HOARE LEA

Former Saville Theatre.
Camden, London.
YC Saville Theatre Limited.

SUSTAINABILITY
WHOLE LIFE CARBON ASSESSMENT
REVISION P07 – 26 FEBRUARY 2025

Audit sheet.

Rev.	Date	Description of change / purpose of issue	Prepared	Reviewed	Authorised
01	25/01/2024	Draft issue for planning	C. Dutton	E. Ray	T. Brown
02	31/01/2024	Draft incorporating comments from design team	C. Dutton	E. Ray	T. Brown
03	28/02/2024	Final planning issue for comment	C. Dutton	D. Wyrill	T. Brown
04	01/03/2024	Responses to comments prior to submission	C. Dutton	D. Wyrill	T. Brown
05	05/03/2024	Update following comments	S. James	C. Dutton	T. Brown
P06	31/01/2025	Draft issue for amended planning submission	C. Dutton	B. Lambert	E. Jolly
P07	26/02/2025	Final issue for amended planning submission	C. Dutton	B. Lambert	E. Jolly

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Contents.

Executive summary.

Summary of planning amendment update

The main design changes which have impacted the Whole Life Carbon in the amendment to the previous 2024 planning submission are as follows:

- Increased excavation of the basement for the theatre space
- Revised façade strategy to the new construction hotel extension including external shading and triple glazing
- Revised internal layouts to optimise internal space for the hotel.

Where detailed information is not available, default assumptions have been made in line with RICS guidance. In addition, results presented take into account cost adjustment factors calculated by the percentage cost coverage.

Introduction

This Whole Life Carbon (WLC) assessment has been prepared by Hoare Lea on behalf of YC Saville Theatre Ltd (hereafter referred to as 'the Applicant') in support of the planning application for the development of the Saville Theatre, (hereafter referred to as 'the Proposed Development') within the London Borough of Camden. The assessment includes the following:

- Calculations of whole life carbon accounting for upfront embodied carbon, in-use embodied carbon, end of life carbon and operational utility (energy and water) carbon, following the RICS Professional Statement for WLC Guidance (2017).
- Comparison with industry benchmarks.
- Overview of the optioneering undertaken to date and future opportunities to reduce emissions further.

The proposed development.

The Proposed Development seeks to re-introduce a live performance venue to this Site and introduce a new hotel use on upper floors. The Proposed Development includes a 6-storey extension, plus plant, on top of the existing Building.

The Proposed Development would include part-demolition, part-retention and stabilisation and refurbishment of the existing grade II listed building. New basement levels will be excavated to accommodate the theatre, with the introduction of retail and theatre lobby, box office and front of house facilities at ground floor level.

Summary of results

The results shown in Figure 1 provide the anticipated impact of the Proposed Development across a 60-year life cycle when assessed in line with the recommended inputs set out in the RICS Professional Statement for WLC Guidance (2017). This includes baseline specification and assumptions around transport for each material, which are summarised in Appendix A. Despite this, the results do take account of the façade and structural retention which has been incorporated into the design. The Proposed Development will seek to reduce emissions further throughout the design and procurement phases. Two example reductions include targeting lower carbon concrete mixes compared to the default assumption of 25% GGBS cement replacement, and procuring structural steel from an Electric Arc Furnace (EAF). Incorporating these two measures would see the upfront carbon (modules A1-A5) reduce by 185 $kgCO_2e/m^2$. This will be dependent on market availability and should be explored through design development.

Figure 2 shows how the Proposed Development compares to LETI, RIBA and GLA targets for Office use types as there are no targets for the complex and bespoke mix of uses. It demonstrates how the upfront carbon (modules A1-A5) is outperforming all of these, despite still employing the RICS baseline specification for materials. Due to the Proposed Development still being within the early phases of design, the results should be considered with a ±10% margin of error.

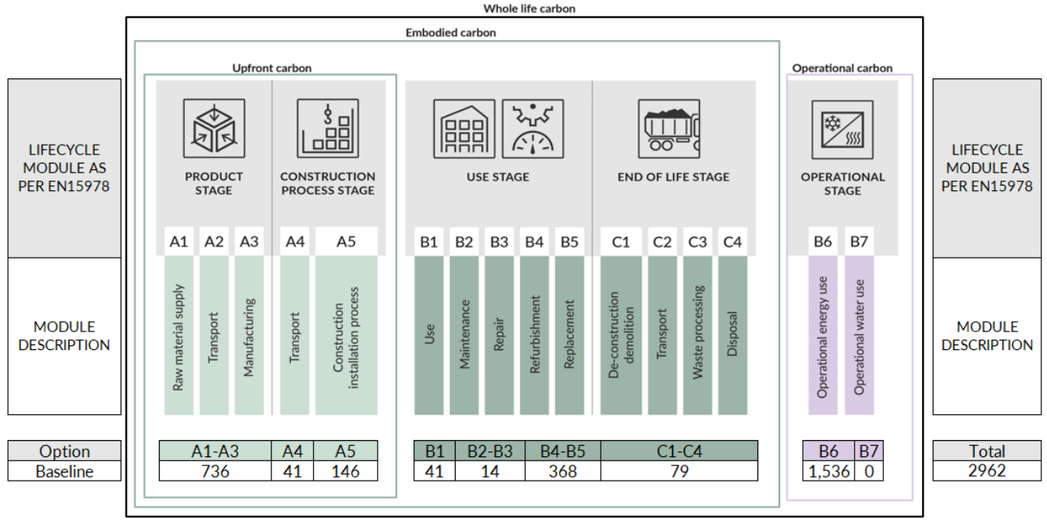

Figure 1: Whole life carbon breakdown of the Proposed Development (excluding cost adjustment factors).

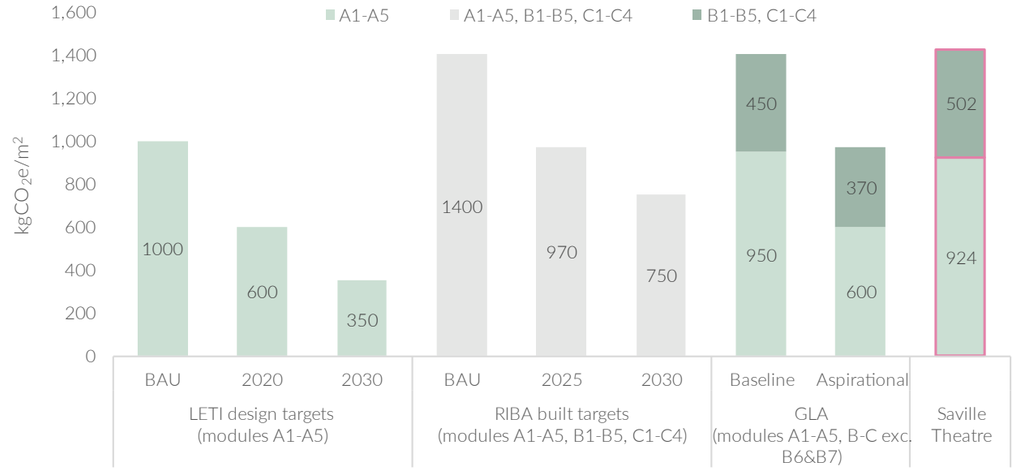

Figure 2: Comparison of the Proposed Development with benchmarks, shown with error bars (Excl. Operational Modules B6 and B7, incl cost adjustment factors)

1. Introduction.

1.1 Purpose of report.

The purpose of this report is to assess the Whole Life Carbon (WLC) for the development, defined as 'those carbon emissions resulting from the construction and the use of a building over its entire life, including its demolition and disposal.' This assessment captures the operational carbon emissions for the development from both regulated and unregulated energy use, as well as its upfront and embodied carbon emissions, i.e. those associated with raw material extraction, manufacture and transport of building materials, construction and the emissions associated with maintenance, repair and replacement as well as dismantling, demolition and eventual material disposal. The study also includes an assessment of the potential carbon emissions 'benefits' from the reuse or recycling of components after the end of a building's useful life.

