Whole Life Carbon Assessment

26th April 2022

West London Film Studio

RIBA Stage 4 Whole Life Carbon assessment in accordance with the RICS Professional Statement

Introduction

This report is intended to provide the initial Whole Life Carbon assessment for West London Film Studio at RIBA Stage 4.

A Whole Life Carbon (WLC) assessment has been carried out on behalf of Elbrook Cash & Carry by Sweco UK, in accordance with the methodology set out in the RICS Professional Statement – Whole life carbon assessments for the built environment (2017) document.

This report represents the initial RIBA Stage 4 assessment study, based on the Stage 4 design information from January 2022. The report provides analysis of the life cycle impacts of the development over a reference 60-year life cycle. The assessment has been made in accordance with the modular requirements of EN 15978:2011, and LCA data has been derived from Bionova's One Click LCA software.

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Sweco UK
Quay 2, 139 Fountainbridge,
Edinburgh, EH3 9QG

Helene Piellard
Graduate Carbon Consultant
0131 550 6409

Helene.Piellard@sweco.co.uk
www.sweco.com/uk

David Jackson
Principal Carbon Consultant
07919 551 402

David.Jackson@sweco.co.uk
www.sweco.com/uk

1 Executive Summary

This report provides the RIBA 4 Whole Life Carbon analysis for the West London Film Studio development on behalf of Elbrook Cash & Carry. The report is constructed to accord with the methodological requirements and reporting of the RICS Professional Statement Whole life carbon analysis for the built environment (2017) publication, which is the methodology required to report against current industry benchmarks and targets. The WLC assessment covers the entire built asset and represents the design at RIBA 4, based on the current quantified materials information set out within the Elbrook Cash & Carry cost estimate and supporting Stage 4 design information from the project team. The reporting covers WLC emissions over the modelled Reference Study Period (RSP) of 60 years.

The report looks to establish a performance for West London Film Studio, developing an assessment for WLC for a building of the same size, shape, and materiality as West London Film Studio, but with no further carbon reduction measures applied. All modelling has been conducted in accordance with the requirements of the RICS Professional Statement, and the results have been reported via Appendix A and B of this report.

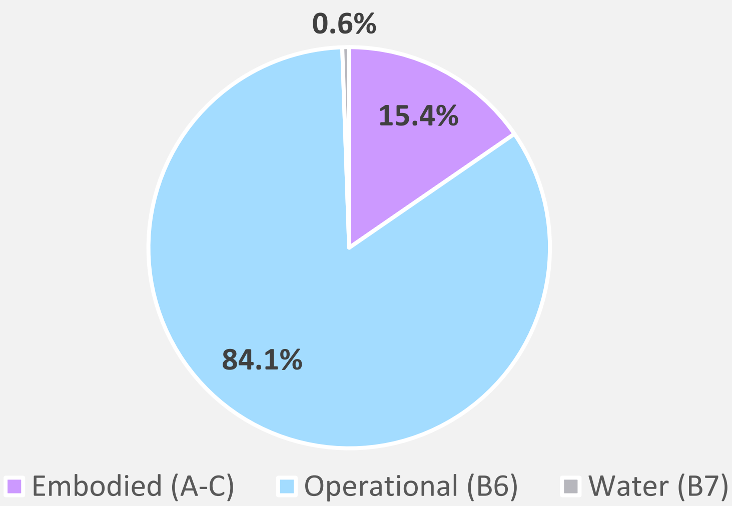
The whole life carbon results for West London Film Studio are as set out below.

58,063

tCO_2e/60 years

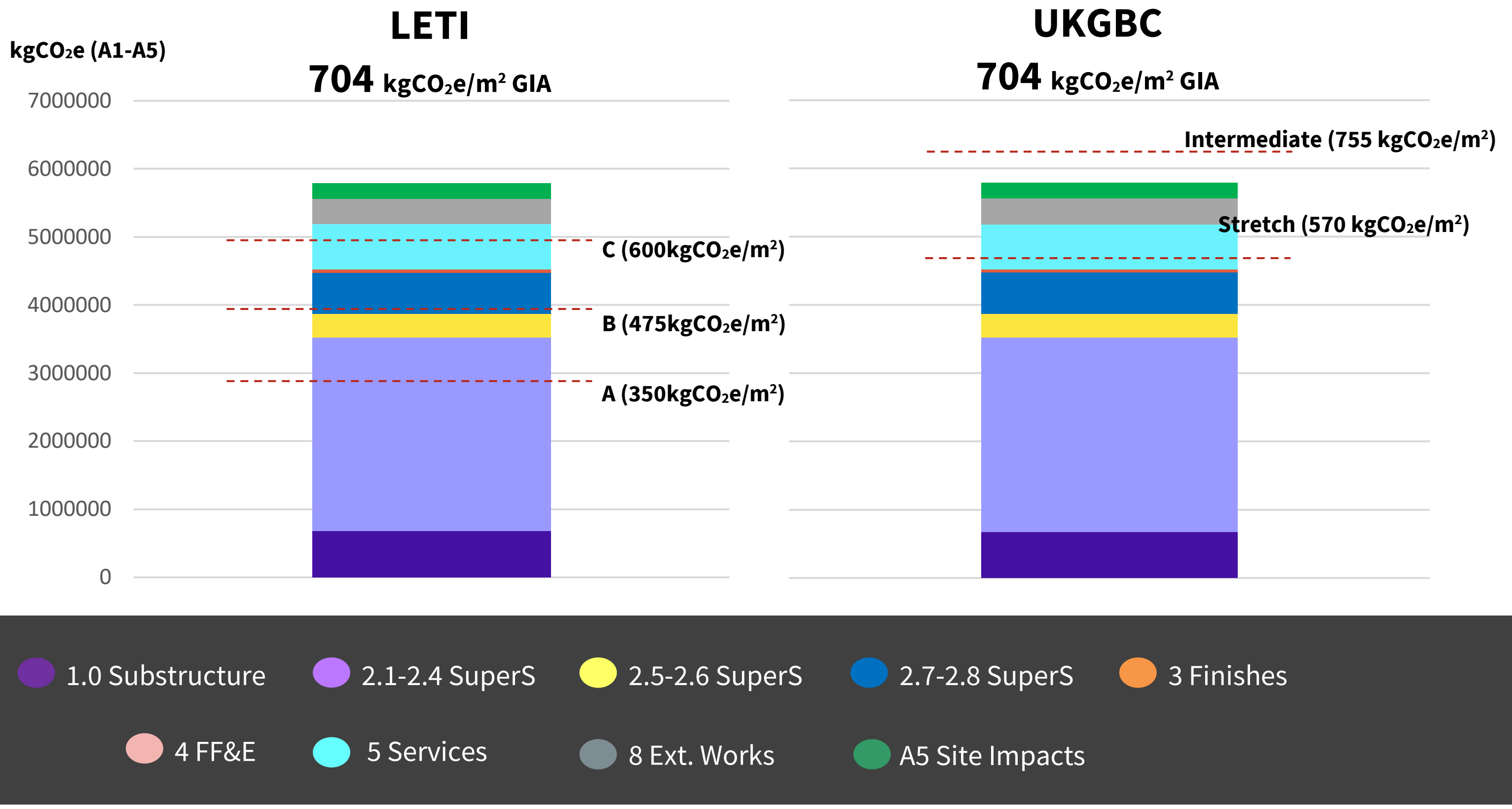
7,062

$kgCO_2e/m^2$ GIA



The embodied carbon results have also been analysed and compared to industry benchmarks to understand the project performance. From previous project experience the embodied carbon impact of West London Film Studio is in line with current results of commercial buildings. Typically baseline values of embodied carbon range from 800 – 1200 kgCO2e/m2 GIA. West London Film Studio sits within this range, however it should be noted that this benchmark is not fully applicable for the development as usually reflective of residential, commercial offices or retail building types. A large majority of the development’s carbon impact is caused by the steel frame.

Current industry benchmarks from LETI and UKGBC have been used for comparison of the baseline embodied carbon results. These show the project performance either on or above current targets, as shown in the graph below. In this case the carbon impact to practical completion (modules A1-A5) has been considered as this is the metric used by the UKGBC and therefore a side-by-side comparison is possible. It acknowledged that the LETI targets are seen as ambitious and require dedication to carbon reduction throughout design whereas the West London Film Studio result represents a baseline performance with no reduction measures taken.

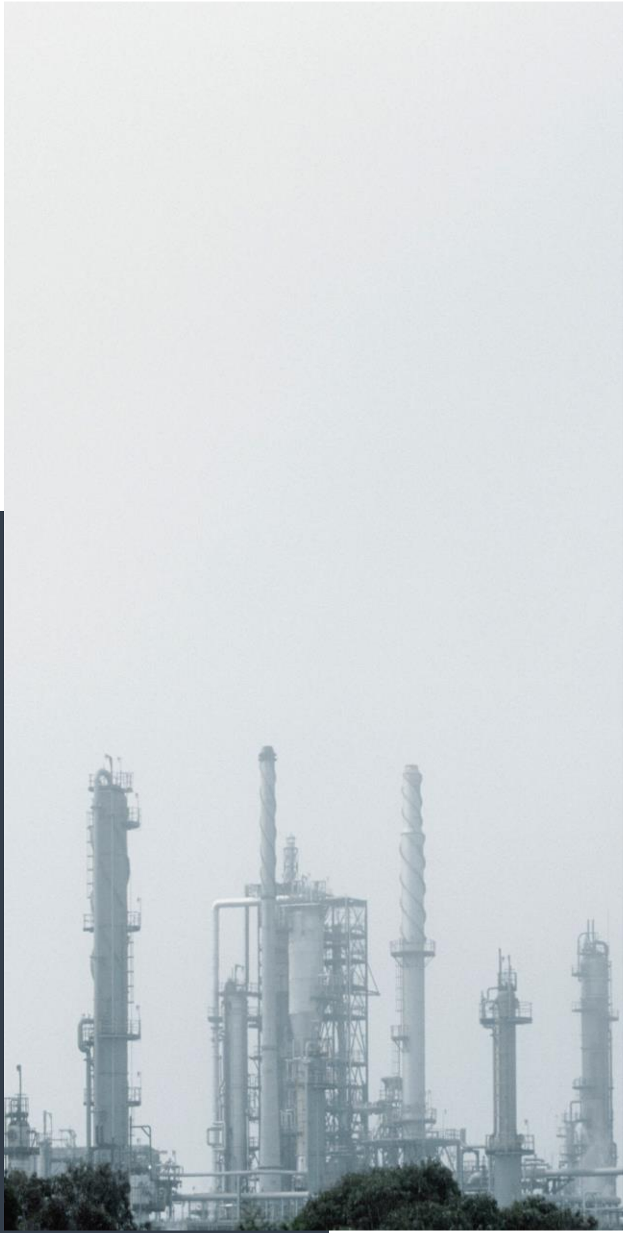


The lower levels of these benchmarks indicate the levels of carbon impact both LETI and UKGBC believe the industry should achieve moving towards 2030. To support this transition to lower carbon buildings the policy and guidance in the area of whole life carbon, and embodied carbon, is rapidly evolving. It is hoped that this will include not only guidance on low carbon design but also case studies on best practice to help developers understand the steps required to minimise the carbon impact of buildings.

The operational carbon values are derived from the Sweco Actual Energy Calculations. These calculations follow the more stringent CIBSE methodology, rather than Part L2A which is seen to be inaccurate. The calculations account for all aspects of the residential heating and cooling within stages, offices and workshop spaces. From this assessment combination of electrical and gas demand was found to be 466 kWh/m^2/annum. The operational energy has a significant impact on the overall WLC of the development, representing about 84% of the impact over the design life of the building. This is due to the buildings use type, with stage lighting playing a large part of the energy consumption.

Furthermore, the effect of grid decarbonisation on the operational carbon and use stage was assessed, finding a reduction in WLC of 67%. This only took into account the electricity demand and therefore there is potential for further reduction if the gas energy sources (AHU equipment) move to a more sustainable method.

