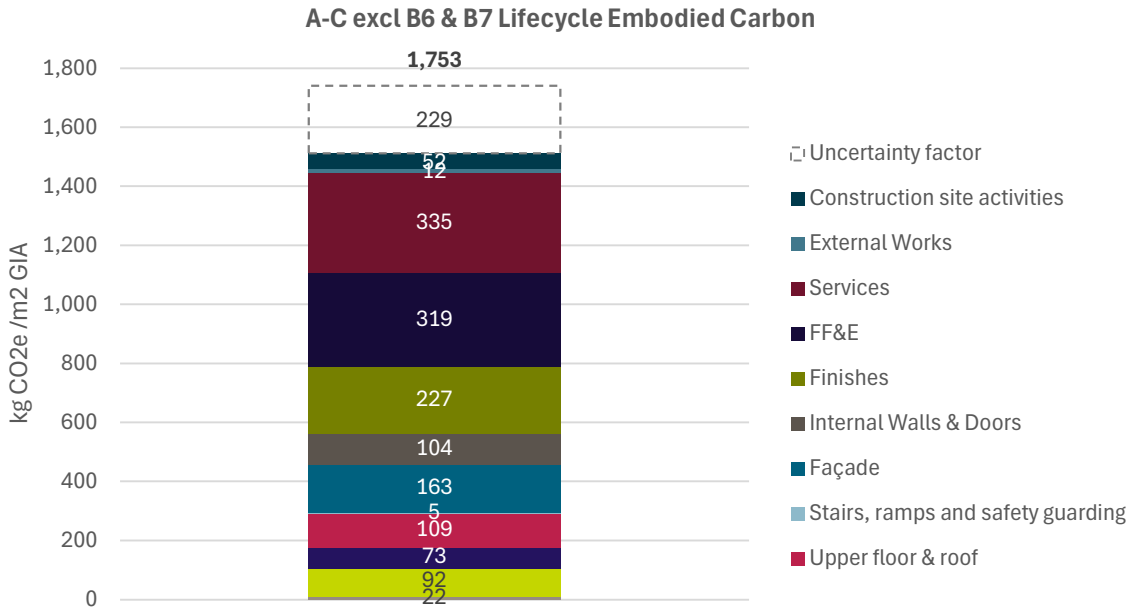


Figure 6—2 Whole Life carbon impact (A-C, excluding B6&B7)

Table 6—3 Whole Life carbon impact (A-C, excluding B6&B7)

Building elements	Total upfront embodied carbon (kgCO₂e)	Embodied carbon intensity (kgCO₂e/m²)
Demolition & Facilitating works	750,744	22
Substructure	3,186,615	92
Frame	2,540,081	73
Upper floor & roof	3,756,355	109
Stairs, ramps and safety guarding	183,623	5
Façade	5,640,777	163
Internal Walls & Doors	3,591,222	104
Finishes	7,849,691	227
FF&E	11,036,333	319
Services	11,588,737	335
External Works	409,735	12
Construction site activities	1,800,167	52
Maintenance and repair	432,733	13
Uncertainty factor	*7,850,112*	*229*
Total	**60,616,925**	**1,753**

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6.1.3 Whole Life Carbon - Non-Decarbonised scenario & Decarbonised scenarios

Results comparing a non-decarbonised and decarbonised scenario are presented in the figure and table below. The results indicate the importance of decarbonisation in reducing the lifetime emissions of our new and existing buildings.

In a decarbonised scenario the in-use and end-of-life embodied carbon emissions are assumed to be 50% of those in a non-decarbonised scenario. This is a more realistic scenario than assuming like for like replacement across a building's life however it is still just an estimate of future decarbonisation of the supply chain. The focus should remain on reducing the requirement for new material across a project's cycle.

The results also indicate the increased importance of upfront emissions in a decarbonised scenario, where they account for roughly half of the whole life carbon emissions of the project. This is particularly true if you consider the time value of carbon - reducing emissions today is more beneficial than reducing the same amount in the future because earlier action prevents more major warming over time.