This report should be read in conjunction with the corresponding Circular Economy and Energy Strategy reports submitted in support of the planning application for the Proposed Development.

1.2 Development description.

Part demolition, restoration and refurbishment of the existing Grade II listed building, roof extension, and excavation of basement space, to provide a theatre (Sui Generis) at lower levels; restaurant / bar and office space (Class E(b) / Class E(g) / Sui Generis) at ground floor level; and hotel (Class C1) at upper levels; provision of ancillary cycle parking, servicing and rooftop plant, and other associated works.

Table 1: Area schedule.

Space Use	GIA m^2
EXISTING	
Cinema	3,353
Ancillary	228
TOTAL	3,581
PROPOSED	
Theatre (Class Sui Generis)	3,688
Hotel (Class C1)	6,097
Ancillary	1,291
TOTAL (from cost plan)	11,076

Location: 135-149 Shaftesbury Avenue, London

Local Authority: London Borough of Camden

The Proposed Development seeks to re-introduce a live performance venue to this Site and introduce a new hotel use on upper floors. The Proposed Development includes a 6-storey extension, plus plant, on top of the existing Building.

The Proposed Development would include part-demolition, part-retention and stabilisation and refurbishment of the existing grade II listed building. New basement levels will be excavated to accommodate the theatre, with the introduction of retail and theatre lobby, box office and front of house facilities at ground floor level.

1.3 Site description.

The former Saville Theatre at 135-149 Shaftesbury Avenue is a grade II listed building. It was built in 1930-1931 as a three-level theatre and opened in 1931. The building was designed by architect T.P Bennett & Son.

The building was damaged during the blitz in 1941 but later restored. In the 1960's, the Theatre was bought by Brian Epstein and opened as a music venue in 1966, hosting artists such as The Who, Jimmi Hendrix and Elton John. After Brian Epstein's death in 1967, The Saville hosted shows created by Cameron Mackintosh. In 1970, the building opened as a two-screen ABC Cinema. It was subsequently acquired by Cannon Cinemas as part of a takeover in 1986, which then folded into the MGM chain in 1992. The Site was taken over by Odeon in 2001 as a four-screen cinema, and the layout that is visible today. The Site is an island site, bordered by Shaftesbury Avenue to the south, St Giles Passage to the east, Stacey Street to the west, and New Compton Street to the south. The Site is not located within a Conservation Area but abuts the Denmark Street Conservation Area to the north, and the Seven Dials Conservation Area to the south. The Site has excellent connectivity with a Public Transport Accessibility Level ("PTAL") of 6b, which is the highest possible PTAL score and is defined as 'excellent'. Key transport facilities in the vicinity of the Site include Tottenham Court Road Underground Station, Covent Garden Station and many bus routes. The Applicant acquired the Site in October 2021. After commissioning a survey of its condition, it was discovered that the building is currently in a poor state of repair, having suffered from corrosion-related damage (also known as 'Regent Street Disease').

Figure 3: Proposed development (Source: SPPARC, 6th January 2025)

1.4 Background to Life Cycle Assessment and Embodied Carbon.

Carbon emissions from operational use of buildings has been the subject of regulation for some time and has historically been the primary focus of reducing the impact of built environment projects. More recently, this focus has been expanded to also include carbon emission associated with the building materials themselves.

Some studies have suggested that historically 40-50% of the total carbon emissions for buildings over their lifetime are due to embodied carbon. With increasing energy efficiency within buildings and an increasingly decarbonised electricity supply, building operational carbon emission are being acknowledged to be rapidly reducing. As this occurs, the significance of embodied carbon emissions increases and the potential for reduction of overall carbon emissions through structural design choice and material selection becomes greater.

1.5 Whole Life Carbon Assessment modules.

In order to standardise Whole Life Carbon Assessments, they are reported against a number of stages as defined in EN 15978; 7.4. These life cycle stages begin with raw material extraction, moving through product manufacture, transportation, and installation within a development, this continues into maintenance and use of a site during operation, and eventual material disposal at the end-of-life stage. These stages are grouped into three modules, A, B, and C, representing upfront, operational, and end-of-life carbon., as set out in Figure 4. Module D represents the circularity of products which are reused or recycled.

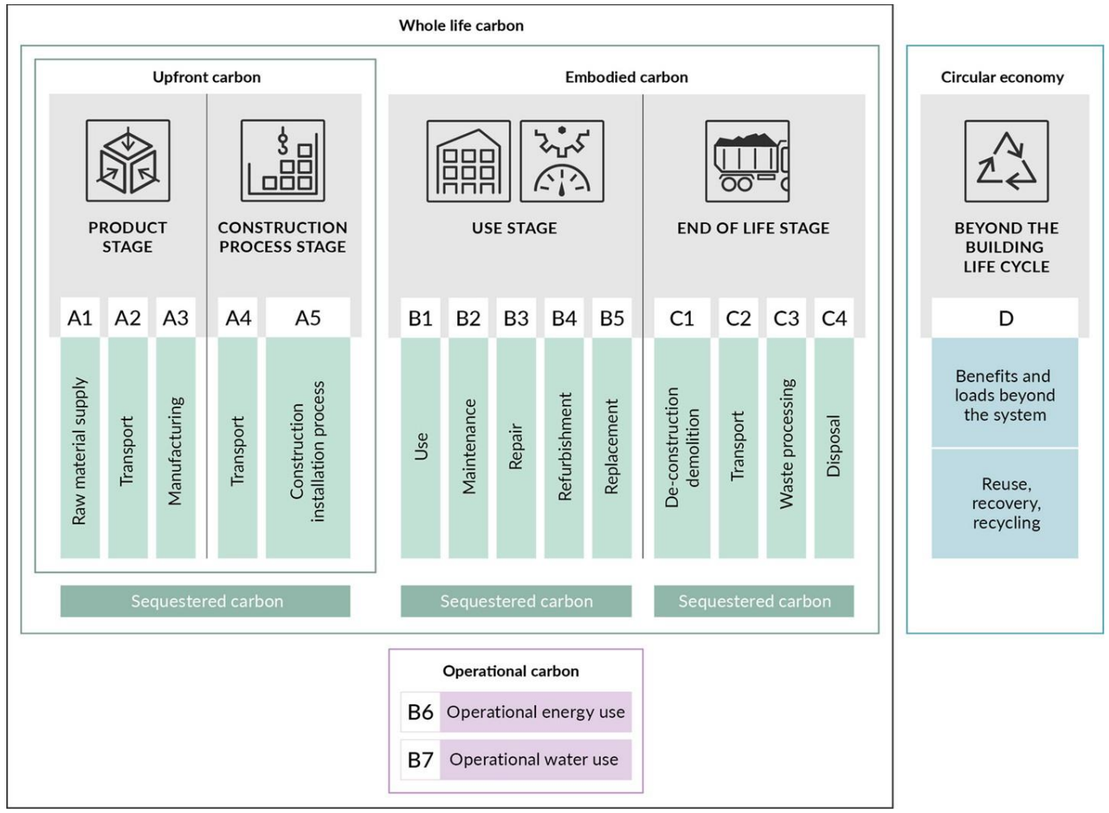

Figure 4: Whole life carbon modules and stages as defined by EN 15978; 7.4

2. Industry guidance and benchmarks.

2.1 RICS whole life carbon.

The RICS professional statement: Whole Life Carbon Assessment (WLC) for the Built Environment, released in 2017, seeks to standardise WLC assessment and enhance consistency in outputs by providing guidance on implementing the broad appraisal methodology set out in EN 15978: Sustainability of Construction Works. The Greater London Authority have adopted the RICS WLC methodology in their guidance methodology for Whole Life Carbon assessment of referable planning applications.