2 Introduction



The Climate Emergency

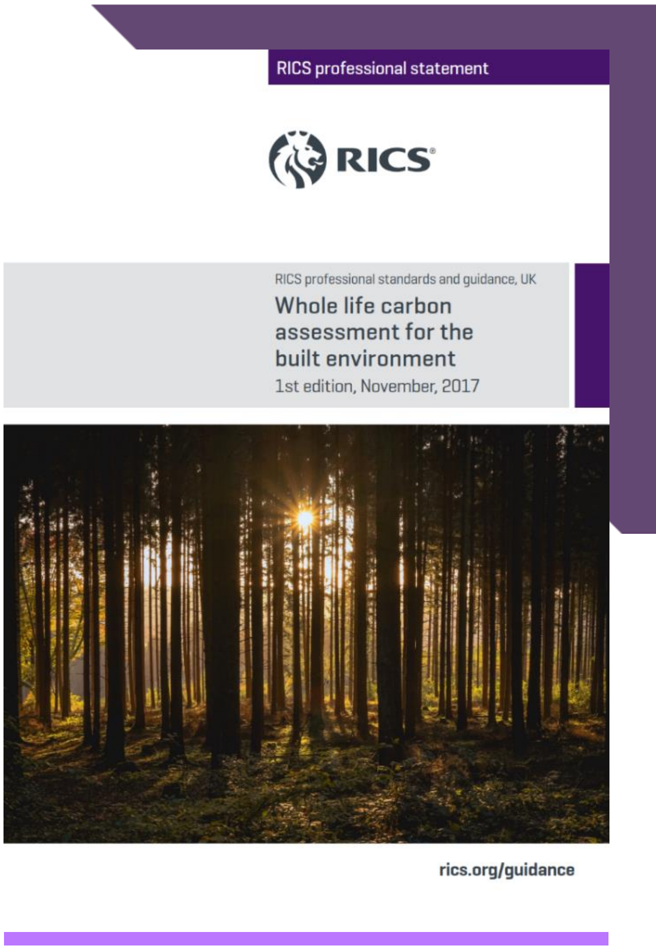
A call to action for the built environment in tackling global climate change.

The climate emergency is a unique global challenge, and one that requires immediate affirmative action at all levels; international, national, local, and personal. In order to meet our commitments to the 2016 Paris Agreement, with the aim of staying below a 2°C temperature increase against pre-industrial levels, and aiming to limit this further to just a 1.5°C change, stakeholders at all of these levels must work together to mitigate climate change. Deep and significant cuts to greenhouse gas (GHG) emissions are required by 2030, with many national governments aiming for zero carbon by 2050. In July 2019, the UK declared its intent to achieve net zero carbon by 2050. The built environment will contribute heavily to the success of this goal. It is estimated that 40% of total UK GHG emissions are resultant from the built environment, through the construction, operation and demolition of buildings and infrastructure. Therefore, immediate steps must be taken within the industry to ensure that this goal is delivered.

2.1 RICS Professional Statement

About

Whole Life Carbon Assessment



The RICS Professional Statement *Whole life carbon assessment for the built environment*, released in 2017, is the foremost assessment methodology for calculating and reporting whole life carbon impacts for the built environment. There is a recognition that, in its drive to reduce emissions, the built environment industry has largely been focused on operational (in-use) emissions reductions, driven by targets and requirements set in the UK Building Regulations, by local authorities and by third-party sustainability assessment schemes such as BREEAM. This focus on operational emissions and top-down drivers for reductions has resulted in more efficient buildings and systems, and consequently reduced GHG emissions from building operation. However, it is now widely recognised that the operational emissions are only one part of the overall carbon story of a building or structure, and that to truly understand this story all its constituent parts must be interrogated.

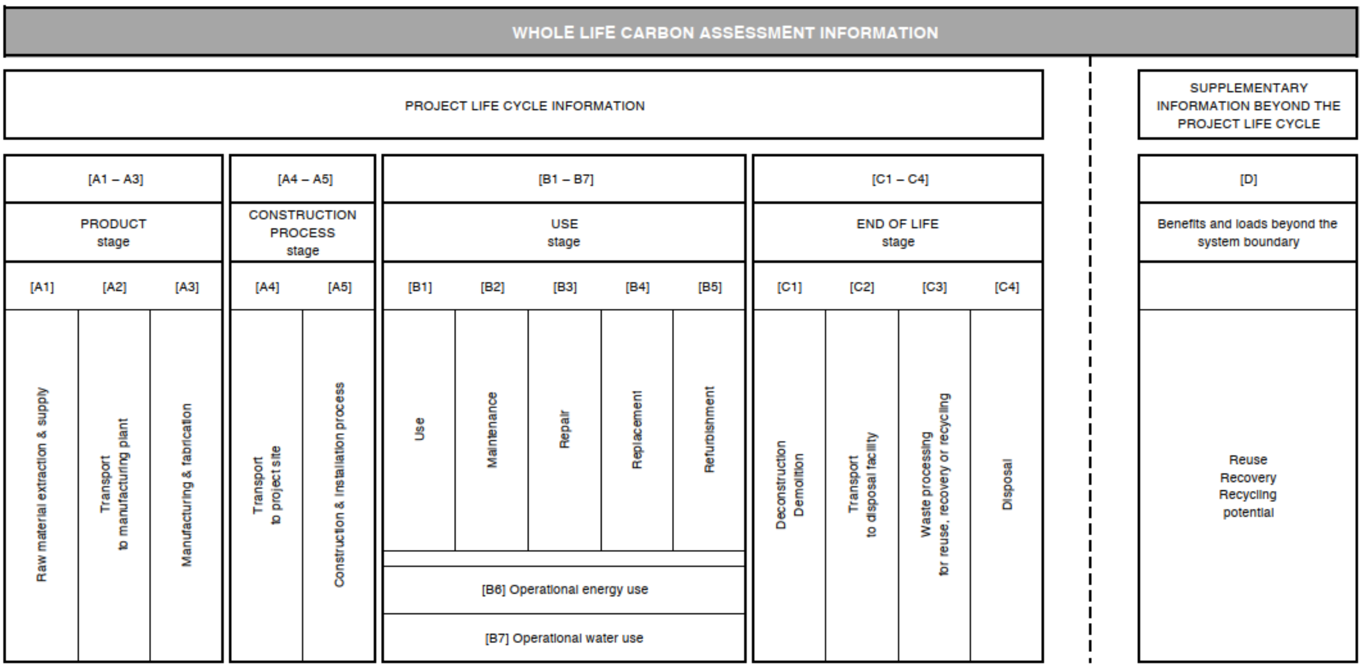
The life cycle embodied emissions resultant from manufacture, construction, operational material replacements and deconstruction have traditionally not been assessed. As the industry continues to drive down operational emissions, so the overall proportion of embodied emissions in a development increases. The RICS Professional Statement provides a robust and thorough assessment method for calculation of the embodied carbon impacts of a development's life cycle. It is important that none of the embodied emission sources are considered in isolation; the intent of the Whole Life Carbon (WLC) study is to ensure that the life cycle emissions are considered as a whole, helping to identify overall combined opportunities for reducing emissions. To be successful, the WLC thought process should be integrated into the project delivery process from the earliest stages and be closely monitored and evaluated throughout design and construction.

2.2 EN 15978:2011

EN 15978:2011 is the European framework setting out the principles for whole life assessment of the environmental impacts of built projects based on life cycle assessment (LCA).

The document provides a modular methodology and set of calculation rules which should be followed when completing Embodied or Whole Life Carbon assessment. The RICS Professional Statement is largely based on the methodology set out in EN 15978:2011, and this standard is referred numerous times throughout the document. Aspects of the implementation of EN 15978:2011 have been erratic, and the RICS Professional Statement notes that this has caused significant discrepancies in the way in which Embodied or Whole Life Carbon assessments are undertaken. This undermines the reliability of carbon measurement and the confidence of stakeholders in the process. The Professional Statement sets out a clear and informed methodology which can be applied to multiple construction projects, providing the required level of repeatability and cross-comparability between assessments.

EN 15978:2011 takes a modular approach to different parts of the life cycle, as shown below and described in more detail in Sections 4 and 5 of this report.



Embodied Carbon + **Operational Carbon** = **Whole Life Carbon**

2.3 WLC & RIBA Plan of Works

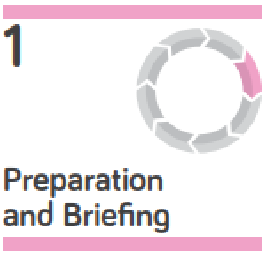
Early action and integration of key themes for whole life carbon is an essential component of eventual success and delivering low-carbon development.

The RICS Professional Statement requires that WLC assessments are undertaken in sequential fashion, starting as early as RIBA Stage 2, with early assessment recommended to establish a baseline carbon estimate for the project. This is important both to integrate the process into the project delivery, but also to establish opportunities for carbon reductions as early as possible in the process. As a minimum, the Professional Statement requires an assessment to be completed before the commencement of RIBA Stage 4. Other assessments should be undertaken to monitor progress, and at least one assessment should be undertaken at practical completion to determine the 'as-built' WLC position.

The most recent revision to the RIBA Plan of Works (RIBA 2020 Plan of Works) now includes some specific guidance on what actions project stakeholders should be taking at relevant RIBA stages of a project. This is set out to assist development teams in strategic implementation of low carbon methodologies at times when they can make the greatest impact to overall sustainable outcomes. A robust process is also highlighted in RIBA's 'Targeting Zero – Embodied and Whole Life Carbon Explained' (2017) publication. These key actions are summarised below.

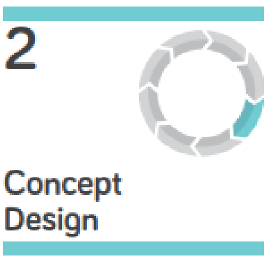
Stage 0 – Strategic Definition

Decision from client to include WLC assessment as a performance indicator and make it a priority. Look to study opportunities for full or partial reuse. Consider ambitious embodied carbon targets. Assess implications of the Net Zero commitment and UK requirements.



Stage 1 – Preparation & Briefing

WLC assessment should be part of a project's sustainability aspirations and client brief. Define for the project team what must be achieved through WLC assessment set targets and assessment boundaries. Consider relationship between embodied and operational impacts.



Stage 2 – Concept Design

WLC thinking to be embedded in the design process from the outset. Provide an introductory session to WLC, which is key to success. Start material considerations & review options using WLC to guide decision-making. Undertake provisional embodied and operational carbon studies/baseline.

Stage 3 – Spatial Coordination

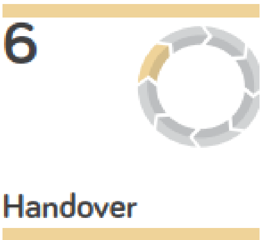
More detailed WLC analysis to be undertaken, for both embodied and operational emissions. Review of carbon budget, benchmarks, and targets. Options to be compared against baseline budget. WLC consultant to be working closely with the design team to support decision-making.

Stage 4 – Technical Design

Low-carbon design choices made at RIBA 3 integrated into design and tender documentation. Carbon budget should be included in tender. Design team to ensure contractor is aware and comfortable with WLC targets. An end-of-design stage WLC model to be provided capturing pre-construction.

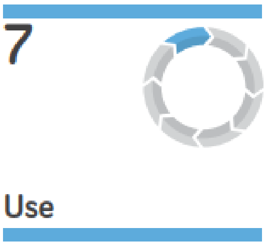
Stage 5 – Manufacturing & Construction

Key issue is to establish a process of monitoring and review of the WLC budgets and carbon through the construction phase of a project. This should be reported at intervals of every 3-6 months. Variations should be brought to client attention, and proposed changes assessed.



Stage 6 – Handover

Final review by the WLC consultant of the 'as-built' information; model update and reporting for client (to inform offsetting payments etc.). The final WLC assessment should be included in the O&M manual, and a session should be held to go through the 'lessons learned'.



Stage 7 – Use

Any Post Occupancy Evaluation (POE) should consider the project WLC assessment and impacts, particularly where decisions made on service lives and replacements impacts performance and maintenance regimes. Carbon studies shared with tenants for their fit outs where relevant.

3 The Development

8,222	G+3	0	B2
Development GIA (m^2)	No. of storeys **above** ground	No. of storeys **below** ground	Planning use class(es)

Introduction to West London Film Studio

This study represents the West London Film Studio development at RIBA Stage 4. West London Film Studio is located in Hayes adjacent to Minet Country Park and Southall. The proposal provides a use development with a total GIA of 8,222 m^2 (based on information provided by BHM Architects). The development provides 4 Stages, office and workspace area as well as a plant deck.

Additional building details for RICS reporting

Building Address

Final address of West London Film Studio is Springfield Road, Hayes.

4

Assessment RIBA Stage

The assessment within this report has been undertaken using the updated **RIBA Stage 4** design information. Sequential modelling updates for the scheme will occur as set out below.

Programme for future sequential WLC models

A further update should be conducted for the West London Film Studio model. The final model and report would be issued at PC, to include a review and 'lessons learned' study with the project team.

Estimated date for building completion

It is currently estimated that the development will be completed the 16th of December 2022.

4 Methodology

This section sets out the core aspects of the methodology used for the West London Film Studio WLC assessment, for reader and verifier reference. The section sets out the remaining details not covered in Sections 2 and 3 required as part of the Project ID matrix (Table 12 of the RICS Professional Statement), including elemental coverage, EN 15978:2011 module coverage, Reference Study Period (RSP), units & metrics, data sources and key process. The contents of this section aim to cover the information requirements of Section 3.2 to 3.4 of the RICS Professional Statement document.