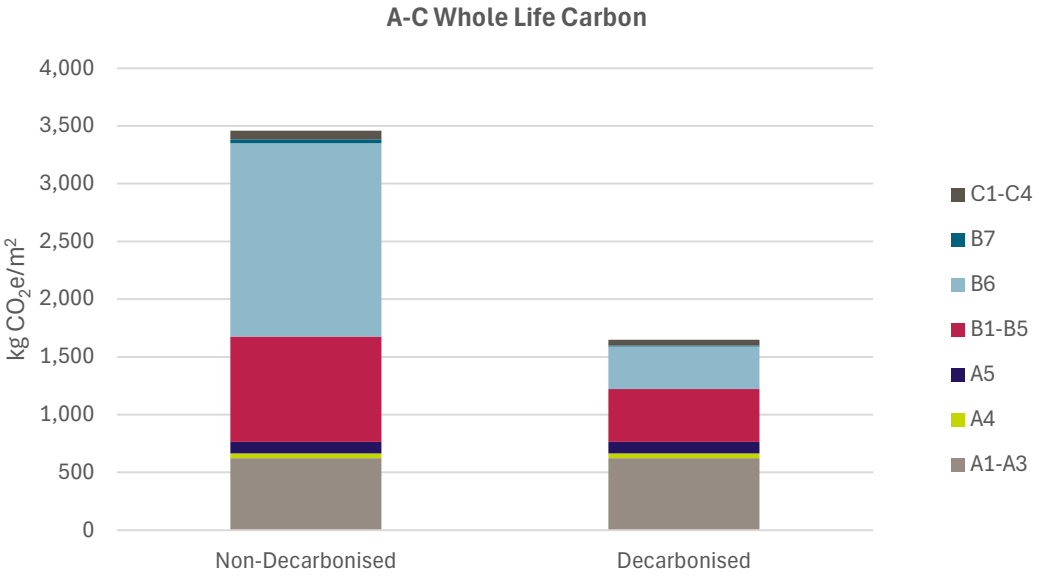


Figure 6—3 Whole Life Carbon - Non-Decarbonised scenario & Decarbonised scenarios

Table 6—4 Whole Life Carbon - Non-Decarbonised scenario & Decarbonised scenarios

Lifecycle Stage	Non-Decarbonised scenario $kgCO_2e/m^2$	Decarbonised scenario $kgCO_2e/m^2$
A1-A3 – Product Stage	622	622
A4 – Transport	42	42
A5 – Construction and Installation	101	101
B1-B5 – In-Use	912	457
B6 – Operational Energy	1,672	368
B7 – Operational Water	34	7
C1-C4 – End of Life	75	51
Total	**3,459**	**1,648**

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6.1.4 Most contributing materials (A-C)

To determine where the onward focus should be in reducing carbon emissions, the top 10 most contributing materials have been identified for the project. These materials will be continually reviewed through the future project stages to determine if their impact can be mitigated through design or procurement.

It is interesting to note that concrete is the most contributing resource even when considering modules A-C, despite having no replacement emissions. For upfront carbon only, the concrete is responsible for almost one third of the carbon emissions. The team have already identified ways to reduce the emissions associated with the concrete, through local procurement and higher levels of cement replacement than average, discussed further in Section 7. Whilst these conversations have already been started, to avoid carbon creep in future stages, a conservative baseline position has been considered for now. Similarly, despite having no replacement emissions, reinforcement also appears in the top ten most contributing materials and has also been considered for potential reduction measure by the team.

Many of the other elements have high life cycle emissions because of the need to replace them multiple times through the building's life. At this stage, service lives have been considered in line with Table 20 in the RICS 2nd edition methodology. As outlined in Section 8, one of the key considerations in future stages will be to refine these assumptions, and prioritise the use of durable, long-lasting materials, ensuring they do not have an impact on the upfront carbon position.