2.2 Greater London Authority WLC requirements.

The new London Plan came into effect on 2 March 2021. It mandates Whole Life Carbon Assessments in a bid to meet net zero carbon commitments for referrable applications (150 residential units, buildings over 30m in height or commercial buildings over 2,500m^2 for all boroughs except the City of London which states buildings over 150m and commercial buildings over 10,000m^2).

- Policy SI2: Minimising greenhouse gas emissions
  Whole Life Carbon (WLC) emissions should be calculated for each project via a life-cycle assessment (LCA) and the actions taken to reduce WLC emissions should be demonstrated. This is mandatory for referable applications, but it should be noted that GLA guidance on WLC encourages LCA to be done for all projects in London.

The GLA defines WLC as including operational carbon (heating, lighting and appliances), as well as embodied carbon from manufacture, maintenance and end-of-life.

The Mayor of London's (Greater London Authority, GLA) 'Whole Life-Cycle Carbon Assessment Guidance (March 2022) follows EN 15978 (the European standard for measuring building performance) and the 2017 RICS (Royal Institute of Chartered Surveyors) Professional Statement: Whole life carbon assessment for the built environment (which has also been adopted by RIBA, the Royal Institute of British Architects).

The GLA sets WLC principles which have been adopted to inform how the Proposed Development's considers WLC. These principles are referred to throughout the document demonstrating how consideration on each key principle have been made.

Whilst the GLA does not provide specific targets for WLC, it provides "benchmarks" based on previous project assessments and have been cross referenced with data provided by WLC tools including OneClick LCA.

The WLC benchmarks should be used as a guide by all applicants. The benchmarks provide a range rather than a set value and are broken down into building components. Projects with higher WLC emissions than the benchmarks should carefully examine how they can reduce WLC emissions. The GLA benchmarks are shown in Figure 2 and compared against the Proposed Development's.

2.3 Camden.

Local Plan 2017

In line with the GLA, Camden is committed to reducing carbon emissions to achieve the Mayor of London's target of net zero emissions by 2050. With that in mind, new development is required to meet the London Plan policy carbon emission requirements.

2.4 Upfront and Embodied Carbon Targets.

Industry standards have been produced by LETI, RIBA and the GLA, each providing targets/benchmarks for embodied carbon. At present the use type categories covered by industry targets are relatively limited, which means there aren't specific targets for theatre or hotel use classifications. The industry targets for offices and residential uses have been selected as most comparable.

Figure 5 provides a comparison of embodied carbon targets from LETI, RIBA and the GLA. However, the scope of each differs slightly as set out below:

- LETI targets relate to upfront carbon, i.e., building life cycle modules A1-A5.
- LETI targets related to the year of design.
- RIBA targets are the full embodied building life cycle, i.e., building life cycle modules A1-A5, B1-B5, C1-C4.
- RIBA targets are performance based and so relate to the years the buildings are completed.
- GLA benchmarks are broken down into lifecycle modules A1-A5 and B-C.

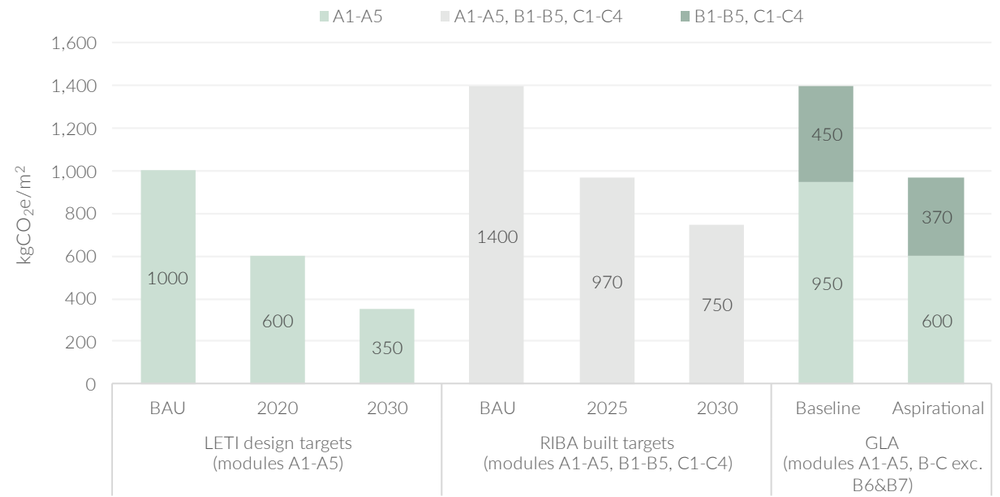

Figure 5: Embodied carbon targets for offices (top) and residential (bottom) from LETI and RIBA (Source: RIBA Climate Challenge 2020 v2, LETI embodied carbon primer).

3. Methodology and inputs.

3.1 Assessment scope.

The assessment of Whole Life Carbon (WLC) emissions consists of the following sections: total operational carbon emissions (regulated plus unregulated); embodied carbon emissions; and any future potential carbon emission 'benefits', post end-of-life, including benefits from reuse and recycling of building structure and materials.

This assessment has been undertaken in line with the GLA guidance for undertaking WLC Assessments and therefore in line with the RICS Professional Statement: Whole Life Carbon Assessment for the Built Environment (2017).

Operational carbon emissions

The anticipated operational energy performance of the Proposed Development has been established from the supporting TM54 assessment. Please refer to the Appendices for details of the operational energy modelling inputs and outputs.

The operational energy has been converted to carbon emissions over a 60-year study period using SAP 10.2 emission factors in line with the GLA's Energy Assessment Guidance.

Embodied carbon assessment and end-of-life emissions

To assess the embodied carbon for the project, a Life Cycle Assessment (LCA) tool – One Click LCA – has been used to make allocations for the anticipated material quantities in an inventory analysis. The materials are represented within the model by using materials with associated Environmental Product Declarations (EPDs). EPDs are produced by manufacturers and identify the carbon emissions of a product. By scheduling the materials proposed for the development, the overall carbon emissions can be approximated.

It should be noted here that the LCA tool has a limited database of materials. In the scenario where a specified material isn't included in the database, the most similar material in terms of material composition is selected instead.

In line with standard UK practice, the LCA process and results included by this report have been assessed in line with BS 15978:2011 and the RICS Professional Statement: Whole Life Carbon assessment for the built environment (2018). All EPDs used have been produced in line with the requirements of BS EN 15804:2012.

3.2 Inputs.

Table 2 lists the building elements covered by the assessment, in line with the Royal Institute of Chartered Surveyors (RICS) Professional Statement: Whole Life Carbon assessment for the built environment (2018).

Table 2: Data used in the embodied carbon assessment.