4.1 - Building Elements Coverage

A complete carbon assessment should cover all of the materials and products which fall under the categories listed in Table 4.1 overleaf in the project's bill of quantities, as relevant to carbon assessment. The table overleaf is based on the BCIS Elemental standard form of cost analysis (SFCA), 4th edition, which facilitates consistency between bills of quantities and carbon assessment. When considering the results in Section 6 of this report, they are grouped as per the 'Building Elements' column in Table 4.1 – refer back to this table when considering which building elements the results include. A minimum of 95% of the total cost of each category should be accounted for in the carbon assessment – items excluded should each account for less than 1% of the total category cost. The coverage stated in this document is based on review of material quantities from the Elbrook Cash & Carry working budget (13th January 2022) as well as information provided by Skyline Development and Construction and BHM Architects. The coverage for elements for this assessment is included in Table 4.1. Cost is selected to determine coverage because it is more practical than deriving material volumes, particularly at early stages.

Where the coverage is less than 100%, an adjustment factor should be applied to account for the carbon impacts of the missing elements/components, as follows:

Coverage adjustment factor = (100% ÷ % of cost covered in the given category)

> **A minimum of 95% of the total cost of each element category should be accounted for in the carbon assessment**

As per the guidance of Table 12 of the RICS Professional Statement (Project ID Matrix), it is important to ensure that the coverage of the building elements is reported for the purposes of transparency and interpretation of results. This is subject to the availability of the cost plan which allows this method to be followed, at the time at which the assessment covered in this report is undertaken. As no cost plan was available at the time of assessment this method of adjustment has not been able to be followed, however, as shown in the table below only relatively low impact categories have a coverage less than 100%. Therefore, in this case it is safe to assume that all high impact items have been included in the assessment.

Table 4.1: Building elements coverage for West London Film Studio.

#	Building parts/element groups	Building elements	Coverage (%)
0	Facilitating works	0.1 Temporary/Enabling works/ Preliminaries	n/a
		0.2 Specialist groundworks	n/a
1	Substructure	1.1 Substructure	100%
2	Substructure	2.1 Frame 2.2 Upper floors incl. balconies 2.3 Roof 2.4 Stairs and ramps	100%
	Superstructure	2.5 External Walls 2.6 Windows and External Doors	100%
	Superstructure	2.7 Internal Walls and Partitions 2.8 Internal Doors	100%
3	Finishes	3.1 Wall finishes 3.2 Floor finishes 3.3 Ceiling finishes	100%
4	Fittings, furnishings and equipment (FF&E)	Building-related Non-building-related	95%
5	Building services / MEP	5.1–5.14 Building-related services	95%
		Non-building-related	100%
6	Prefabricated Buildings and Building Units	6.1 Prefabricated Buildings and Building Units	n/a
7	Work to Existing Building	7.1 Minor Demolition and Alteration Works	n/a
8	External works	8.1 Site preparation works 8.2 Roads, Paths, Pavings and Surfacings 8.3 Soft landscaping, Planting and Irrigation Systems 8.4 Fencing, Railings and Walls 8.5 External fixtures 8.6 External drainage 8.7 External Services 8.8 Minor Building Works and Ancillary Buildings	95%

4.2 - EN 15978 Module Coverage

As per the requirements of the RICS Professional Statement Table 2, the WLC assessment must cover the modules set out in the table opposite. These are the core modules of EN 15978:2011, typically representing where the majority of whole life carbon impact falls. As an absolute minimum, a Sweco WLC assessment will cover these modules. Where possible, the assessment should also incorporate the other relevant life cycle modules (see Section 2.2 of this report), as appropriate to the assessment and subject to availability via the assessment tools used for the process.

Table 4.2: Minimum module coverage requirements for a WLC assessment.

Life stages to be included – see 3.2.4	**Product stage [A1–A3]** **Construction process stage [A4–A5]** **Replacement stage [B4]** for facade **Operational energy use [B6]**

Sweco look to include all relevant EN 15978:2011 modules, subject to the limitations of the One Click LCA tool, the RIBA stage/timing of the assessment and the availability of data/scenario information at the time of writing. The below demonstrates which modules have been included in this study. Section 3.2.4 of the RICS Professional Statement makes it clear that it is essential that the life cycle stage modules used are explicitly stated, and omissions justified, in the reporting process. Note that Modules B2 and B3 have been excluded from the assessment as is allowable under RICS Professional Statement Table 2 (as above). One Click LCA does not provide ability for user input of data for these modules, due to the significant uncertainties that surround their calculation, and lack of explicit maintenance and repair data that can be readily converted to embodied carbon impact.

	A1-A3	A4	A5			
Product & Construction Process Stage	✓	✓	✓			
	B1	**B2-B3**	**B4**	**B5**	**B6**	**B7**
Use Stage	✓	✗	✓	n/a	✓	✓
	C1	**C2**	**C3**	**C4**		
End of Life Stage	✓	✓	✓	✓		
	D					
Beyond the Project Life Cycle (reported separately)	✓					

4.3 – Reference Study Period

The RICS Professional Statement has set requirements for the reference study period (RSP) which must be used for the assessment process. These are based on the principles set out in Section 7.3 of EN 15978:2011. For domestic and non-domestic projects, the RSP is 60 years. The RSPs are fixed to provide a level of comparability between results for different projects, and to enable better future interrogation and interpretation of results. The RSP is selected to be broadly representative of the typical required service life of commercial and residential buildings, allow sufficient time for wear and tear and replacement cycles to be accounted for, and stretch across a time period in the future that is reasonably predictable.

60
years

4.4 – Units of Measurement

Section 3.2.7 of the RICS Professional Statement notes that results must be reported using kgCO_2 equivalent (kgCO_2e), or any clearly stated multiple metrics thereof (tCO_2e etc.). The results in this report have been provided in both metrics; where a carbon intensity is reported, it is provided in kgCO_2e/m^2 GIA, and where numbers are too large (i.e. into the millions of kgCO_2e) the metric has been changed to tCO_2e. Figures in the reporting matrix have been provided as per the requirements of the study.

The CO_2e metric describes different greenhouse gasses in a common unit; for a given quantity and type of greenhouse gas, CO_2e denotes the amount of CO_2 that would have the equivalent global warming impact. Therefore, the result represents the impact of the overall greenhouse gas emissions related to the scope of embodied and operational emissions covered by the study undertaken in this report.

CO2

All results will be reported in metrics of 'CO_2 equivalent' (CO_2e)

4.5 – Measurement Source References

For further transparency of results and how they were derived, the RICS Professional Statement also requires declaration of measurement source references for both the floor area measurement and the quantities measurements used in the embodied carbon model. The floor area used for the project is already highlighted in the dashboard at the start of Section 3. The floor area used in the embodied carbon study should come from one of the following sources, in order of preference and subject to stage of the project: BIM Model, Bill of Quantities/Cost Plan, consultants' drawings.

Similarly, material quantities used must also be derived from approved sources. The RICS Professional Statement refers back to EN 15978:2011 sections 9.1-9.3, and notes the following approved materials data sources, as applicable to the stage of the project and in order of preference for data quality: materials delivery records, BIM model, Bill of Quantities/Cost Plan, estimations from consultant drawings. A detailed cost plan for the development was not available at this stage and therefore material quantities had to be derived from multiple sources.

Key sources of data for the West London Film Studio baseline model have been provided in the tables below.

Table 4.3: Floor area measurement data source.

Data Source	Data Source Type	Comments
BHM Architects	GIA confirmed by email	

Table 4.4: Key material quantities data sources (non-exhaustive).

Data Source	Data Source Type	Comments
Skyline D&C Cost Estimate	Cost Plan equivalent	Key info on materials quants for input into model
Architectural Drawings	Consultant Drawings	
BHM Architects Mechanical Equipment Schedule	Technical Schedule	Material quantities/specifications
BHM Specification for Construction Issue	Specifications	Structural and Architectural specifications
Sweco Structural (Building) Specification	Structural specifications	

4.6 – Carbon Data & One Click LCA

A carbon assessment, performed to the standards of the RICS Professional Statement, must also include allowable sources of carbon data. These allowable data sources are largely based on Type III Environmental Product Declarations (EPDs). These approved data sources are shown in the box opposite, taken from Section 3.3.1 of the RICS Professional Statement. Where there is no qualifying data for an exact material or product, it is allowable for equivalent or closely similar carbon information to be used in the model. The most recent geographically and technologically appropriate data has been selected, based on the project location and the anticipated supply chains. Where possible at this early stage of design, generic EPDs and inputs were used in the absence of specific information to inform the correct choice of EPD.

The assessor must explicitly state the data sources used in the whole life carbon assessment.

The following are acceptable sources of carbon data for materials and products, in order of preference:

- **Type III environmental declarations (EPDs and equivalent) and datasets in accordance with EN 15804**
- **Type III environmental declarations (EPDs and equivalent) and datasets in accordance with ISO 21930**
- **Type III environmental declarations (EPDs and equivalent) and datasets in accordance with ISO 14067**
- **EPDs and datasets in accordance with ISO 14025, ISO 14040 and 14044**
- **Type III environmental declarations (EPDs and equivalent) and datasets in accordance with PAS 2050.**

The carbon assessment was carried out by Sweco UK using Bionova's 360 Optimi software, also known as 'One Click LCA'. One Click LCA has been developed in line with the British Standard EN 15978:2011 Sustainability of construction works - Assessment of environmental performance of buildings – Calculation method. The software enables the user to calculate life cycle impact from a large database of verified EPDs. There are >25,000 Type III EPDs on the One Click LCA database.

5 Module-specific Information

This section intends to cover the module-specific information and assumptions made as part of the WLC modelling process for the West London Film Studio development, split out as per the modular structure of EN 15978:2011, and grouped as set out in Section 4.2 of this report. The intent of this is to provide a level of transparency as to how the carbon numbers were derived, the methods used, and the key assumptions made in the model which resulted in the outputs described in Section 6. This follows the advice and guidance provided in Section 3.5 of the RICS Professional Statement. Not every single assumption is listed, but the key items that influenced the process are set out below.

5.1 – Modules A1-A3

A1-A3 is the ‘product’ stage, representing material and product emissions from cradle to factory gate (i.e. excluding transport emissions to site, which is covered under Module A4). All of the Module A1-A3 data has been derived from One Click LCA, using the acceptable carbon data sources listed as per the table set out in Section 4.6. The selection of materials in this assessment is reliant mainly on outline specifications, and therefore will require further updates when actual material specifications become known. Where material specifications are unknown, the advice shown in Table 5.1 opposite is followed.

As noted previously, the material quantities used in the model were derived from a number of sources. Inputs into the One Click LCA software directly reflects these quantities and materials specifications. The WLC assessor also cross-referenced this against the design consultants’ Stage 4 sets of drawings and specification documents, where further information on particular material specification were required to enable better selection of EPDs.

The Mechanical and Electrical Technical Specification and Schedules were used to quantify building services component types and sizes. For the pipework and ductwork, a similar model from the Sweco portfolio was used, in the absence of a full schedule. This model is however designed for residential buildings and therefore might overestimate the impact of plumbing equipment. This should be confirmed or refined at practical completion.

In terms of the structural quantities that have been provided by Sweco. The EPD selections in One Click LCA have been made to reflect as closely as possible the specifications shown in the data source. This is important in terms of levels of cement replacement material that is assumed at this baseline stage.

Where material specifications remained unknown at this stage, generic data representative of standard, market-average specifications have been used in the assessment. Where this is the case, assumptions have been made as per Table 5.1 below (reflective of Table 6 in the RICS Professional Statement).

Table 5.1: Default specifications for building materials, where they are unknown at this stage (as per RICS Professional Statement Table 6).

	Material	Details	Specification
1.	Concrete	Piling	C32/40 20% cement replacement [1]
		Substructure	C32/40 20% cement replacement [1]
		Superstructure	C32/40 20% cement replacement [1]
		Generic concrete	C16/20 0% cement replacement [1]
2.	Steel	Reinforcement bars	97% Recycled Content [2]
		Structural steel sections	20% Recycled Content [3]
		Studwork/Support frames	Galvanised steel, 15% Recycled Content [4]
3.	Blockwork	Precast concrete blocks	Lightweight blocks for building envelope
			Dense blocks for other uses
4.	Timber	Manufactured structural timber CLT, Glulam, etc.	100% FSC/PEFC [5]
		Formwork	Plywood
		Studwork/Framing/Flooring	Softwood
5.	Aluminium	Cladding panels	Aluminium sheet, 35% Recycled Content [6]
		Glazing frames	Aluminium extrusions, 35% Recycled Content [6]
6.	Plasterboard	Partitioning/Ceilings	Min. 60% Recycled Content [7]
7.	Insulation	To floors, roofs & external walls	PIR

There are a number of specific assumptions/scenarios used for the modelling that are relevant to Modules A1-A3 and would have played a part in the results noted in Section 6. This non-exhaustive list is set out below, for reference and in accordance with the RICS requirement for key assumptions and calculation methods to be listed by the carbon assessor.

Holding Down Bolts and Grouting

Due to the quantity provided for this item, an additional 10% in weight of beams and columns based on previous Sweco projects has been used to model holding down bolts and grouting elements.