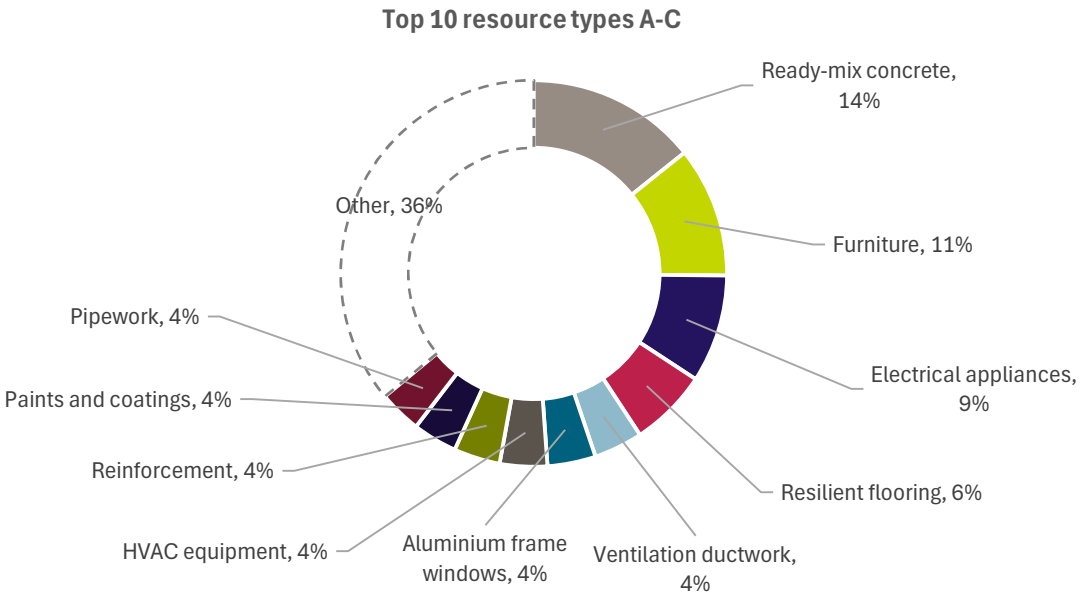


Figure 6—4 Most contributing materials (A-C)

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6.1.5 Industry Target Comparison (A1-A5)

Industry benchmarks, such as the LETI/RIBA target, or the NZCBS limits report against a limited scope that excludes demolition and facilitation works, loose FF&E, PV and external works to compare building level performance. For this scope, the upfront carbon reduces to **712 kgCO₂e/m²**. Note this figure also excludes demolition and facilitating works.