Building element group	Building element (NRM level 2)	Basis for information
0 Demolition	0.1 Toxic/hazardous/contaminated material treatment	An allowance for contaminated land removal and treatment has not been included for the Site at this stage of the design as it is not currently anticipated any treatment will be required. This will be considered further as the scheme progresses.
	0.2 Major demolition works	GLA guidance states that where possible actual figures should be used for demolition. The Reusefully pre-demo audit provided estimated figures for the waste associated with the strip out and demolition of the building. Using this data, calculations were undertaken in OneClick LCA to determine the carbon emissions associated with the waste streams, waste processing and transportation of waste from site. This equated to a rate of 12 $kgCO_2e/m^2$ which has therefore been used in the assessment. In addition to the emissions associated with the materials, the on-site utility consumption (energy and water) during the demolition works has been captured in the A5 calculation for the project using the RICS suggested rate of 1,400 $kgCO_2e$/(£100k project value). See Table 5 for further detail. In lieu of actual figures, GLA guidance states assessments can apply a rate of 50 $kgCO_2e/m^2$ for the demolished floor area. As data has been taken from the pre-strip out and pre-demolition audits, this rate has not been used in the assessment. However, if this value was to be employed over the 7,753 m^2 being demolished, it would be equivalent to 6 $kgCO_2e/m^2$.
0 Facilitating works	0.3 & 0.5 Temporary/enabling works	Temporary works have not been quantified at this stage of design due to a lack of information.
	0.4 Specialist groundworks	Specialist ground works were included, with individual ground works accounted for in the relevant sub structure / external landscaping sections. Excavation of the substructure most notably has been included as per the cost plan.
1 Substructure	1.1 Substructure	These materials have been estimated in line with information provided by the design structural rates, the cost plan and supporting drawings. It has been assumed all structural steel will be treated with intumescent paint. The specification of materials has been informed by the following: RICS WLC Guidance for RICS Spec. calculations
2 Superstructure	2.1 Frame	These materials have been estimated in line with information provided by the design structural rates, the cost plan and supporting drawings. It has been assumed all structural steel will be treated with intumescent paint. The specification of materials has been informed by the following: – RICS WLC Guidance for RICS Spec. calculations
	2.2 Upper floors incl. balconies	These materials have been estimated in line with information provided by the design team structural rates, the cost plan and supporting drawings. The specification of materials has been informed by the following: – RICS WLC Guidance for RICS Spec. calculations
	2.3 Roof	These materials have been estimated in line with information provided by the cost plan. The specification of materials has been informed by RICS WLC Guidance for all calculations.
	2.4 Stairs and ramps	These materials have been estimated in line with information provided by the design team and cost plan. Standard construction data in the OneClick database has also been utilised.
	2.5 External walls	These materials have been estimated in line with information provided by the design team, façade specific embodied carbon calculations, and supporting drawings.

Building element group	Building element (NRM level 2)	Basis for information
	2.6 Windows and external doors	These materials have been estimated in line with information provided by the design team and cost plan.
	2.7 Internal walls and partitions	These materials have been estimated in line with information provided by the design team and cost plan.
	2.8 Internal doors	These materials have been estimated in line with information provided by the design team and cost plan.
3 Finishes	3.1 Wall finishes	These materials have been estimated in line with information provided by the design team and cost plan. The design of many landlord areas is still in abeyance and therefore allowances for elements have been included for now. These materials have been highlighted with Appendix D.
	3.2 Floor finishes	
	3.3 Ceiling finishes	
4 Fittings, furnishings and equipment (FF&E)	4.1 Fittings, furnishings & equipment incl. building-related* and non-building-related**	These materials have been estimated using the components listed within the cost plan.
5 Building services/MEP	5.1–5.14 Services incl. building-related* and nonbuilding-related**	Allowances for all building services / MEP components have been established using the methodology set out in RICS 2nd edition (2023) MEP Supplementary tables.
6 Prefabricated Buildings and Building Units	6.1 Prefabricated buildings and building units	No prefabricated elements are applicable.
7 Work to Existing Building	7.1 Minor demolition and alteration works	The minor demolition of the retained area has been accounted within the demolition waste allowance. This has used the waste arisings from the Pre-demolition audit which includes material waste arisings from the 45,564 m^2 of strip-out area and the demolished area.
8 External works	8.1 Site preparation works	No allowance was considered for site preparation works at this stage. This will be considered further as the scheme progresses.
	8.2 Roads, paths, paving and surfacing	These materials have been estimated in line with information provided by the design team and cost plan.
	8.3 Soft landscaping, planting and irrigation systems	No allowance was considered for soft landscaping, planting and irrigation systems at this stage. This will be considered further as the scheme progresses.
	8.4 Fencing, railings and walls	These materials have been estimated in line with information provided by the design team and cost plan.
	8.5 External fixtures	External fixtures were excluded from the assessment due to lack of available data. This will be considered further as the scheme progresses.
	8.6 External drainage	No allowance for external drainage has been incorporated at this stage. This shall be reviewed as the scheme progresses.
	8.7 External services	External services were excluded from the assessment due to lack of available data. This will be considered further as the scheme progresses
	8.8 Minor building works and ancillary buildings	No allowance was considered for minor building works and ancillary buildings. This will be considered further as the scheme progresses.

Life-cycle modules

Table 3 gives a description of each life cycle stage, and a commentary on, the source of information used for each stage.

Table 3: The Life Cycle Modules included in the assessment and commentary on the data source.

Module	Description	Commentary of Data Source
A1-A3 Construction Materials	Raw material supply (A1) includes emissions generated when raw materials are taken from nature, transported to industrial units for processing and processed. Loss of raw material and energy are also taken into account. Transport impacts (A2) include exhaust emissions resulting from the transport of all raw materials from suppliers to the manufacturer's production plant as well as impacts of production of fuels. Production impacts (A3) cover the manufacturing of the production materials and fuels used by machines, as well as handling of waste formed in the production processes at the manufacturer's production plants until end-of-waste state.	Calculated using EPD's which align the most-applicable similar product. (See Appendix for standard specifications). For external façade, construction specific design specification was provided by the façade engineer. For the structural design the Structural engineer provided detail on the new superstructure elements and the column strengthening to the existing structure.
A4 Transportation to site	A4 includes exhaust emissions resulting from the transport of building products from manufacturer's production plant to building site as well as the environmental impacts of production of the used fuel.	Transport distances were estimated based on typical average transport distances based on material type & project location, in line with RICS standard assumptions. (See Appendix).
A5 Construction/ installation process	A5 covers the exhaust emissions resulting from using energy during the site operations, the environmental impacts of production processes of fuel and energy and water as well as handling of waste until the end-of-waste state.	At this stage of design, A5 emissions have been estimated in line with RICS WLC PS Rev 01, which resulted in 70 $kgCO_2e/m^2$. when accounting for the RICS recommended rate of 1,400 $kgCO_2e$/(£100k project value) and the emissions associated with any waste arisings of the new materials. When coupled with the demolition of 12 $kgCO_2e/m^2$, this becomes the 82 $kgCO_2e/m^2$ reported within this assessment. This assumed to be an overestimate with the new RICS WLC PS 2nd edition suggesting an

Module	Description	Commentary of Data Source
		allowance of 40 $kgCO_2e/m^2$, for the onsite construction works (excluding demolition).
B1 In-Use Emissions	The in-use module B1 captures the in-use emissions arising from the life of a building from its components. It is expected that the primary contributor to this will be the fugitive emissions stemming from refrigerant leakage.	Refrigerant charges have been provided by MEP Engineers. The refrigerant leakage rates are taken in line with CIBSE TM65 as below (See Appendix): ASHP Annual leakage rate– 4% End-of-life leakage rate- 2%
B2 & B3 Maintenance and Repair	Module B2 accounts from the carbon emissions arising from any activity relating to maintenance and cleaning. Module B3 accounts or any of the carbon emissions relating to repair.	Following GLA Whole Life Carbon Guidance: B2 has been assumed to be the greater of either 10 $kgCO_2e/m^2$ or 1% of the emissions produced in modules A1-A5. B3 has been assumed to be 25% of B2.
B4 & B5 Material Replacement/Refurbishment	The emissions B4 and B5 cover impacts from raw material supply, transportation, and production of any replaced new material as well as the impacts from manufacturing the replaced material and handling of waste until the end-of-waste state.	Modules B4/B5 has been determined with reference to the 'indicative component lifespans' contained within the RICS PS. (See Appendix for lifespan)
B6 Energy use	The considered use phase energy consumption (B6) impacts include exhaust emissions from any building level energy production as well as the environmental impacts of production processes of fuel and externally produced energy. Energy transmission losses are also taken into account.	Energy consumption has been estimated based off the TM54 operational energy assessment for the proposed development
B7 Water use	The considered use phase water consumption (B7) impacts include the environmental impacts of production processes of fresh water and the impacts from wastewater treatment.	Total water consumption is based off the BSRIA water consumption estimates for the appropriate use types
C1-C4 Deconstruction	The impacts of deconstruction include impacts for processing recyclable construction waste flows for recycling (C3) until the end-of-waste stage or the impacts of pre-processing and landfilling for waste streams that cannot be recycled (C4) based on type of material. Additionally, deconstruction impacts include emissions caused by waste energy recovery.	C1 Deconstruction/demolition) and C2 (Transport) are based on default values. C3 (Waste Processing) and C4 (Disposal) use OneClick LCA's default end of life scenarios, please refer to the appendix for further detail.
D External impacts/end-of-life benefits	External benefits for re-used or recycled material types include the positive impact of replacing virgin-based material with recycled material and the benefits of the energy which can be recovered from the materials.	D (End of Life) use OneClick LCA's default end of life scenarios, please refer to the appendix for further detail.