Cavity Barriers

Only given a length of cavity barriers, assumptions were made regarding the materials that is assumed to be a thermal break panel.

PCC and Steel Stairs

Only given as a no. of flights in the Stage 4 cost estimate, it is typically not sufficient for the LCA model. Steel stair volumes were determined using measurements from elevation and landscaping drawings and steel density from a relevant OneClick LCA EPD.

Precast-Concrete Stairs dimensions were taken similarly from drawings and volumes estimated from a previous Sweco LCA project, based on no. of risers. Landings are assumed 225mm deep. Concrete is based on a typical precast specification of C30/37 (no SCMs applied), with 120 kg/m^3 of reinforcement based on feedback from a structural engineer on a previous project in the Sweco LCA portfolio.

5.2 – Module A4

Module A4 captures the transport emissions of the products and materials from the factory gate to the project site. The carbon emissions associated with this process are calculated as the **material mass x transport distance x carbon conversion factor**. The transport distance is subject to the supply chain route of each item. Often, at an early project stage the specifics of material procurement, and therefore transport distance, are largely unknown. The RICS Professional Statement provides a table of assumptions to use when this is the case (Table 5.2 opposite) and is for UK-based projects. These are expected to be updated for the final LCA model and will need to be accurate as per the actual transport emissions at practical completion. The practical completion model will include a detailed list of all transport distances and sources of data for transparency.

Table 5.2: Default transport distances for UK projects (RICS PS Table 7).

Transport scenario	km by road*	km by sea**
Locally manufactured e.g. concrete, aggregate, earth	50 [1]	-
Nationally manufactured e.g. plasterboard, blockwork, insulation	300 [1]	-
European manufactured e.g. CLT, façade modules, carpet	1,500 [2]	-
Globally manufactured e.g. specialist stone cladding	200 [3]	10,000 [3]

For the West London Film Studio development, Table 5.2 has been used to define the assignment of transport distance, and therefore carbon associated with Module A4, at this stage of design in the absence of specific decisions on material procurement. Table 5.3 below broadly groups the materials into their assigned sourcing distance groups, as per the embodied carbon model inputs. It should be noted that façade materials have been input as individual material EPDs, and therefore have two 1,500 km transport legs applied as default to account for the façade system fabrication process.

Table 5.3: Assigned transport distances for material/product groups.

Assumed Transport Distance (km)	Product group/material in project embodied carbon analysis
50 (local)	Concrete, rebar, screed, general paint
300 (UK)	Formwork, structural steelwork, intumescent paints, XPS insulation, bitumen membranes, pedestals, pavers, balustrades & handrails, stone pavers, internal timber doors, blockwork, cement mortar, plasterboard, steel studwork, acrylic paint, carpet, vinyl flooring, suspended metal ceiling, sanitaryware, pipe/duct insulation, lighting.
1500 (EU)	Waterproofing membranes for structure, façade components (aluminium, stainless steel, mineral wool, laminated glass, membranes, plant screens/louvres), riser doors, internal doors, stair core doors, cycle racks & lockers, ceramic tiles, concrete sealant, terrazzo, ductwork & pipework, all other building services items not assumed in UK (300km) list above.

5.3 – Module A5

Module A5 covers all on or off-site construction activities, including any energy consumption for the site accommodation, plant use and the impacts associated with any waste generated through the construction process, including treatment and disposal. Typically, at pre-construction stages an average value is provided for the purposes of the calculation, as per the conversion factor set out in Section 3.5.2.2 of the RICS Professional Statement.

The data used in the early-stages calculations must be replaced with actual site information from the project main contractor when this is available. This will be included in the full model at practical completion of the project. One Click LCA does not use EPD data for Module A5, and therefore any potential issues with this are avoided. Wastage rates are included as per the WRAP net waste tool, and the carbon assessor has currently used the UK average wastage rated in One Click. As with the other site impacts, these will be refined and updated with the actual wastage rates at practical completion.

The estimated A5 value at RIBA 4 is 460 tCO_2e (or 460,060 $kgCO_2e$). This value is reflected as an 'addition' in the results sheet in Appendix A of this document. The results in the Appendix A matrix against each RICS NRM 1 category grouping (i.e. 2.1-2.4, 2.5-2.6 etc.) for A5 is associated only with the applied material wastage % from that group, not the site activities.

For the practical completion assessment, it is expected that the principal contractor will provide the measured energy and water use from all site activities. This should also include the emissions from any fuel consumed by site equipment and construction processes. Accurate wastage rates will also need to be provided by the principal contractor at practical completion for key waste groups, detailing the level of wastage for the relevant components.

5.4 – Module B4

Module B4 covers the replacement emissions associated with key materials over the development's modelled 60-year life cycle and is a mandatory module for inclusion in an embodied carbon assessment. Some material groups will have a design life that will match that of the overall development, including the majority of substructure and superstructure elements, and therefore these elements are unlikely to have significant emissions associated with this stage of the assessment process.

However, products and materials in other elemental groups will need replacement during the development's design life. The RICS Professional Statement requires the impacts of Module B4 to be reported for the roof, external walls and windows, external doors, finishes, FF&E, and MEPH equipment. As a minimum, the impacts of replacements have been covered for these elements as part of this study. The model should assume that items are being replaced on a like-for-like basis and full replacement (100%) of the item is assumed once end-of-life is reached.

At pre-construction stage, the actual procurement details for the majority of products and materials remains unknown. Therefore, it is not always possible to apply product-specific life cycle replacement values (always in 'years') to each material/component. Where no replacement data is available, the values in Table 5.6 overleaf have been used (representing Table 9 of the RICS Professional Statement). These are based on information from BCIS Life expectancy of building components (2006) and CIBSE Guide M.

For the façade system, it has been assumed that primary and secondary façade components are independent of one another, and that secondary façade components (glass, sealants, gaskets etc.) can be replaced while leaving primary components in situ (i.e. not having to replace an entire module when replacing secondary components). As it tends to be a common undertaking for the façade systems, and the RICS assumptions opposite are not common for an entire façade in Sweco's experience, this former method was used for this project. Relevant assumptions on design life were made for primary and secondary elements.

For landlord plant/Cat. A building services equipment and vertical transportation (i.e. all those items captured under RICS NRM 1 Section 5), the service life values from CIBSE Guide M have been used for the modelling process, where not provided as part of Table 5.6.

The full set of service life values assumed for the project can be provided on request, for transparency of information in this module. These will be challenged and updated as the project develops towards practical completion and updated with actual life cycle information from manufacturers and suppliers. Some of the specific scenarios and assumptions are challenged in Section 6 of this report.

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Table 5.5: Indicative component lifespans used in the WLC model (via RICS Professional Statement Table 9).

Building part	Building elements/components	Expected lifespan
Roof	Roof coverings	30 years
Superstructure	Internal partitioning and dry lining	30 years
Finishes	Wall finishes: Render/Paint	30/10 years respectively
	Floor finishes Raised Access Floor (RAF)/Finish layers	30/10 years respectively
	Ceiling finishes Substrate/Paint	20/10 years respectively
FF&E	Loose furniture and fittings	10 years
Services/MEP	Heat source, e.g. boilers, calorifiers	20 years
	Space heating and air treatment	20 years
	Ductwork	20 years
	Electrical installations	30 years
	Lighting fittings	15 years
	Communications installations and controls	15 years
	Water and disposal installations	25 years
	Sanitaryware	20 years
	Lift and conveyor installations	20 years
Facade	Opaque modular cladding e.g. rain screens, timber panels	30 years
	Glazed cladding/Curtain walling	35 years
	Windows and external doors	30 years

5.5 – Module B6

The emissions associated with operational energy consumption are covered by Module B6. This is an essential component of a WLC study and is a mandatory module to include as per Section 4.2 of this report. It is very important to understand the proportionality of operational and embodied carbon emissions in the whole-life story, and to assess the synergies and interplay between how decisions for reducing embodied carbon may impact on operational, and vice versa.

Sweco have undertaken and provided a separate combined Actual Energy Calculations Outline Report for West London Film Studio, issued April 2022. This section refers to specific parts of that report but does not copy it in full – for full details, please refer to that separate report.

It is recognised that the energy calculations typically derived from Building Regulation Approved Document Part L2A are not fit for purposes and do not provide an accurate picture of all of the energy use items for a commercial building. Some of the fundamental issues with Part L2A include a lack of accuracy of the results which are based on standard inputs for operational and occupational hours and old historical weather information. This is the purpose of undertaking more accurate and in-depth energy modelling for the purposes of the overall WLC process.

Sweco typically employ the CIBSE TM54 methodology to model the operational energy use and consequential emissions. The TM54 process is significantly more involved than an assessment against Part L of the Building Regulations, and also requires an assessment of both regulated and unregulated energy consumption together. The process can help us to better understand actual energy performance of a building at an earlier stage and is a key component in an attempt to address the ‘performance gap’ between as-designed and operating developments.

Sweco utilised the Integrated Virtual Environment (I.E.S) VE 2021 software to carry out dynamic simulation for the space heating and cooling loads (Dynamic Simulation Model, DSM). All other components of energy consumption have been analysed using Sweco’s internal operational energy assessment tools. The building service strategy adopted in the modelling reflects the current RIBA Stage 4 mechanical and electrical system design. It is worth noting that lighting energy and the auxiliary energy required by pumps and fans have been calculated outside the DSM software.

Due to the nature of the building, energy consumption is composed of both base landlord consumption and tenant consumption. The latter is entirely correlated to the use of the building and therefore likely to vary depending on the tenant.

The Sweco energy model for West London Film Studio includes fixed building services within the offices and the stages area, small power and stage lighting, as described on p.4 of the Actual Energy Calculations RIBA Stage 4 Outline Report. The below details these inclusions/exclusions.

- Base Building Services: space heating, space cooling, fan power, ventilation, toilet extract, cold water booster set, domestic hot water, general and emergency lighting, lifts, other landlord energy
- Tenant Energy: small power, lighting to stages

This results in energy consumption of 3,500,351 kWh per year. Of this total only 29% or 999,075 kWh/yr is the net base building energy with the remaining resulting from tenant energy use, the majority of which is the stage lighting.

The base landlord energy use is in line with benchmarks, however the tenant energy use is significantly higher than typical values. This is due to the use of the building and the requirement for extensive stage lighting which means that energy consumption is higher than what is usually

A second model for Module B6 applies grid decarbonisation to the components that are consuming grid electricity at WLFS. Components such as the commercial cooling systems, ventilation (AHUs) and unregulated energy consumption is driven by grid electricity and may therefore take advantage of this decarbonisation. As per the rules of the RICS Professional Statement, the assessment uses the National Grid's Future Energy Scenarios 'Slow Progression' prediction for this process.

Due to a small amount of gas space heating, 456 kWh/m^2/annum (NIA) of the total 466 kWh/m^2/annum (NIA) has grid decarbonisation applied as per the RICS requirements in this WLC model. Figure 5.3 shows the National Grid's Future Energy Scenarios; the decarbonisation of this energy proportion is based on carbon factors extrapolated from the 'slow progression' scenario. This is applied to B6 only and is reflected in the decarbonisation model in Appendix B of this report.

It is likely that, given modelling against the NG FES 'slow progression' scenario, carbon emissions will be reduced significantly by 2050 and will be moving close to zero.

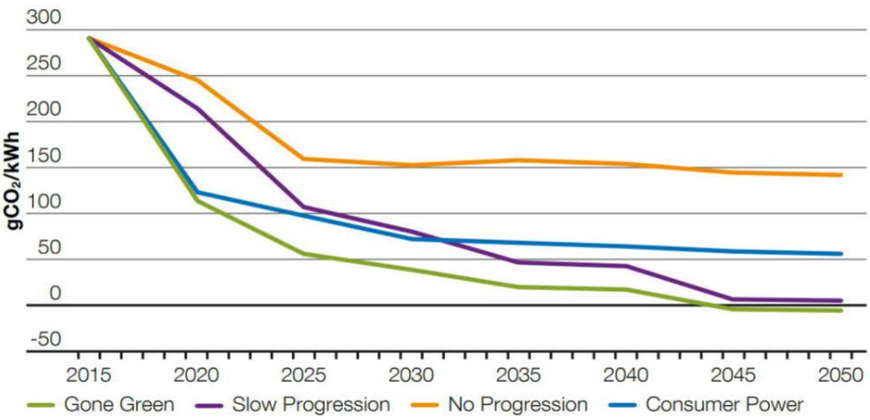

Fig. 5.3: National Grid FES graph to show diminishing carbon intensity of grid electricity under different scenarios ('Slow Progression' relevant to this study).

5.6 – Module B7

Module B7 covers the carbon emissions associated with water consumption and use during the development's operational life cycle. This covers the emissions associated with both water supply and wastewater treatment, excluding water use during maintenance, repair and replacement that are reported elsewhere. Any emissions associated with energy expended from water-related systems are captured under Module B6 outputs.