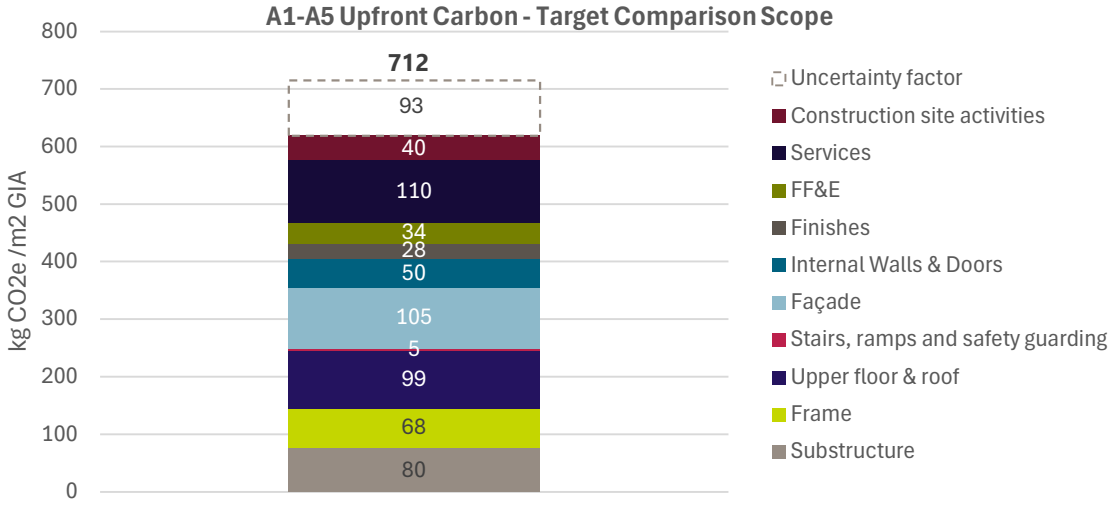


Figure 6—5 Upfront embodied carbon impact (A1-A5) Target Comparison Scope

Table 6—5 Upfront embodied carbon impact (A1-A5) Target Comparison Scope

Building elements	Total upfront embodied carbon (kgCO₂e)	Embodied carbon intensity (kgCO₂e/m²)
Substructure	2,761,130	80
Frame	2,347,932	68
Upper floor & roof	3,442,481	99
Stairs, ramps and safety guarding	176,601	5
Façade	3,635,620	105
Internal Walls & Doors	1,720,711	50
Finishes	971,415	28
FF&E	1,180,381	34
Services	3,800,689	110
Construction site activities	1,384,744	40
Uncertainty factor	*3,213,256*	*93*
Total	**25,385,703**	**712**

The NZCBS upfront carbon limits have been based on the most complete data set of any UK industry benchmarking to date. It is notable how the limit is higher for commercial residential than for flats, which stems from the reasons outlined in Section 6.1.1. Due to this, and the aforementioned challenges with using RICS 1st edition based LETI/RIBA targets as benchmarks, we urge caution against comparing the building to the GMCA residential benchmark. Having said that, should the embodied carbon savings that have already been considered (detailed in Section 7) be realised, and the uncertainty factor be conservative, which is expected given the comprehensive modelling undertaken, then the building could deliver against this GMCA benchmark in future stages.

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7 Whole Life Carbon Reduction Measures

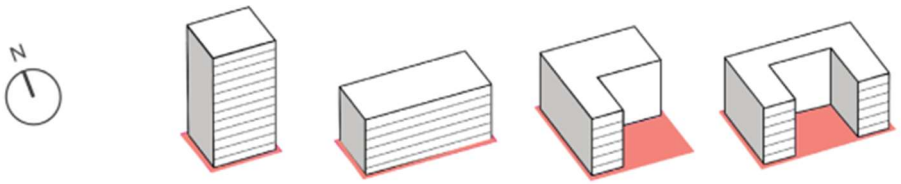
7.1 Reporting against 'Design Guidance for Net Zero'

Significant design work has already occurred to prioritise a low carbon solution for the building. These measures have been aligned against the recommendations in the Design Guidance for Net Zero.

7.1.1 Compact building form

The development is simple and compact in its form, leading to operational efficiencies and also a reduced façade area for a given GIA, thereby reducing façade emissions. The building has a form factor of approximately 0.68, which is significantly lower than those presented in the GMCA guidance, as seen below.

Illustration of the influence the form factor has on upfront embodied carbon of the façade.



	12 storey building GIA of 3455 m² (4 dwellings/floor)	6 storey buildings each with a gross internal floor area (GIA) of 3455 m² (8 dwellings/floor)		
Dual aspect	Yes	No	Partially	Yes
Form factor	0.88	0.88	0.95	1.13
Façade upfront embodied carbon* ($kgCO_2e/m^2$ GIA)	172	131	150	192

Figure 7—1 Form factor implications on performance (GMCA Design Guidance for Net Zero)

7.1.2 Transparency of design

The simple and compact building form also lends itself well to avoiding non-typical features such as significant overhangs and large transfer structures which are relatively high in embodied carbon. High performance solar control glazing, local shading to the opening windows via external louvres and solar shading from façade articulation are helping to mitigate solar gains and ensure a passive approach to mitigating overheating. This is being balanced with the embodied carbon impacts of incorporating these measures.