3.3 Life cycle assessment impacts.

A building Life Cycle Assessment considers a range of environmental indicators that assess the relevant overall impacts of the materials selections. Whilst ideally an LCA assessment would consider all environmental factors relevant to the product or material, due to lack of information in some cases, and lack of consensus in how to calculate Key Performance Indicators (KPIs) within the industry, not all environmental impacts can be considered.

Standard ratios are used to convert the various greenhouse gases into equivalent amounts of CO_2. These ratios are based on the global warming potential (GWP) of each gas. GWP is a relative measure of how much a given mass of greenhouse gas is estimated to contribute to global warming over a given time interval – usually 100 years. It is expressed relative to carbon dioxide which is set as the baseline which other emitters are compared against, and which therefore has a GWP of 1.

This assessment thus reports on the embodied carbon of the development as 'global warming potential' with the annotation 'CO_2 equivalent (CO_2e)'.

3.4 Data sources.

There are a number of approaches to complete a building specific life cycle assessment. In particular, a flexible approach is needed when utilising a dataset of product specific environmental product declarations and more generic data calculated within the LCA tool.

Table 4: Types of data required for a WLC assessment.

Data Source	Comments
Cost Plan	Cost plans can be useful for calculation of uncertain quantities which are not product specific, however often an allowance is made at early design stages which may reduce accuracy. Stage 2 Cost Plan - Shaftesbury Avenue Estimate 22nd January 2024 Issue.
Architectural/Structural Drawings and Area schedule	A more traditional and slower approach to determining quantity of building elements, if build-ups are available to support.

The assessment has utilised multiple data sources described above and is based on the level of detail available at the current stage of design.

3.5 Coverage Adjustment Factor Application .

In order for accurate carbon assessment in construction projects, GLA Guidance requires the use of a coverage factor. This factor ensures that all elements contained within a cost plan are included in the assessment of whole life carbon, despite not having detail of the materiality of all building elements at early stages.

The GLA expects 95% of the cost for each package (RICS category) must be considered in assessments. The coverage factor is calculated by finding the cost value of those items included in the assessment modelling and those not included, then using the two values to find the cost value proportion missing from the assessment. The following formula is then used to calculate the coverage factors to apply to each package (category):

Coverage adjustment factor = (100 per cent / per cent of cost covered in the given category).

The cost coverage has been calculated and an adjustment factor applied as necessary – notably to the external walls, roof and external doors.

3.6 Lifespan of the Development.

In line with the RICS Whole Life Carbon (WLC) Guidance, our assessment assumes a standard 60-year lifespan. However, the project is expected to achieve a longer lifespan of 100 years. In this assessment the extended lifespan has not been used, to allow comparability with benchmarks and other projects. However, it should be recognised that the building's extended life expectancy is an important factor. Extending the buildings life would result in higher Module B carbon emissions assessment due to the extended 40 years of additional maintenance, energy and water use etc., but it also signifies a reduced carbon emissions rate per operational year. Additionally, it underscores the project's commitment to sustainability by minimising the need for premature demolition and rebuilding in the foreseeable future, aligning with the goal of long-term environmental responsibility.

4. Current anticipated performance.

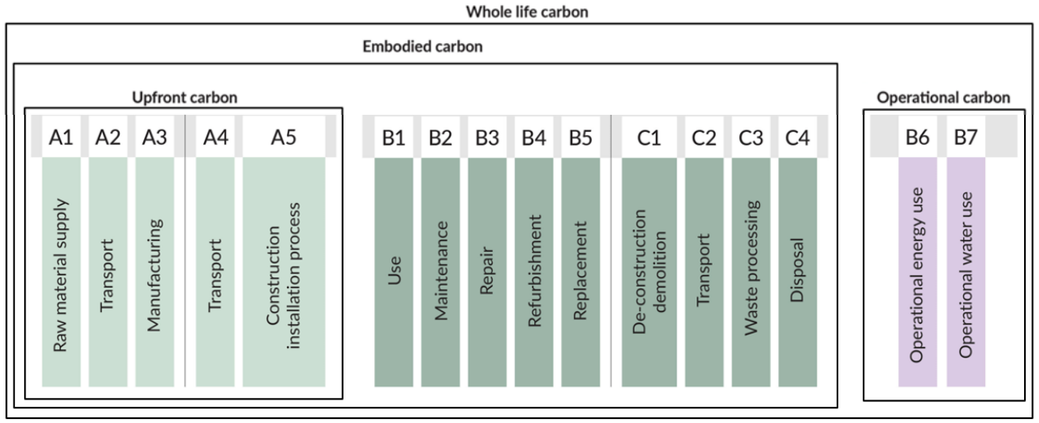

Figure 6: Whole life carbon modules and stages as defined by EN 15978; 7.4

Table 5: Whole life carbon results broken down per building element and life cycle module (including cost adjustment factor)

	A1-A5 ($KgCO_2e/m^2$)	B1-B5, C1-C4 ($KgCO_2e/m^2$)	B6 & B7 ($KgCO_2e/m^2$)
0.2 Demolition	17	6	
0.4 Groundworks	2	0	
1 Substructure	198	11	
2.1 Frame	205	6	
2.2 Upper Floors	34	2	
2.3 Roof	3	2	
2.4 Stairs & Ramps	80	2	
2.5 Ext. Walls	101	76	
2.6 Windows & Ext. Doors	3	4	
2.7. Int. Walls & Partitions	27	25	
2.8 Int. Doors	3	3	
3 Finishes	42	101	
4 Fittings, furnishings & equipments	2	64	
5 Services (MEP)	93	199	1,536
A5 Site operations	115	0	
TOTAL	924	502	1,536

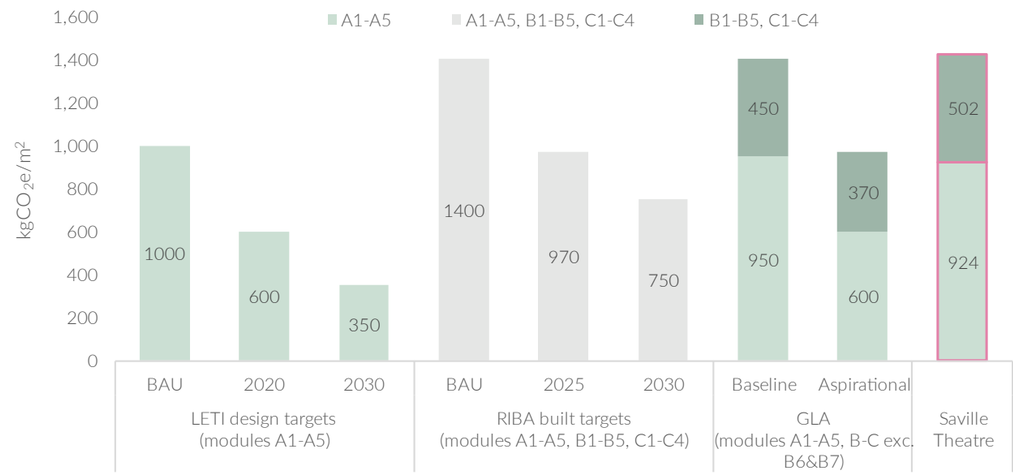

Figure 7: Comparison of the Proposed Development with benchmarks (Excl. Operational Modules B6 and B7)

4.1 Opportunities to reduce embodied carbon.

Two example reductions include targeting lower carbon concrete mixes compared to the default assumption of 25% GGBS cement replacement, and procuring structural steel from an Electric Arc Furnace (EAF). Incorporating these two measures would see the upfront carbon (modules A1-A5) reduce by 185 $kgCO_2e/m^2$. This will be dependent on market availability and should be explored through design development.