The water consumption of the commercial space at West London Film Studio is based on the Better Building Partnership's (BBP) Real Estate Environmental Benchmarks (REEB) base water intensity of 35 liters/person/day as a starting point. The maximum number of occupants is determined using an occupant density of 0.111 person/m2 from BREEAM 2018, and working days are assumed excluding weekends.

The emissions factors associated with water use and treatment are taken from the UK Government GHG Conversion Factors for Company Reporting publication, as per the requirement for allowable carbon conversion factors in Section 3.3.2 of the RICS Professional Statement. Section 9 of the 2019 version of the aforementioned document confirms that Water UK have discontinued its 'Sustainability Indicators' report, and therefore conversion factors remain unchanged since 2012. The emissions factors are split for water supply and water treatment.

The 2020 version of the GHG Factors for Company Reporting confirms that the emissions factor for water supply is **0.34 $kgCO_2e/m^3$**, and **0.71 $kgCO_2e/m^3$** for water treatment. A peer review of existing reports/data found a Cundall report titled 'What Colour is Your Building' (2013). Section B10 of this report further confirms the above figures, and also notes that there is an assumption made that 90% of potable water ends up going to sewer. In the absence of specific data at this stage, this is the assumed factor in the treatment results. The inclusion of water recycling will likely impact this and improve the result, with less water going to sewer and therefore lower carbon emission, given that the treatment emission factor is more than double the supply.

No. of occupants **913**	**Home days in yr.** **261**
WUI (l/person/day) **35**	**Building Life Cycle** **60 years**

Total water use = (WUI x no. of occupants) x home days in a year x building life cycle

Water use = ((35 x 913) x 261 x 60) ÷ 1000 = 500,219m^3 of water consumed over development life.

Supply = 500,219 x 0.34 = 170,074 $kgCO_2e$

Treatment = (500,219 x 0.9) x 0.71 = 316,714 $kgCO_2e$

Total water emissions = **489,714 $kgCO_2e$**

5.7 – Modules C1-C4

Modules C1-C4 cover the end of life (EoL) emissions. The EoL stage commences when the built asset has reached the end of its life and will no longer be used; in the case of this RICS assessment, this is at the end of the stated reference study period in Section 4.3 (60 years). The LCA assessor should develop specific scenarios for EoL, and these should be explained or stated within the assessment report. This should be based on future intentions provided by the project team, precedent and understanding of current EoL practices. In the absence of this information at pre-construction, the EoL scenario should be based on current standard practice. One Click LCA already assigns the current expected country-based EoL scenario to product groups and materials, and the list overleaf shows which base scenarios have been assigned to which products. One Click LCA also now has a feature where you can choose from a list of potential EoL scenarios.

Module C is split into four parts, as follows:

C1 Module C1 covers demolition and deconstruction emissions. Deconstruction should cover all site-based activities required to dismantle, deconstruct and/or demolish the built asset being assessed.

C2 Module C2 covers the carbon emissions associated with the transportation of demolition and deconstruction arisings to the appropriate disposal site, including any interim waste management stations.

C3 Module C3 covers the carbon emissions of waste processing for reuse, recovery, and recycling, including their treatment & processing prior to reaching the end-of-waste state.

C4 Module C4 covers the emissions arising from any disposal (i.e. landfill or incineration) for products that are not expected to be recovered and repurposed at their EoL.

Sweco are able to split out the impacts of each of the C modules for better clarity on where the impacts fall within the above. This report therefore provides a greater module coverage than is typical of carbon assessments to date. Understanding and interrogating EoL is of particular interest to see where future opportunities may be to increase reuse and recycling of key products and materials.

As previously described, One Click LCA allows a selection to be made related to the EoL scenarios most appropriate for key product and material groups. At this point, the automatically selected items, those representing the most common EoL scenario for that product in the development location, have been chosen for the study. These are set out in Table 5.6 below. These have been provided for the purposes of transparency, and so that the project team can interrogate this and begin to challenge and create new plausible scenarios at the next project stage to inform the model update and alignment with project EoL intent for each key material group/type.

Table 5.6: Table of EoL scenarios chosen for key materials/product groups at West London Film Studio.

Location	Material	End of life scenario
Substructure	Concrete	Concrete crushed to aggregate (for sub-base)
	Rebar	Steel recycling
	Formwork	Incineration
	Screeds	Cement/mortar used as backfill
Superstructure & Facades	Concrete	Concrete crushed to aggregate (for sub-base)
	Rebar	Steel recycling
	Formwork	Incineration
	Structural steelwork	Steel recycling
	Intumescent paints	Landfilling (inert)
	XPS insulation	Plastic-based material incineration
	Bitumen membranes	Landfilling (inert)
	Timber decking	Incineration
	Floor gratings (TBC)	Steel recycling
	Terrace/roof pedestals	Steel recycling, plastic-based material incineration
	Concrete pavers	Rebar separated, concrete to aggregate
	Handrails/balustrades	Metal recycling (as appropriate to material)
	Aluminium	Aluminium recycling
	Mineral wool	Landfilling (inert)
	Stainless steel	Steel recycling
	Laminated glass	Glass recycling (as Grade 2 cullet)
	EPDM/gaskets	Plastic-based material incineration
Internal Walls	Blockwork	Concrete crushed to aggregate
	Cement mortar	Cement/mortar used as backfill
	Plasterboard	Gypsum recycling
	Steel studwork	Steel recycling
Stairs & Ramps	Concrete	Concrete crushed to aggregate (for sub-base)
	Rebar	Steel recycling
	Handrails/balustrades	Metal recycling (as appropriate to material)
FF&E	Cycle racks	Metal recycling (as appropriate to spec)
	Lockers	Metal recycling (as appropriate to spec)
Doors	Steel doors	Metal-containing product recycling
	Timber doors	Incineration

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Finishes	Acrylic paints (floors)	Landfilling (inert)
	Carpet tiles	Incineration
	Ceramic tiles	Brick/stone crushed to aggregate
	Tile adhesives	Landfilling (inert)
	Concrete sealants	Landfilling (inert)
	Vinyl flooring	Landfilling (inert)
	RAF systems	Steel recycling/plastic incineration
	Paint (general)	Landfilling (inert)
	Ceiling (baffle)	Metal recycling
	Ceiling (office susp.)	Metal recycling
Services	WCs	Landfilling (inert)
	Taps/showers	Metal recycling
	Steel cleaners sinks	Steel recycling
	Shower trays	Landfilling (inert)
	Shower screens	Glass recycling
	Ducts (steel)	Steel recycling
	Ducts (PVC)	Landfilling (inert)
	Duct insulation	Landfilling (inert)
	Pipe (steel)	Steel recycling
	Pipe (copper)	Copper recycling
	Pipe (PVC)	Landfilling (inert)
	Pipe (HDPE)	Plastic-based material incineration
	Pipe (cast iron)	Metal recycling
	Pipe insulation	Landfilling (inert)
	Other major plant equipment	System-dependent – can be clarified in greater level of detail on request/by system.
	PV panels	Metal-containing product recycling
External Works	Concrete	Concrete crushed to aggregate (for sub-base)
	Rebar	Steel recycling
	Formwork	Incineration
	Paving stones	Brick/stone crushed to aggregate

5.8 – Module D

Module D covers any benefits or burdens accruing from the repurposing of elements discarded from the built asset, and any energy recovered from them beyond the building's life cycle. It is intended to provide a broader picture of a project by accounting for the future potential of its components after repurposing/reuse/recycling. This section captures the avoided emissions from utilising these items to substitute primary materials for future developments. This is crucial to the concept of circularity; Module D can be used as an approach to determining what the future impact might be of avoidance of landfill/incineration of materials and products on a future development beyond the life of the one under assessment in this process.

Module D is always reported separately to the values provided for the carbon assessment (covering EN 15978:2011 Modules A-C). This is largely down to the inherent future uncertainty in how these materials will actually be treated at the end of their life, particularly when this is a minimum of 60 years away from practical completion of the asset. However, it is important to report Module D alongside A-C, to provide a holistic view of the environmental impacts of a development. The process should promote thinking about the future, including how we design for circularity.

Module D is always reported separately to the A-C values

A-C (+D)

The RICS Professional Statement asks for scenarios to be developed for Module D (much like in Module C), which can be supported and substantiated. Scenarios that can be considered may include reuse of major components (frame, foundations etc.) in situ, offsetting impacts in Modules A1-A5 and C, or reconstitution / recycling / reuse of materials and building components offsite, thus offsetting the impacts in Modules A1-A3 only. At this point, the assumed EoL, and therefore the expected benefits to future developments represented by D, are as per Table 5.6 in Section 5.8. Where products and materials are recycled, their future benefits beyond the system life are captured in Module D reporting in Appendix A. Energy recovery from incinerated products (such as timber) are also captured in Module D, where their energy recovery rate is >60%. The current results have taken the Module D calculations directly from the One Click LCA system.

When an item is fabricated from reused materials, Module D quantifies the avoided or potential additional emissions, comparing secondary fabrication with an equivalent for primary materials. Therefore, Module D contains the benefit from substituting the primary product and not making it from scratch, as well as any emissions stemming from the processing of the secondary product.

6 Results

6.1 – Baseline Performance

This section sets out the initial results of the Whole Life Carbon analysis for West London Film Studio, in accordance with the requirements of the RICS Professional Statement. The model is based on the updated Stage 4 scheme from January 2022.

The assessment has been undertaken using the methodology set out in Section 4. Specific details of the assumptions and measures related to the EN 15978:2011 modules are set out in Section 5 and inform the assessment results presented here.

The baseline results are presented in three ways (and in the order set out below):

- As whole life carbon (A-C all modules included, no grid decarbonisation to B6)
- As whole-life embodied carbon (A-C excluding B6 and B7).
- As embodied carbon to practical completion (A1-A5 only)

It is important to understand what this baseline represents. This baseline is a **business-as usual development**, representing a building of the same size, shape, and materiality as West London Film Studio, but without further material-selection-based embodied carbon reduction measures applied. It represents the base quantity data in the Stage 4 design information from the project team. The baseline model therefore captures any material efficiency decisions from Stage 4 that were accounted for in the cost estimate, but does **not** include any specification-level reduction measures such as additional GGBS applied to concrete, hydroelectric aluminium, and largely relies on base specifications as per Table 5.1 in Section 5.1. The purpose of this baseline is to provide an initial project-specific benchmark, against which defined reduction measures can be quantified.

6.1.1 – Performance at Three Levels

As noted above, this sub-section is split into three levels of detail and captures the baseline performance of West London Film Studio in terms of whole life carbon, whole life embodied carbon and capital embodied carbon. The results are presented in largely the same way for consistency and comparison between the levels of detail/modular inclusions, with minor modifications be reflective/appropriate for the level of information being discussed. Each section has short commentary included under the pie charts to describe some of the key focal points that are evident from the studies and key to each level of interrogation.

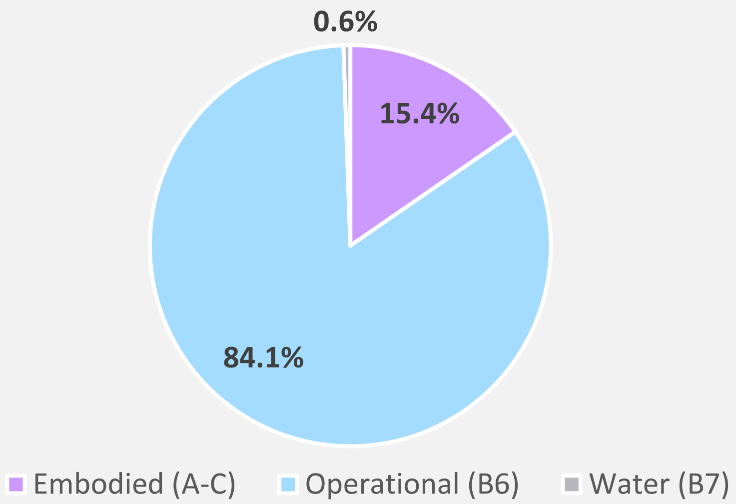
Whole Life Carbon Modules A-C (60 years)