7.1.3 Lean and light structure

The structure has been designed using Finite Element Analysis software to assess a series of framing out options which work both architecturally and provide an efficient structural frame. Due to the scale and form of the building, an RC frame is the only viable structural material. The column layout proposed has enabled slab depths to be minimised to 225mm at residential floor levels. This results in a lighter building which allows furthers reductions in material use at

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foundation level. Due to the constraints relating to the basement, the tower core bases have been modelled in Finite Element Analysis software to ensure the size and depth of the base is sufficient to withstand the large forces from the core without being oversized. All the structural elements are designed to work efficiently and have limited built in redundancy for any significant future change of use as it is deemed very unlikely to occur.

7.1.4 Architectural elements

Several façade options were considered through the design process, with the whole life carbon impact of these solutions a key part of the design decision matrix. To provide embodied carbon comparisons, Buro Happold shared a study comparing a range of build-ups all achieving the same U-value performance. Note, these results come with a significant range which is reflective of the number of assumptions that must be made when trying to conduct high level comparative performance optioneering.

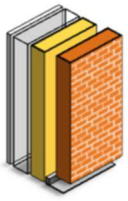
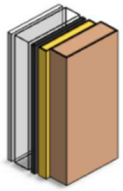
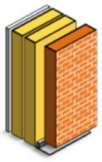
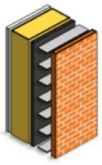
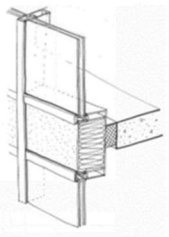
Primary Façade Type	Weight	Baseline A1-A3 Embodied Carbon Range [per m² FSA]
Traditional brick-faced precast concrete  Assumes 150mm thick concrete + 50mm thick UK brick		164 - 305
Traditional precast concrete  Assumes 150mm thick concrete panel		126 - 219
Aluminium rainscreen with SFS  Assumes 3mm thick semi-finished flat cladding		124 - 319
Handset brick masonry with SFS  Assumes 103mm thick UK brick		182 - 325
Brick slip on metal rainscreen with SFS  Assumes 23mm thick UK brick slip		204 – 432
Aluminium stick curtain wall  Includes opaque insulated spandrel at slab		152 – 480 (100% Opaque) 158 – 312 (100% Glazed)

Figure 7—2 Early-stage façade upfront carbon estimates

The precast solution can be a low embodied carbon option and interacts well with the structural solution and therefore does not have a negative impact on other discipline carbon targets. It was also chosen as it is a robust solution which, with good maintenance, is designed to last for the building design life. Another important aspect is making the façade solution as simple as possible to reduce the amount of additional material required to account for challenging details. This will be a key driver in future stages.

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7.1.5 Building services

Whilst the early-stage analysis has been based on the RICS 2nd edition supplementary table, studies have been undertaken to reduce the impact of the building services. These include strategies to use low Global Warming Potential (GWP) refrigerants and exploring alternatives to traditional insulated galvanised steel ductwork and steel and copper insulated pipework. These studies will be further developed during detailed design.

7.1.6 Embodied hierarchy for materials

Section 7.1.3 provides details on the structural material choice for the development. Through the next stages the procurement of low carbon materials will be a key priority for the project in order to minimise its environmental impact. Clear contractor requirements will also be developed to ensure that the good design work is carried through into construction.

Section 8 describes in more detail how the project will seek to reduce its carbon impact going forward.

7.1.7 Low Carbon Procurement

While average UK average carbon factors have been used for modelling purposes to prevent carbon creep through design and construction, low-carbon procurement routes have already been identified by the team. These include specifying **cement-replacement** in concrete mixes, maximising **recycled content in reinforcement**, selecting **low-carbon and high-recycled-content aluminium**, and prioritising **local transport and supply chains** to reduce transportation emissions. Their projected impact has been quantified, and the resulting carbon reductions are illustrated in the following waterfall chart.