The design is still in early stages of development and opportunities will be explored at the next design stage based on the outcome of the RIBA Stage 2 assessment to focus opportunities on high embodied carbon elements.

4.2 Other considerations for minimising embodied carbon.

4.2.1 Maximise Recycled Content

By specifying products with high contents of recycled material, the product life cycle emissions can be significantly reduced, compared to products procured with virgin material. Noting the relationships confirmed in EPD data displayed in Figure 8, Figure 9 & Figure 10, embodied carbon can be reduced at the technical design stage.

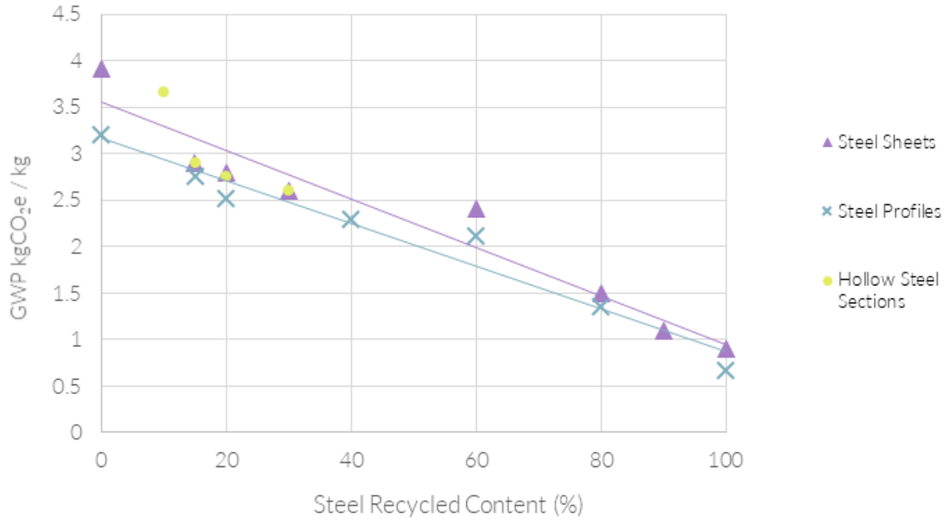

Figure 8: Product life cycle emissions (A1-A3) of construction grade steel and reporting the impact of recycled content.

Figure 10: Product life cycle emissions (A1-A3) of aluminium and steel by volume, confirming that the quantum of material contained within a product is just as important as the material itself.

4.2.2 Influence of product specification

The specific requirements of a product can significantly impact the carbon emissions at the product stage, often due the components of the product requiring more carbon intensive treatment & subsequent transportation prior to fabrication.

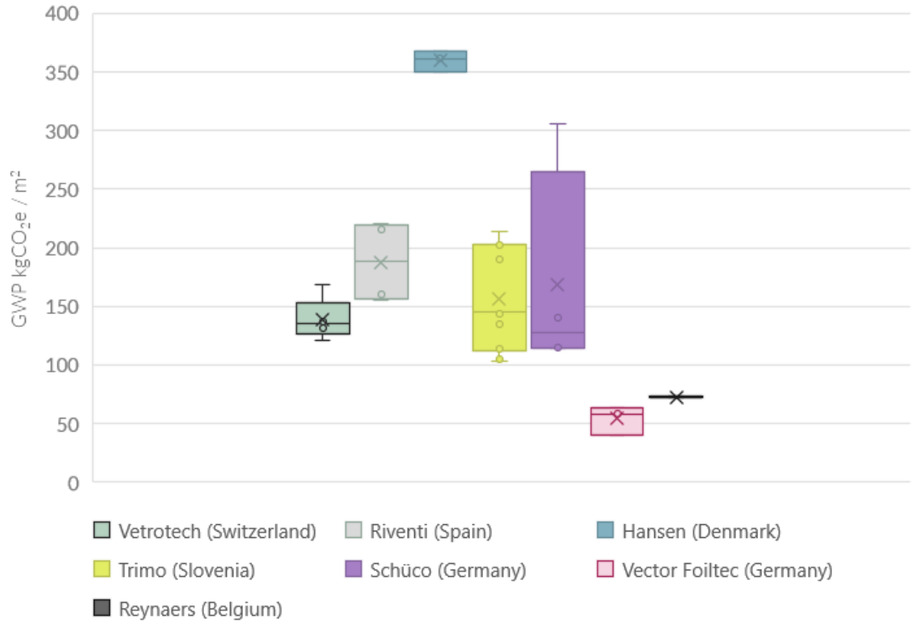

Figure 11: Comparison of Environmental Product Declarations (EPDs) of leading façade fabricators.

Figure 9: Product life cycle emissions (A1-A3) of aluminium, steel, zinc and ceramic and the impact of including recycled content.

4.2.3 Refrigerant use

The use of refrigerants in building services can have a significant impact on whole life cycle emissions, the B1 emissions module. Currently, R32 and R454C refrigerant is specified.

There are a number of refrigerants that have a low GWP that could reduce total WLC emissions if feasible, some examples provided in the table below.

Table 6: List of common refrigerant types with low GWP.

R-Number	Chemical Name	GWP 100-yr
R-30	Dichloromethane	9
R-170	Ethane	3
R-290	Propane	3
R-600	Butane	3
R-600a	Isobutane	3
R-702	Hydrogen	5.8
R-717	Ammonia	0
R-744	Carbon dioxide	1
R-1150	Ethylene	3
R-1234yf	2,3,3,3-Tetrafluoropropene	4
R-1270	Propylene	3

5. Conclusion.

5.1 Summary.

This report has summarised the whole life carbon impacts for the Proposed Development, with the results analysed for the following scopes, commonly referred to in industry:

- Upfront carbon (modules A1-A5 excluding sequestration).
- Embodied carbon (modules A1-A5, B1-B5, C1-C4 including sequestration).
- Operational energy (module B6).
- Whole Life Carbon (modules A-C, module D reported separately).

During the design and pre-application stage, the design has looked at multiple approaches in order to reduce the whole life carbon of the development. Innovative design elements and features have been included in the proposed design to reduce the whole life carbon with particular focus on the upfront carbon. The key features included in the design are:

- Retention of lower building substructure and superstructure.
- Retention of the façades on lower levels, with window replacement to enhance thermal performance.
- Full replacement of the MEP services including new central plant to enable electrification of the building.
- Rooftop extension of L5-10.
- New highly efficient façades to new rooftop extension.

Table 7 Whole Life Carbon Breakdown of the Proposed Development (incl. cost adjustment factors).

Design	**Upfront Carbon A1-A5 ($kgCO_2e/m^2$)**	**Embodied Carbon A1-A5, B1-B5, C1-C4 ($kgCO_2e/m^2$)**	**Whole Life Carbon A1-A5, B1-B7, C1-C4 ($kgCO_2e/m^2$)**
Baseline	**924**	**1,425**	**2,691**

Table 8: Embodied carbon breakdown per building element (incl. cost adjustment factors)

Result category *All results presented in $kgCO_2e/m^2$*	Upfront carbon A1-A5	Embodied carbon (A1-A5, B1-B5, C1-C4)
0.1-0.5 Facilitating works inc. Demolition	18	22
1 Substructure	198	209
2.1-2.4 Superstructure - structure	322	334
2.5-2.6 Superstructure – façade	104	184
2.7-2.8 Superstructure – internal walls and partitions	30	59
3 Finishes	42	142
4 Fittings, furnishings & equipment	2	66
5 Services (MEP)	93	292
8 Ext. works	0	0
A5 Site operations / demo, B2, B3	115	115
TOTAL	924	1,425

5.2 Comparison to benchmarks.

The table and graph opposite show the current upfront and embodied carbon performance against GLA, RIBA and LETI benchmarks. Comparing upfront and total embodied carbon against the GLA baseline and aspirational benchmarks shows that the development improves upon all available industry benchmarks and targets.