58,063

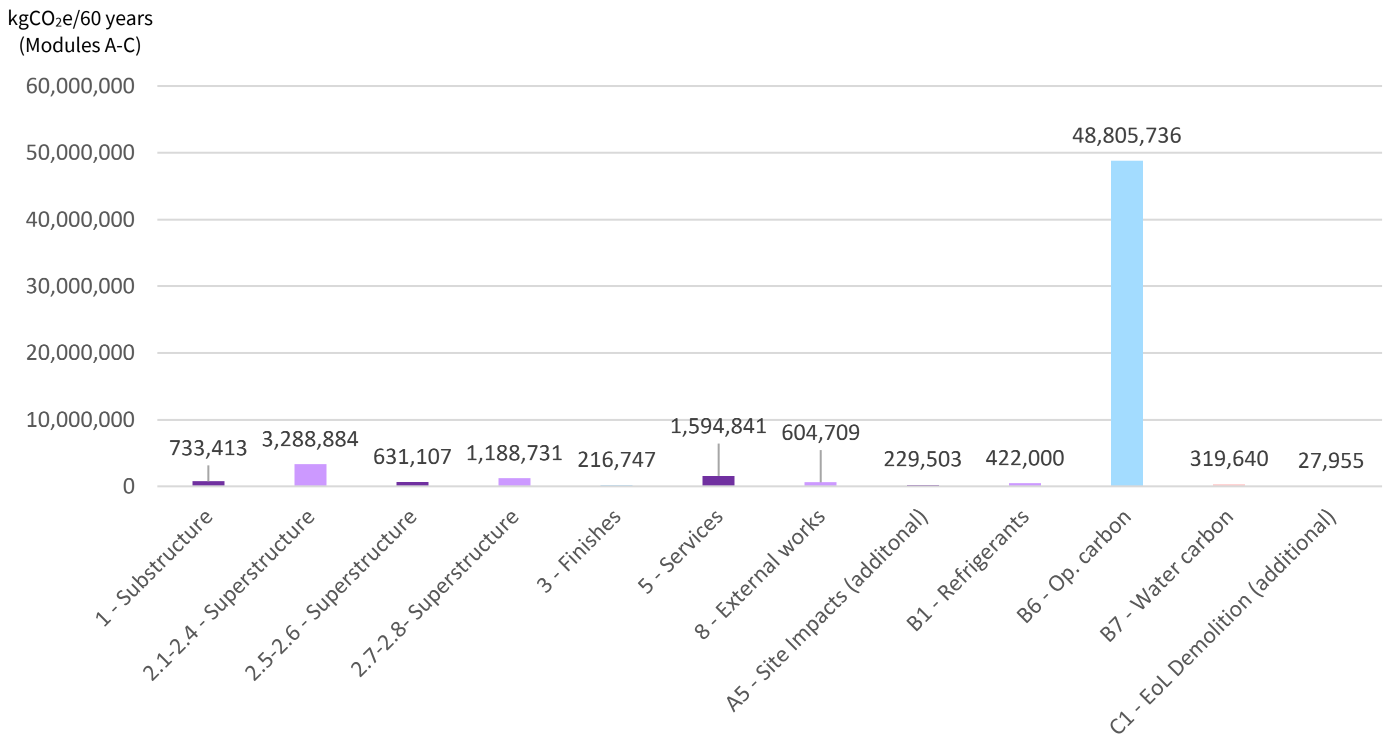
tCO_2e/60 years

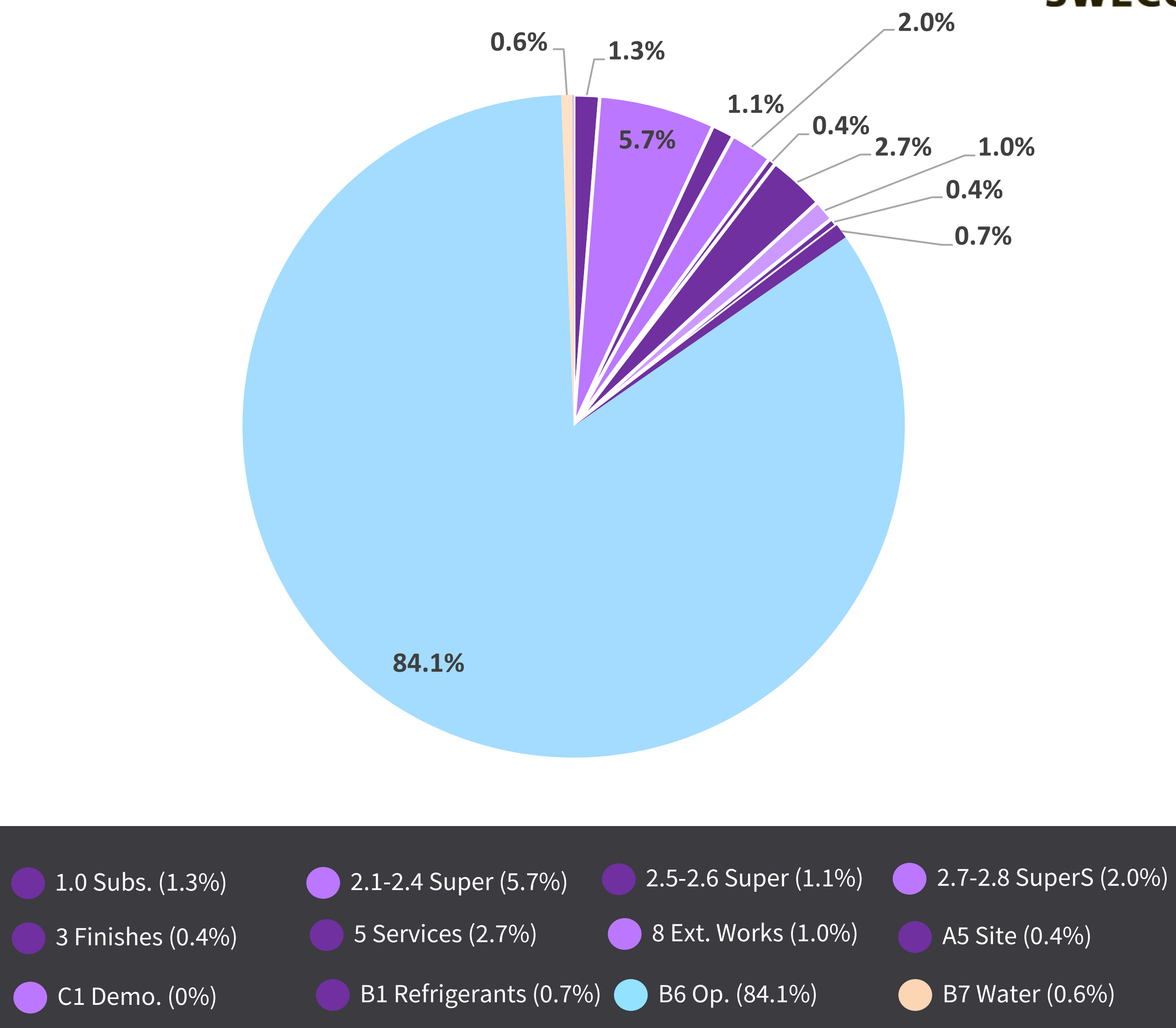
7,062

$kgCO_2e/m^2$ GIA



WLC Key Category	Impact ($kgCO_2e$/60 years)	WLC Proportion (%)
Embodied Carbon (A-C)	8,937,891	**15.4%**
Operational Carbon (B6)	48,805,736	**84.1%**
Water Carbon (B7)	319,640	**0.55%**





It is evident from the baseline results that the embodied carbon is the major contributing factor in the study, at 8,938 tCO_2e/60 years or 15.4% of the total development whole life carbon. The operational emissions are 48,805 tCO_2e, or 84.1% of the total WLC emissions for the development. The operational emissions calculated here come from the advanced CIBSE TM54 modelling exercises undertaken for West London Film Studio, and it is therefore expected that they would have more of an impact compared to some industry models which are still using Building Regulations Part L to determine B6 impacts, which never provides an accurate enough picture of the operational emissions. In the whole-life total, emissions associated with water use and treatment only have a comparatively marginal impact, at just 319 tCO_2e or 0.55%.

When viewing the model at this all-inclusive level of detail, the Substructure and Superstructure (specifically 2.1 – 2.6, which contains the frame, upper floors, roof and facades) should have a significant impact of total WLC, however due to the significant impact of tenant energy usage, it is not clearly shown here despite their major impact (8% or 4,653 tCO_2e/60 years). This will be exemplified further in the following studies which exclude operational and water emissions.

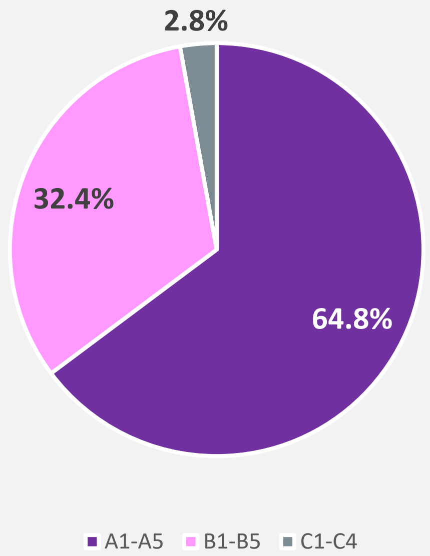
Embodied Carbon Modules A-C (60 years)