These measure account for a saving of 45kgCO_2e/m^2 compared to the results presented, with the high cement replacement in the substructure elements, and the high recycled rate in the reinforcement being key drivers. The team also acknowledges that in 2023 a Joint Taskforce of the IStructE, Concrete Zero and MPA produced a paper that determined GGBS is a constrained resource that is almost fully utilised globally, and it should not be used unless technically required as it will have no global decarbonisation effect. The team is continuing to work with the supply chain to consider other potential cement replacements.

Procurement opportunities will continue to be explored in future stages, and the team will continue to engage with the supply chain early in the process to determine availability and feasibility of low carbon options for the project.

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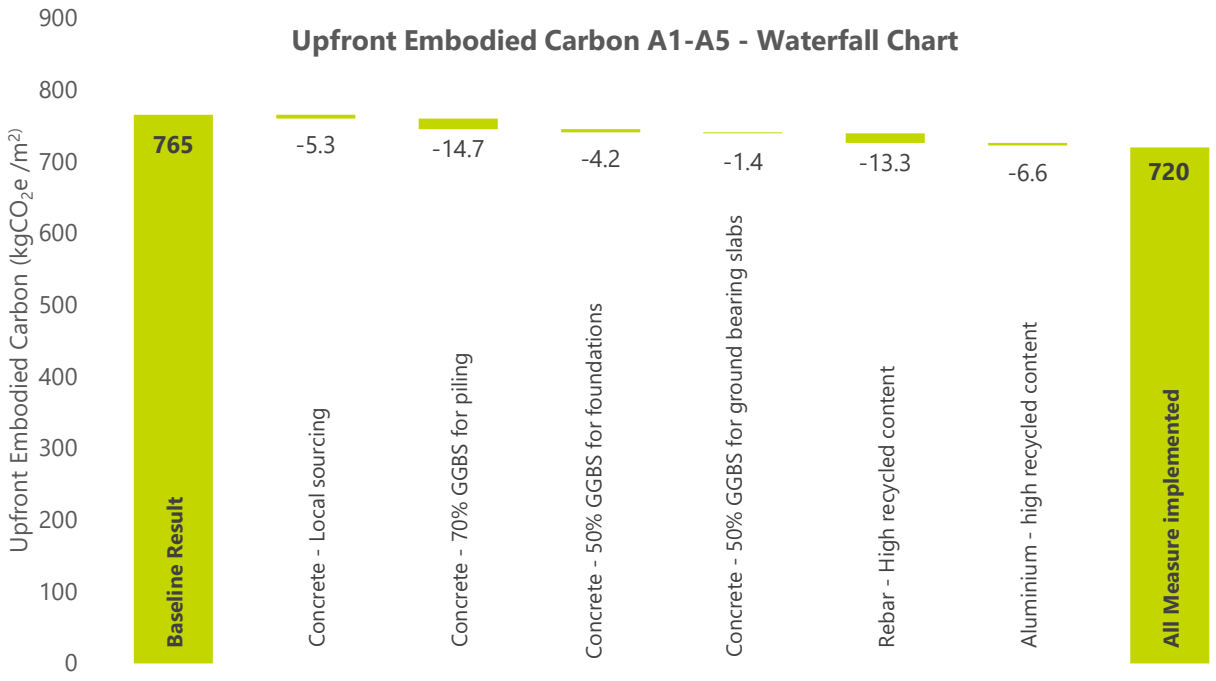


Figure 7—3 Low Carbon Procurement Waterfall Chart

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8 Further Whole Life Carbon Reduction Opportunities

8.1 Upfront embodied carbon (A1-A5) reduction opportunities

Significant design work has already occurred to prioritise a low carbon solution and onward optimisation will continue in the future stages, therefore improving against the baseline position will focus on betterment of material carbon performance. With regards to material specification, the current assessment is based on industry guidance. However, the ambition is to drive further conversations with manufacturers to procure low carbon materials and explore any emerging technologies, to reduce the embodied carbon. The recommendations will be communicated to the contractors to help them with material procurement.