Comparison to the B1-B5 and C1-C4 has been presented in the graphs, however it is important to note that these modules have to be calculated based on RICS guidance and assumptions to ensure consistency across projects. The focus has therefore been on the A1-A5 modules as these are based on the actual building design and specification of materials.

The largest contributor to in-use and end-of-life emissions are the B6 and A1-A3 emissions, B6 emissions are presented in the associated energy strategy report, the A1-A3 emissions are those associated with the product stage of each building element, this number is likely to be due to the extent of new structural elements and will be subject to more detailed analysis further down the design development process.

Table 9: Summary of GLA, RIBA and LETI benchmarks met based on proposed analysis ($kgCo_2e/m^2$) (incl. cost adjustment factors)

Benchmarks	Upfront carbon ($kgCO_2e/m^2$)	Embodied Carbon ($kgCO_2e/m^2$)	Proposed Development	Met?
GLA Baseline	950	1400	924/1,425	✓/✗
GLA Aspirational	600	970		✗/✗
RIBA BAU	X	1400		✗
RIBA 2025	X	970		✗
LETI BAU	1000	X		✓
LETI 2020	600	X		✗

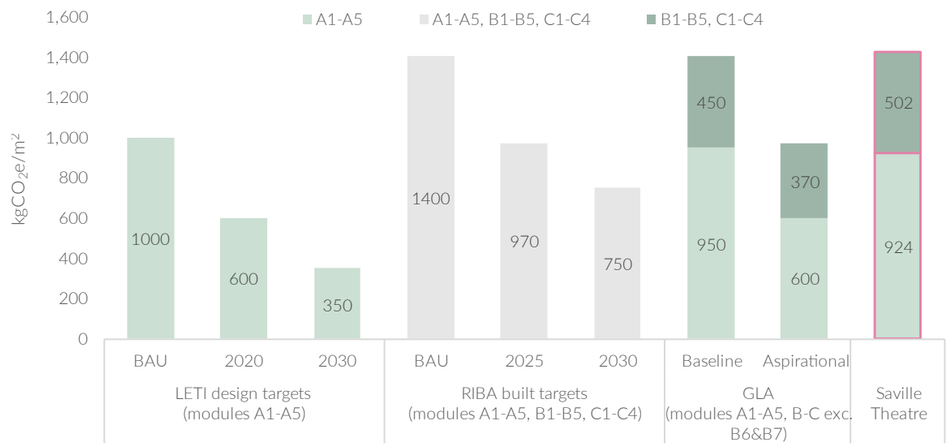

Figure 12: Comparison of proposed Development with benchmarks. (Excl. Operational Modules B6 and B7)

Appendix A – WLC Assumptions.

Table 10 Default Material Specification for UK Projects, used in the absence of detailed information (RICS 2017)

Material	Details	Specification
Concrete	Piling	C32/40, 25% cement replacement
	Substructure	C32/40, 25% cement replacement
	Superstructure	C32/40, 25% cement replacement
	Generic Concrete	C16/20, 0% cement replacement
Steel	Reinforcement bars	97% Recycled Content
	Structural Steel sections	15% Recycled Content
	Studwork/Support frames	Galvanised Steel, 15% Recycled Content
Blockwork	Precast Concrete blocks	Lightweight blocks for building envelope
		Dense blocks for other uses
Timber	Manufactured Structural Timber (CLT, Glulam etc.)	100% FSC/PEFC
	Formwork	Plywood
	Studwork/Framing/Flooring	Softwood
Aluminium	Cladding Panels	Aluminium sheet, 0% Recycled Content
	Glazing Frames	Aluminium extrusions, 0% Recycled Content
Plasterboard	Partitioning/Ceilings	Min. 60% Recycled Content

Table 11 Refrigerant leakage rates as of CIBSE TM65

Product	Annual leakage rate	End of life recovery rate
Package heat pump or chiller, where no refrigerant is managed on site	2%	99%
Heat pump or chiller where some works to refrigerant pipework are carried out on site	4%	98%
VRF systems where a large amount of refrigerant pipework is installed and filled on site.	6%	97%

Table 12 Default Transport Distances for UK Projects (RICS 2017)

Transport Scenario	km by road	km by sea
Locally manufactured e.g. concrete, aggregate	50	-
Nationally manufactured e.g. plasterboard, blockwork, insulation	300	-
European manufactured e.g. CLT, façade modules, carpet	1,500	-
Globally manufactured e.g. specialist stone cladding	200	10,000

Table 13 Default component lifespans (RICS, 2017)

Building part	Building element	Expected lifespan
Roof	Roof covering	30
Superstructure	Internal partitions and linings	30
Finishes	Wall finishes: Render/Paint	30/10
	Floor finishes: Raised Access Floor/Finish layers	30/10
	Ceiling finishes: Substrate/paint	20/10
FF&E	Furniture and fittings	10
Services/MEP	Heat source	20
	Space heating/ air treatment	20
	Ductwork	20
	Electrical installations	30
	Lighting fittings	15
	Communications installations/ controls	15
	Water and disposal installations	25
	Sanitaryware	20
	Lift and conveyor installations	20
Façade	Opaque modular cladding, e.g. rainscreen, timber panels	30
	Glazed cladding/ curtain walling	35
	Windows and external doors	30

Table 14 Default End-of-Life Scenarios (OneClick LCA)

Material group	End of life scenario	Materials included	C3 – C4, waste processing and landfilling	D, recycling benefits
Mineral building materials	Recycling for ground works	Concrete*, Cement*, Bricks, Porcelain, Plaster, Clay products, Stone, Ceramics, Asphalt	C3: Construction waste preparation for recycling	Recycling benefit from replacing the primary gravel
Metals	Metal preparation	Aluminium, Steel, Stainless steel, Galvanized steel, Copper coated, Copper uncoated, Brass, Zinc, Lead	C3: Metal waste preparation	Recycling benefits for

Material group	End of life scenario	Materials included	C3 – C4, waste processing and landfilling	D, recycling benefits
	and recycling**			replacing virgin metal
Biobased materials with heating value	Incineration and energy recovery	Wood, Wood products	C3: Construction waste incineration for energy recovery	Recovered energy
Other materials with heating value	Incineration and energy recovery	Plastics	C3: Construction waste incineration for energy recovery	Recovered energy
Other materials that can be landfilled in construction waste site	Disposal / landfilling of inert material	Coatings, Synthetic materials, Panels and boards***, Insulating materials***, Glass, Window and façade components***	Disposal of inert construction waste	-

Table 15: Cost adjustment factors per RICS Category

	Total % of cost plan included	Cost adjustment factor applied
0.2 Demolition	62%	1.61
1 Substructure	62%	1.61
2.1 Frame	100%	1
2.2 Upper Floors	100%	1
2.3 Roof	25%	4
2.4 Stairs & Ramps	100%	1
2.5 Ext. Walls	77%	1.3
2.6 Windows & Ext. Doors	46%	2.17
2.7. Int. Walls & Partitions	100%	1
2.8 Int. Doors	100%	1
3 Finishes	100%	1
4 Fittings, furnishings & equipments	50%	2
5 Services (MEP)	100%	1
A5 Site operations	100%	1

Appendix B – Terminology.

The following note provides a summary of key terminology commonly used when discussing life cycle assessments and accompanying works, and the definitions associated with each term.

Life Cycle Assessment (LCA)
A life cycle assessment is an overarching term used for assessing the environmental aspects associated with a product or asset over its life cycle. Common LCA scopes include embodied carbon, upfront carbon, and whole life carbon assessments.