8,938

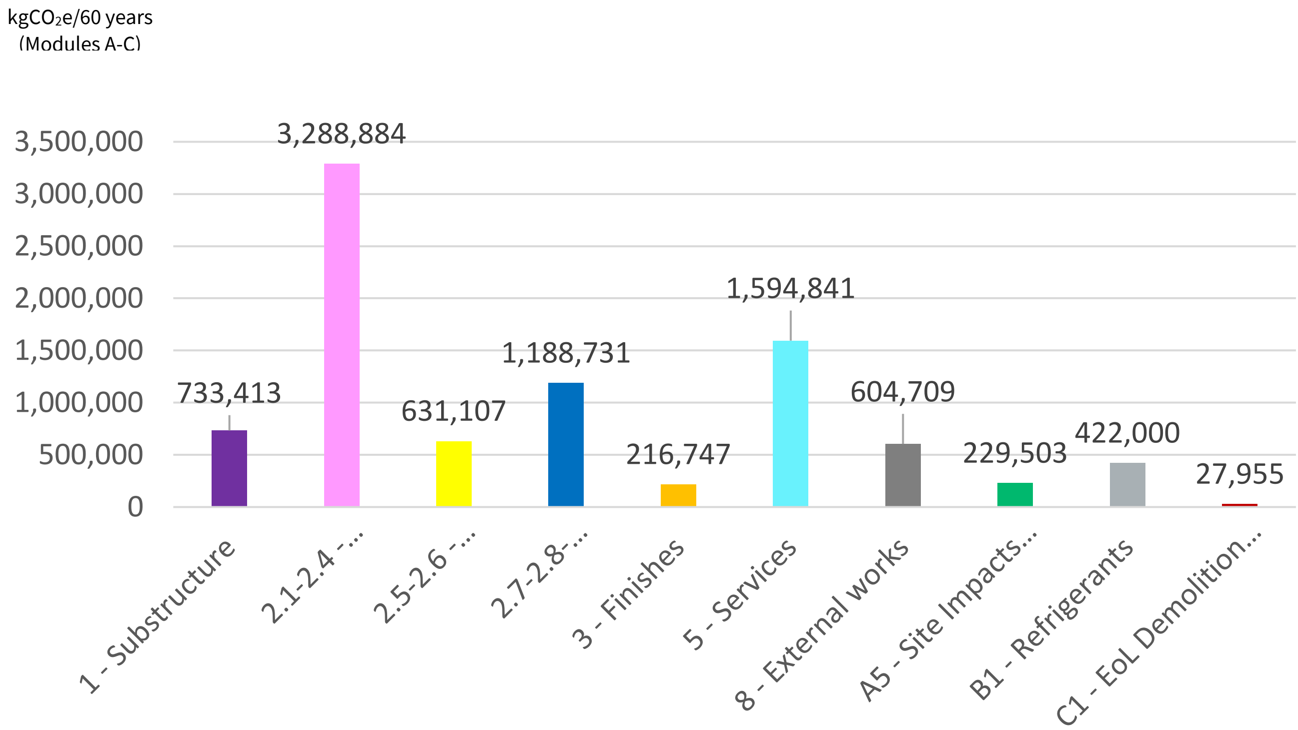
tCO_2e/60 years

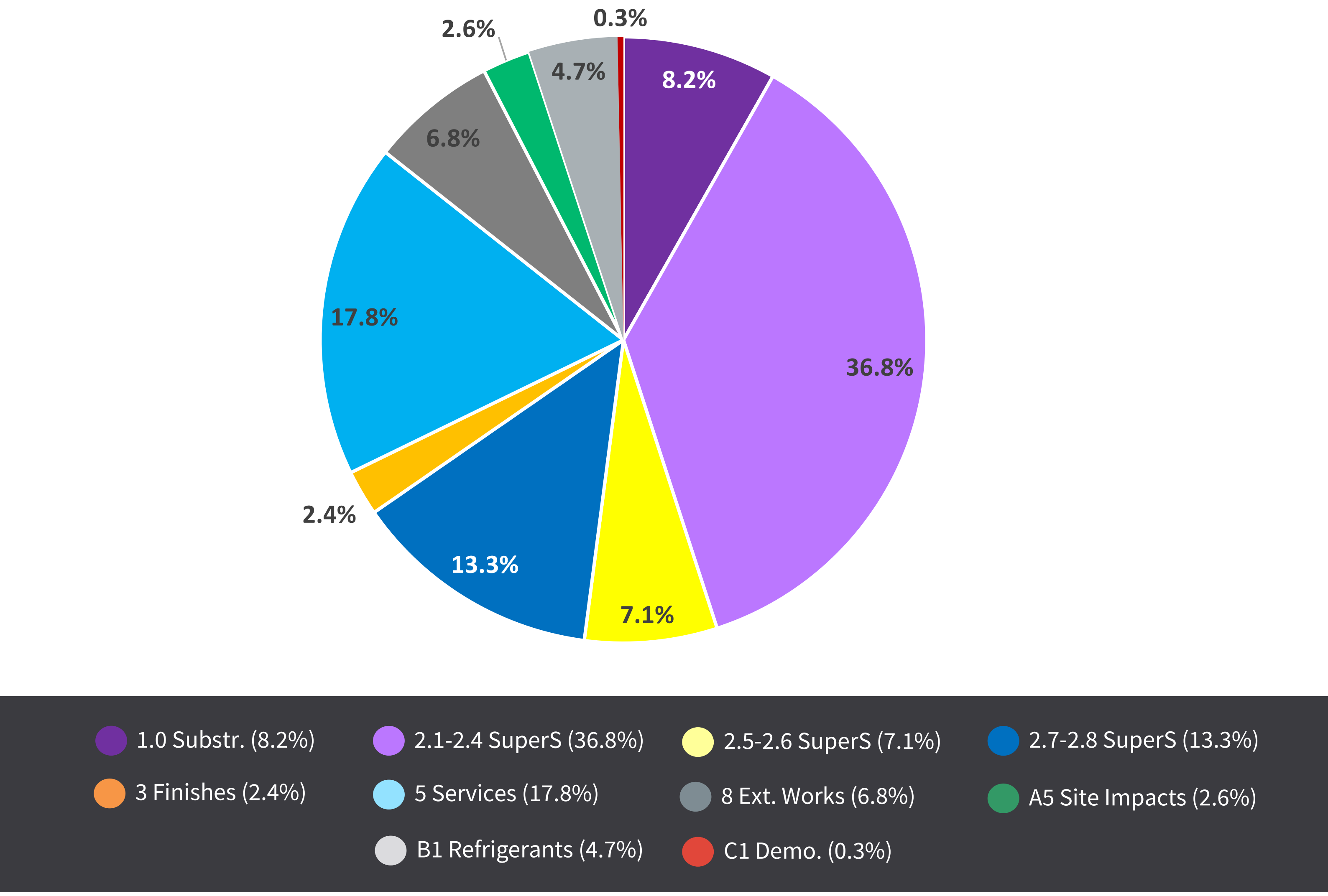
1,087

$kgCO_2e/m^2$ GIA



EN 15978 Modules	Impact ($kgCO_2e$/60 years)	Intensity ($kgCO_2e/m^2$ GIA)	WLC Proportion (%)
A1-A5	5,789,778	704	**65%**
B1-B5	2,894,542	352	**32%**
C1-C4	253,572	31	**3%**





This model looks only at whole life embodied carbon (i.e. modules A-C excluding B6 and B7), as the embodied performance of West London Film Studio is the area of particular focus within this report. At this level it is easier to see the significant impact of the structural elements, those items captured in '1.0 – Substructure' (8.2% or 733 tCO_2e/60 years A-C), '2.1-2.4 – Superstructure' (36.8% or 3,289 tCO_2e/60 years A-C) and '2.5-2.6 – Superstructure' (7.1% or 631 tCO_2e/60 years A-C); together these structural elements make up over 50% of the total WLC impact for West London Film Studio.

It is interesting in particular to see the significant impact Services (17.8% or 1,595 tCO_2e/60 years A-C) at the whole-life-embodied level. The impact here is dominated by Mechanical, Electrical and Plumbing Equipment in the current design, but is also exacerbated by the shorter life cycle replacement periods (30 years in average) to structural items (as building). Services are also more impactful at this whole-life level compared to the embodied distribution shown in the A1-A5 (i.e. capital embodied carbon to practical completion) graphs below, again related to the significance of material replacement over the West London Film Studio RSP for these particular elements.

Embodied Carbon A1-A5

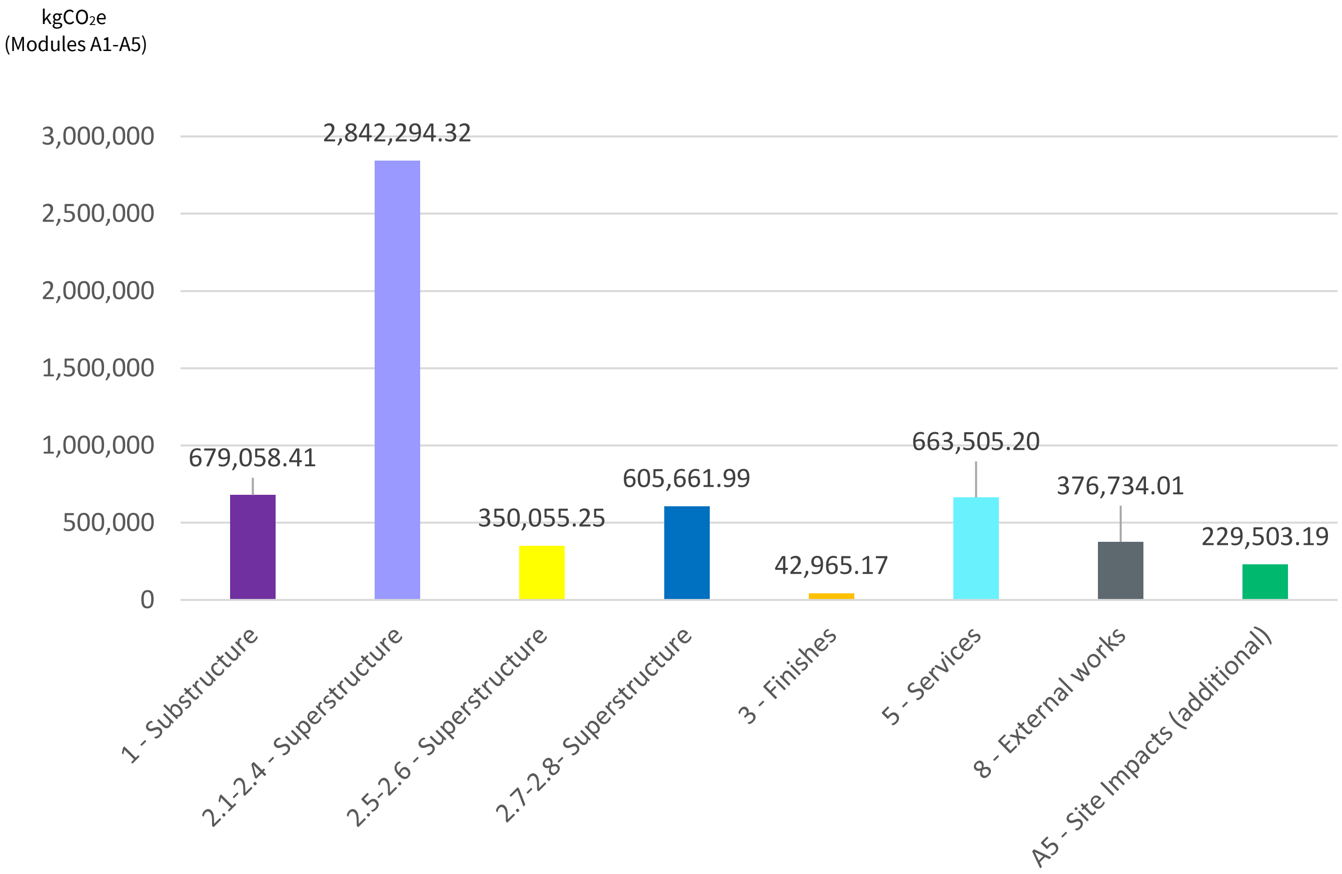
5,790

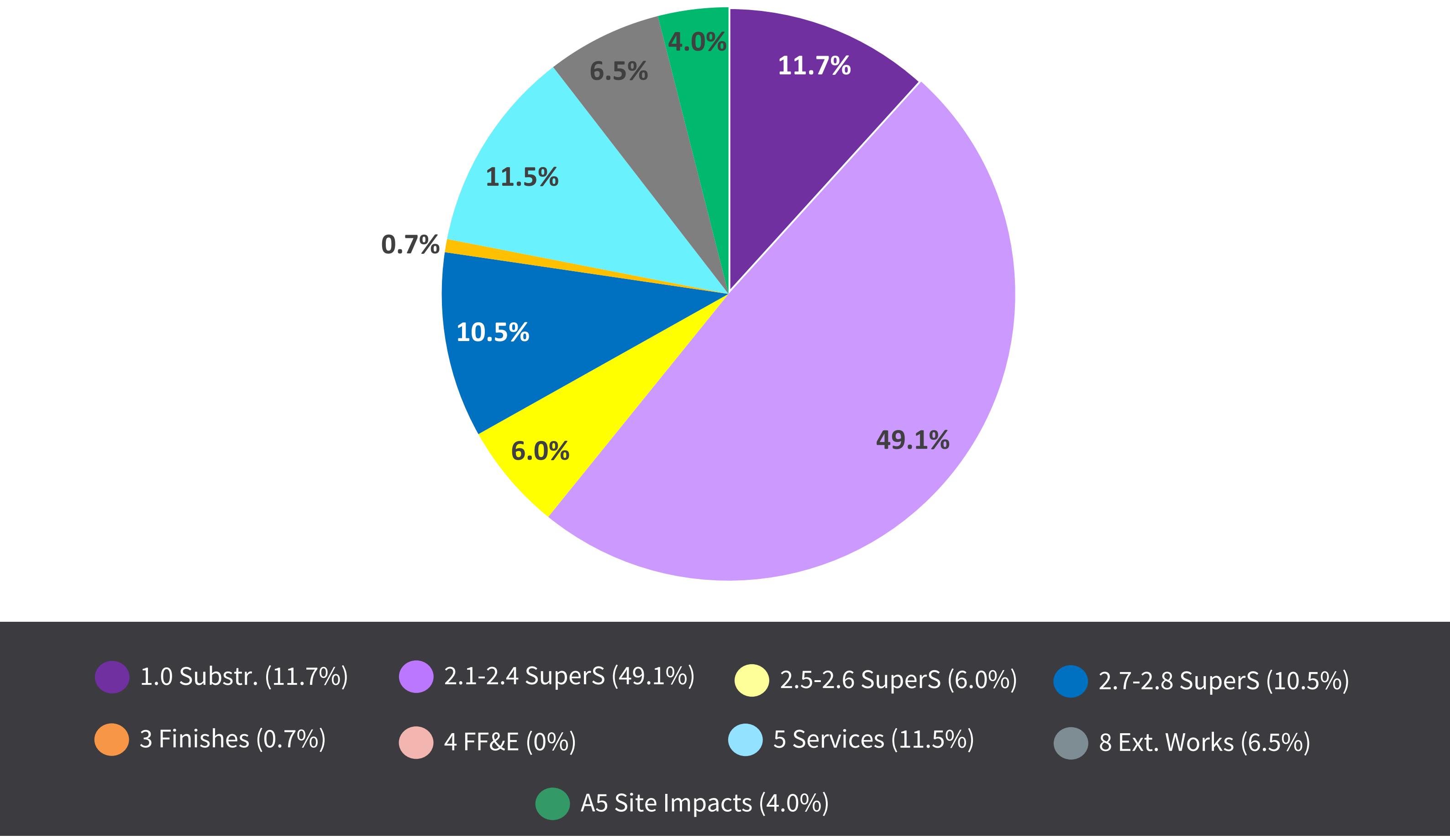
tCO_2e/60 years

704

$kgCO_2e/m^2$ GIA

EN 15978 Modules	Impact ($kgCO_2e$/60 years)	Intensity ($kgCO_2e/m^2$ GIA)	WLC Proportion (%)
A1-A5	5,789,778	704	**10%**





This section looks at capital embodied carbon only (Modules A1-A5, embodied carbon to practical completion of West London Film Studio).

At this level, which excludes not only the operational carbon (B6 & B7) but also the embodied carbon over the development life cycle (Module B) and end of life (Module C), it is interesting to see how the proportional impact of embodied carbon within the different building elements changes. Those elements which see the majority of their embodied impacts prior to practical completion now dominate the embodied impact of West London Film Studio; the substructure (1.0) and the superstructure (2.1-2.8) now make up 67% of the total capital impact of West London Film Studio, compared to 62% when looking at A-C. Other elements, particularly finishes and building services, are diminished in their proportionality compared to the A-C model, further supporting the fact that their life cycle replacements constitute the majority of their impact.