This section provides a summary of further strategies that are recommended to reduce the upfront embodied carbon of the project to be on track to reduce the product carbon (A1-A3):

- **Low Carbon Ductwork**
  Use of low carbon ductwork in lieu of typical galvanized steel ductwork can help lower emissions.
- **Ensuring carbon reduction opportunities are carried through to construction**
  In order to ensure that the low carbon considerations are realised, and to mitigate carbon increases through construction, an embodied carbon section should be included in the Employer Requirements to the contractor. This should provide transparency on their carbon target, set clear expectations on reporting through construction, and identify specific material carbon factors that need to be achieved through procurement.

8.2 Other upfront carbon opportunities

Transport emissions (A4)- Transport distances and carbon factors are currently based on RICS guidance, The project will aim to maximise selection of locally available materials and reducing the transport emissions as has already been taking place for the concrete.

Construction emissions (A5)- Construction activity emissions include site investigations, temporary works, worker accommodation and any on-site electricity use, water use and fuel consumption. These should be monitored during construction to contribute to an accurate as-built embodied carbon calculation at project completion. However, in absence of this information, 40 kg CO_2e/m^2 GIA based on RICS 2nd Edition guidance, has been used. It must be noted that this value should be superseded with site-specific data when available. Therefore, it is recommended that energy efficient strategies are deployed during construction and waste is minimised to reduce the embodied carbon associated with module A5.

8.3 Whole life embodied carbon (A-C, excluding B6, B7) reduction opportunities

The focus to date has been on reducing the upfront embodied carbon of the building. The focus during later RIBA stages should also be on specifying materials that have a longer service life than the standard conservative assumptions, reducing the replacement cycles and therefore the replacement emissions.

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8.3.1 Service Life

For module B4, replacement, at this stage in the design, reasonable service life periods have been assumed based on Table 20: Indicative component lifespans of the RICS 2nd edition. Based on previous project experience, these numbers tend to be slightly conservative, and we anticipate an increase in service lives and associated decrease in emissions when we work with specific manufacturers for construction. Preference should be given to products with longer service lives appropriate to that layer to minimise life cycle embodied carbon. The need to provide manufacturer specific EPDs will be a key criteria in the contractor requirements, to improve embodied carbon accuracy but also to determine more exact service lives.

8.3.2 Maintenance and Repair

At this stage in the design, for module B2, due to the lack of data, a total figure of 10 $kgCO_2e/m^2$ GIA has been used to cover all building element categories as per the RICS methodology. The guidance has also been followed for module B3, where 25% of module B2 is taken – 2.5 $kgCO_2e/m^2$ GIA.

In later phases, the team should work with the client to develop Operation & Maintenance (O&M) manuals for the development, clearly identifying the maintenance strategy for the building. From this, suitable scenarios for both maintenance and repair can be established. Again, from project experience we anticipate this to lead to a reduction in the carbon numbers.

8.3.3 End of Life Scenarios

The development has been designed for longevity, with the substructure and superstructure designed for a service life in excess of 60 years. However, when the end of life for elements does come, there is a strong ambition to enable easy disassembly and open up opportunities for reuse.

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9 Conclusion

The whole life carbon analysis undertaken for Sister Plot H captures the impacts of the building elements for planning and follows the GMCA guidance.

The upfront embodied carbon (A1-A5) result is estimated to be **765 kgCO_2e/m^2 GIA.** Measures have been identified to further reduce embodied carbon, including procurement of low carbon and local materials. Refinement of assumptions on transport distances, contingency factors and material carbon factors may result in further reductions going forward.

The life cycle embodied carbon results (Module A-C exc. B6 & B7) are **1,273 kgCO_2e/m^2 GIA** in a decarbonised scenario. Refinement of assumptions on product service lives and end of life scenarios at later design stages may result in further reductions.

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