Greenhouse gases (GHG)
'Greenhouse Gases' are constituents of the atmosphere, both natural and anthropogenic, that absorb and emit radiation at specific wavelengths within the spectrum of infrared radiation emitted by the Earth's surface, the atmosphere, and clouds. They are also referred to as 'carbon emissions' in general usage, carbon being the most common of the greenhouse gases.

Carbon dioxide equivalent (CO_{2e})
Greenhouse Gas emissions are often expressed as CO_2 equivalent (CO_2e or CO_2eq), a unit of measurement based on the relative impact of a given gas on global warming over a given time period. For example, over 100 years methane has a global warming potential of 28, or 1kg of methane has the same impact on climate change as 28kg of carbon dioxide and thus 1kg of methane would count as 28kg of CO_2e.

Building lifecycle modules
Building lifecycle modules are defined by BS EN 15978:2011 and determine the system boundaries of an assessment. The modules cover the whole life cycle of a building, from product stage (A1-A3) construction and transport (A4-A5) in-use (B1-B7), end of life (C1-C4) and benefits and loads beyond the system boundary (D).

Whole Life Carbon (WLC)
'Whole Life Carbon' emissions are the sum total of all asset related GHG emissions and removals, both operational and embodied over the life cycle of an asset including its disposal (Modules: A1-A5; B1-B7 (plus B8 and B9 for Infrastructure only); C1-C4). Whole Life Carbon asset performance includes separately reporting the potential benefit from future energy recovery, reuse, and recycling (Module D).

Embodied carbon
The 'Embodied Carbon' emissions of an asset are the total GHG emissions and removals associated with materials and construction processes throughout the whole life cycle of an asset (Modules A1-A5, B1-B5, C1-C4).

Upfront carbon
'Upfront Carbon' emissions are the GHG emissions associated with materials and construction processes up to practical completion (Modules A1-A5). Upfront carbon excludes the biogenic carbon sequestered in the installed products at practical completion.

Operational carbon
Operational carbon is the GHG emissions arising from all the energy consumed (Module B6), water supply and wastewater treatment (Module B7) by the asset in-use, over its life cycle.

Carbon sequestration
Carbon sequestration is the process by which carbon dioxide is removed from the atmosphere and incorporated as biogenic carbon in biomass, through photosynthesis and other processes associated with the carbon cycle. In LCAs we typically consider sequestration when incorporating timber in buildings.

Environmental Product Declarations (EPDs)
An Environmental Product Declaration is a document which transparently communicates the environmental performance or impact of any product or material over its lifetime. EPDs are generated based on data obtained through a product level LCA in line with EN 15804, ISO 14025, or other related international standards.

EPDs support carbon emission reduction by making it possible to compare the impacts of different materials and products in order to select the most sustainable option and are used when undertaking asset level LCAs to illustrate carbon performance.

Net zero carbon – construction
When the amount of carbon emissions associated with a building's product and construction stages up to practical completion (Modules A1-A5) equals zero.

Net zero carbon – embodied
When the amount of carbon emissions associated with a building's product and construction stages throughout the whole life cycle of the asset (Modules A1-A5, B1-B5, C1-C4) equals zero.

Net zero carbon – operational energy
When the amount of carbon emissions associated with the building's operational energy (Module B6) on an annual basis is equals zero. A net zero carbon building is highly energy efficient and powered from on-site and/or off-site renewable energy sources, with any residual emissions offset.

Net zero carbon – whole life
When the sum total of all asset related GHG emissions, both operational and embodied, over an asset's life cycle (Modules A1-A5, B1-B7, C1-C4) are minimized, meet local carbon, energy and water targets, and with residual emissions 'offset', equals zero.

Appendix C – Detailed breakdown of results.

tCO_2e.

Result category	Biogenic carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations	B1 Use Phase	B2 Maintenance	B3 Repair	B4/B5 Material replacement / refurbishment	B6 Operational Energy use	B7 Operational Water use	C1-C4 End of Life Stage	TOTAL (excluding Biogenic and D)	D External impacts (not included in totals)	*TOTAL with margin of error Added (excluding Biogenic and D)*
0.1-0.5 Facilitating works inc. Demolition	0	16	111	0	0	0	0	0	0	0	38	**165**	0	42
1 Substructure	0	1245	59	58	0	19	5	0	0	0	53	**1440**	-248	422
2.1-2.4 Superstructure	0	3354	35	151	0	52	13	13	0	0	41	**3659**	-1793	1430
2.5-2.6 Superstructure	0	831	34	10	0	13	3	645	0	0	13	**1549**	-334	576
2.7-2.8 Superstructure	0	222	79	32	0	3	1	309	0	0	6	**651**	-110	1069
3 Finishes	0	414	7	39	0	6	2	1059	0	0	53	**1579**	-140	1042
4 Fittings, furnishings & equipment	-293	99	5	0	0	2	0	169	0	0	301	**577**	-37	272
5 Services (MEP)	0	1000	15	16	459	15	4	1703	17008	0	24	**19786**	-745	27558
6 Prefabricated	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0
7 Existing bldg.	0	0	1	0	0	0	0	0	0	0	0	**0**	0	19
8 Ext. works	0	0	0	0	0	0	0	0	0	0	0	**0**	0	0
A5 Site operations / demo, B2, B3	0	0	0	1271	0	0	0	0	0	0	0	**1271**	0	1069
TOTAL	**-294**	**7182**	**344**	**1577**	**459**	**111**	**28**	**3897**	**17008**	**0**	**529**	30676	**-3408**	**33500**

$kgCO_2e/m^2$.

Result category	Biogenic carbon	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations	B1 Use Phase	B2 Maintenance	B3 Repair	B4 Material replacement	B5 Material refurbishment	B6 Operational Energy use	B7 Operational Water use	C1 Deconstruction / demolition	C2 Waste transportation	C3 Waste processing	C4 Waste disposal	TOTAL (excluding Biogenic and D)	D External impacts (not included in totals)
0.1 Toxic Mat.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.2 Demolition	0	1	9	0	0	0	0	0	0	0	0	3	0	0	0	14	0
0.3 Supports	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0.4 Groundworks	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0
0.5 Diversion	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1 Substructure	0	112	5	5	0	2	0	0	0	0	0	0	4	0	0	130	-22
2.1 Frame	0	197	2	7	0	3	1	1	0	0	0	0	1	1	0	211	-100
2.2 Upper Floors	0	32	1	1	0	0	0	0	0	0	0	0	1	0	0	36	-7
2.3 Roof	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
2.4 Stairs & Ramps	0	74	0	6	0	1	0	0	0	0	0	0	1	0	0	82	-55
2.5 Ext. Walls	0	74	3	1	0	1	0	57	0	0	0	0	1	0	0	137	-29
2.6 Windows & Ext. Doors	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	3	-1
2.7. Int. Walls & Partitions	0	17	7	3	0	0	0	25	0	0	0	0	0	0	0	52	-7
2.8 Int. Doors	0	3	0	0	0	0	0	3	0	0	0	0	0	0	0	6	-2
3 Finishes	0	37	1	4	0	1	0	96	0	0	0	0	0	5	0	143	-13
4 Fittings, furnishings & equipments	-26	9	0	0	0	0	0	15	0	0	0	0	0	27	0	52	-3
5 Services (MEP)	0	90	1	1	41	1	0	154	0	1,536	0	0	1	2	0	1,787	-67
6 Prefabricated	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7 Existing bldg	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8 Ext. works	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
A5 Site operations / demo, B2, B3	0	0	0	115	0	0	0	0	0	0	0	0	0	0	0	115	0
TOTAL	-27	649	31	142	41	10	3	352	0	1,536	0	3	8	35	1	2,770	-308

Appendix D – Operational Energy Assessment (TM54).

Please refer to the Energy Strategy for a breakdown of the operational energy assessment.

Appendix E – Embodied carbon inputs.

Can be provided separately.

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