6.2 - Initial Results Discussion

6.2.1 – Industry Benchmarking

This section looks to investigate the baseline embodied carbon results presented in Section 6.1 and analyse these from a regulatory and industry benchmarking context. From previous project experience the total embodied carbon (1,087 $kgCO_2e/m^2$ GIA or 1,077 $kgCO_2e/m^2$ GIA incl. sequestration) of West London Film Studio is in line with current 'business-as-usual' results found in the industry. Standard values for baseline embodied carbon tend to range from 800 – 1200$kgCO_2e/m^2$ GIA depending on the size and materiality of the building. The results are therefore typical for West London Film Studio when put against this range. However, it should be noted that benchmark values are provided for specific building types which do not fully apply to this design, hence direct comparisons are difficult to draw. Nevertheless, despite the nature of the development, the overall carbon impact of the building's construction is line with standard industry practice.

A number of industry benchmarks currently exist that look to set targets for embodied carbon in terms of intensity ($kgCO_2e/m^2$ GIA). Foremost amongst these are the London Energy Transformation Initiative (LETI) and the UK Green Building Council (UKGBC). Before comparing the results of West London Film Studio with these benchmarks two key clarifications need to be made:

- Benchmarks are based on either residential or commercial buildings. Commercial benchmarks have been used to compared to the West London Film Studio results, however it is acknowledged that the different use type makes this comparison difficult.
- Embodied carbon benchmarks use either upfront carbon (modules A1-A5) or whole life embodied carbon (modules A-C excl. B6 and B7). Ensuring equivalent benchmarks/results is vital for comparison.

Figure 6.1: graph to compare the A-C (incl. sequestration) results with the equivalent LETI benchmark.

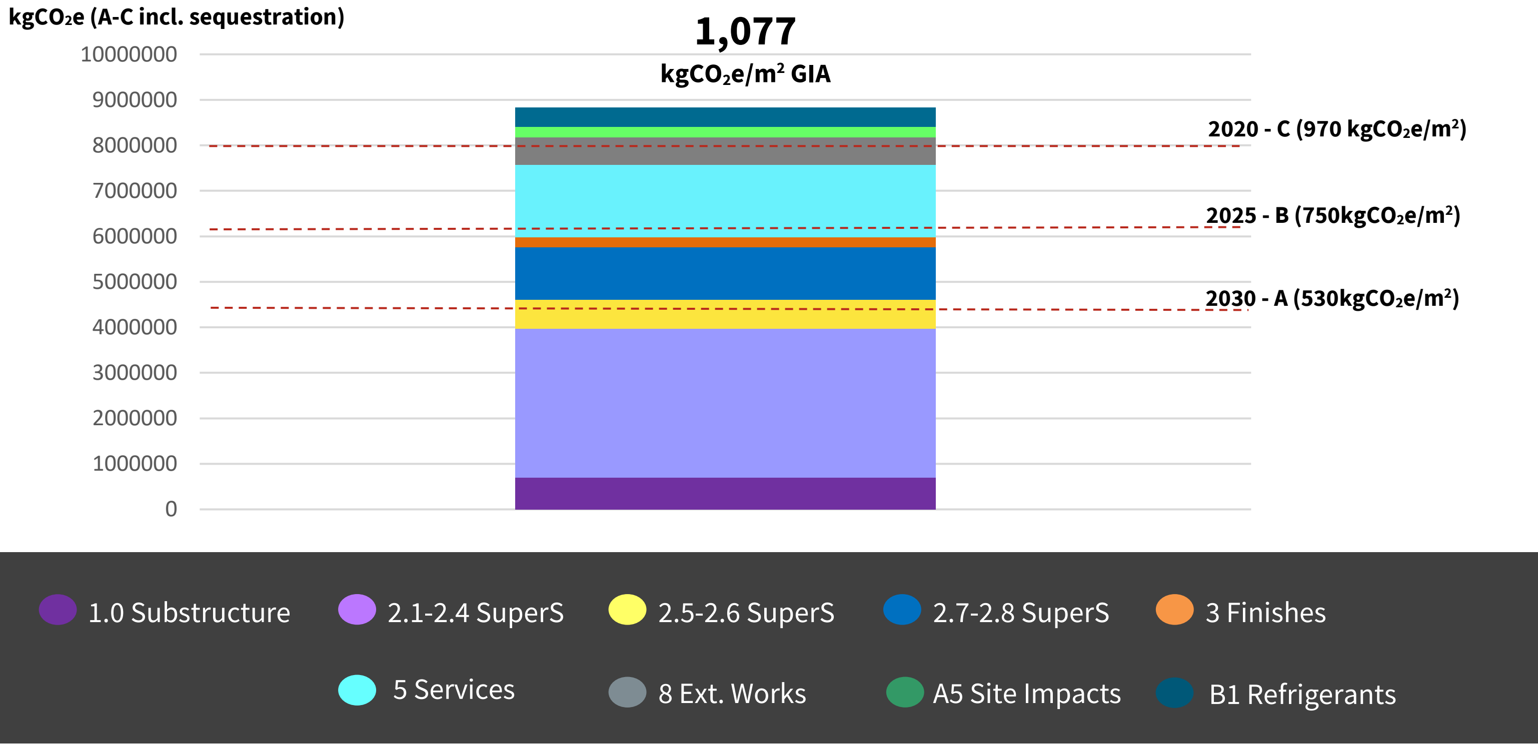


Figure 6.2: graph to compare LETI and UKGBC benchmarks for upfront embodied carbon

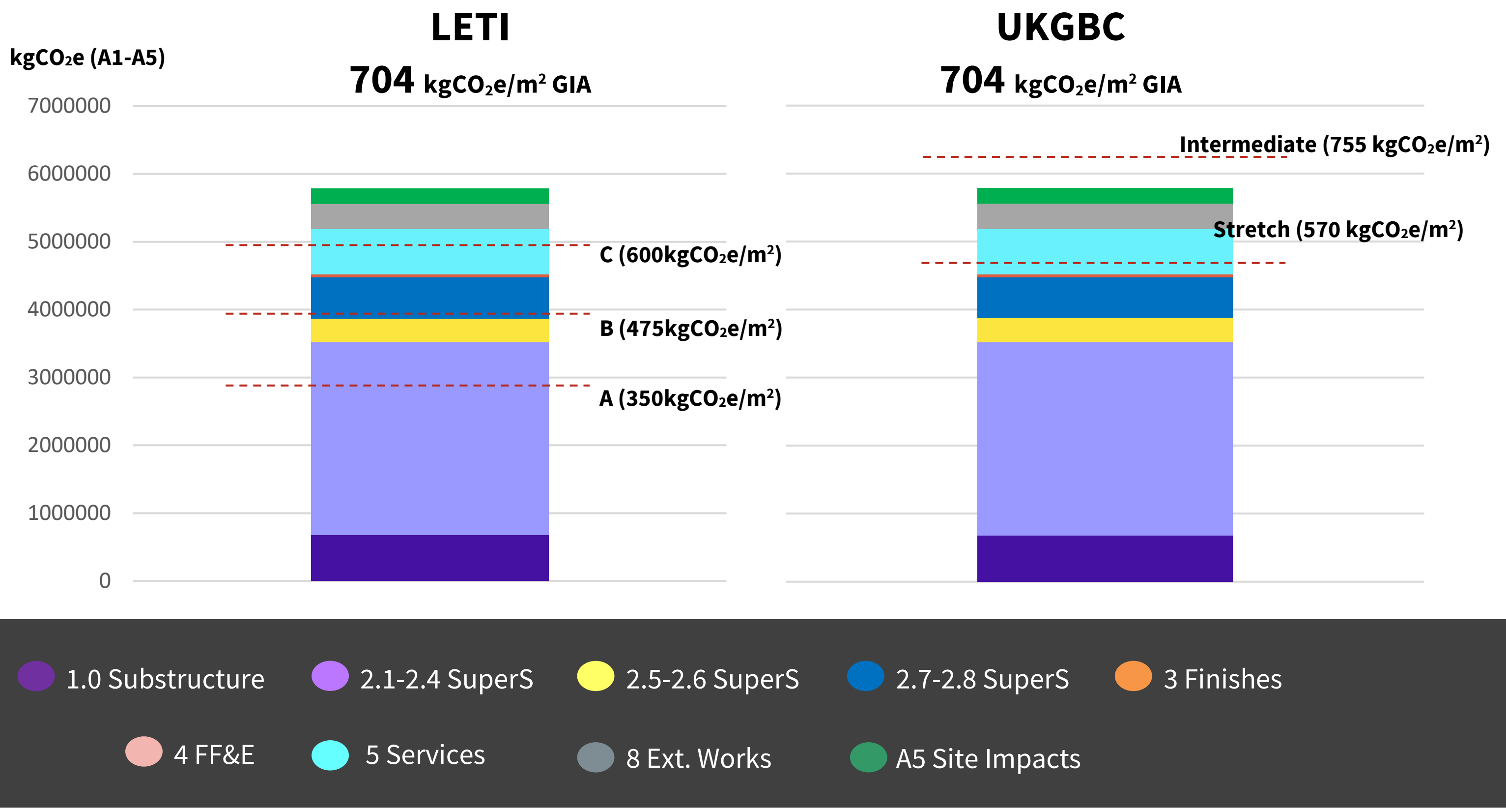


Figure 6.2 compares the A1-A5 results with the equivalent LETI and UKGBC benchmarks.

The benchmarks not only show where these organisations believe the industry should currently be in terms of embodied carbon performance but also indicates the reductions required to achieve future targets. From this benchmark analysis it can be see that West London Film Studio compares favourably to UKGBC targets while missing the LETI targets (for both A-C and A1-A5). The current LETI targets (for both assessment levels) can be seen as ambitious and are likely not to be achieved on a project without high levels of commitment to reduction of embodied carbon throughout the design process. As stated previously the result at West London Film Studio is typical for a building of its type, therefore, it is not surprising that without reduction measures considered the LETI target has not been achieved.

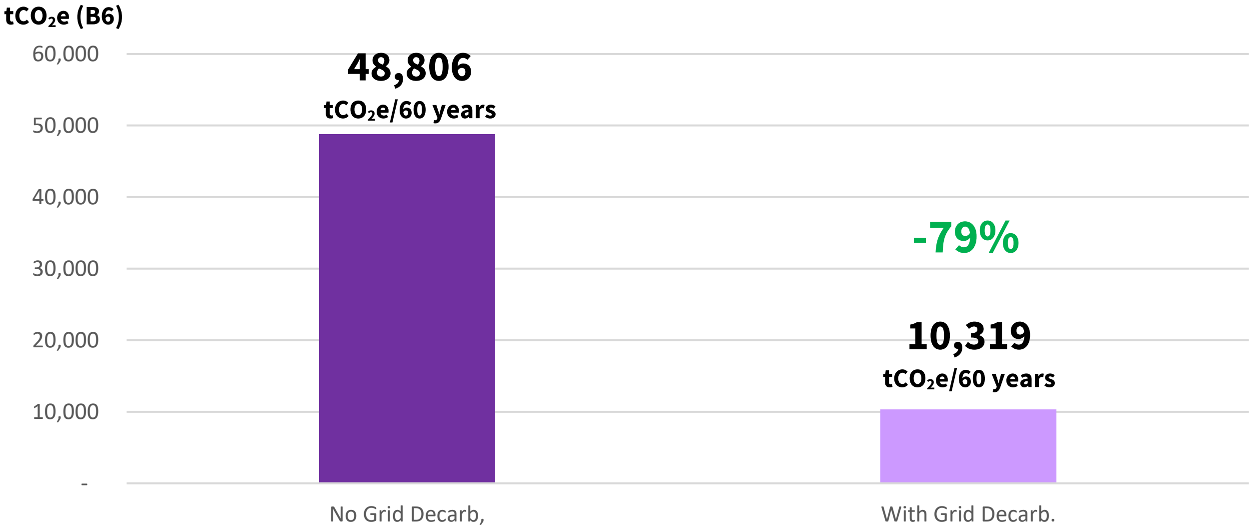
Policy and guidance in relation to embodied carbon is rapidly changing and the benchmarks shown are likely to be updated as the pathway to net zero carbon in the built environment becomes clearer. Publications such as the National Future Homes Standard should help to further clarify the roadmap and realise reductions in the range of 10-20%. As policy develops it is hoped that more detailed case studies on low carbon buildings will be published to aid developers to understand the steps required to achieve the targets.

6.2.2 – Grid Decarbonisation

In terms of the operational carbon emissions presented in this WLC report, there is anticipated to be a reduction in emissions over time due to grid decarbonisation. Decarbonisation of the electrical proportion of grid-supplied electricity as set out in Section 5.6 is assumed to occur as per the National Grid's Future Energy Scenarios 'slow progression' scenario, starting with the SAP 10 carbon factor of 0.233 $kgCO_2e/kWh$, and reducing to approximately 0.005 $kgCO_2e/kWh$ by 2050.

It is interesting to understand how the B6 operational carbon emissions compare with a base assumption of no decarbonisation (Appendix A results matrix), and then a second decarbonisation model (Appendix B Results Matrix) which accounts for grid decarbonisation to the electricity supply. This is shown in Figure 6.3 below. This demonstrated that the long term-decarbonisation results in a 79% reduction in operational carbon compared to the base model without decarbonisation applied.

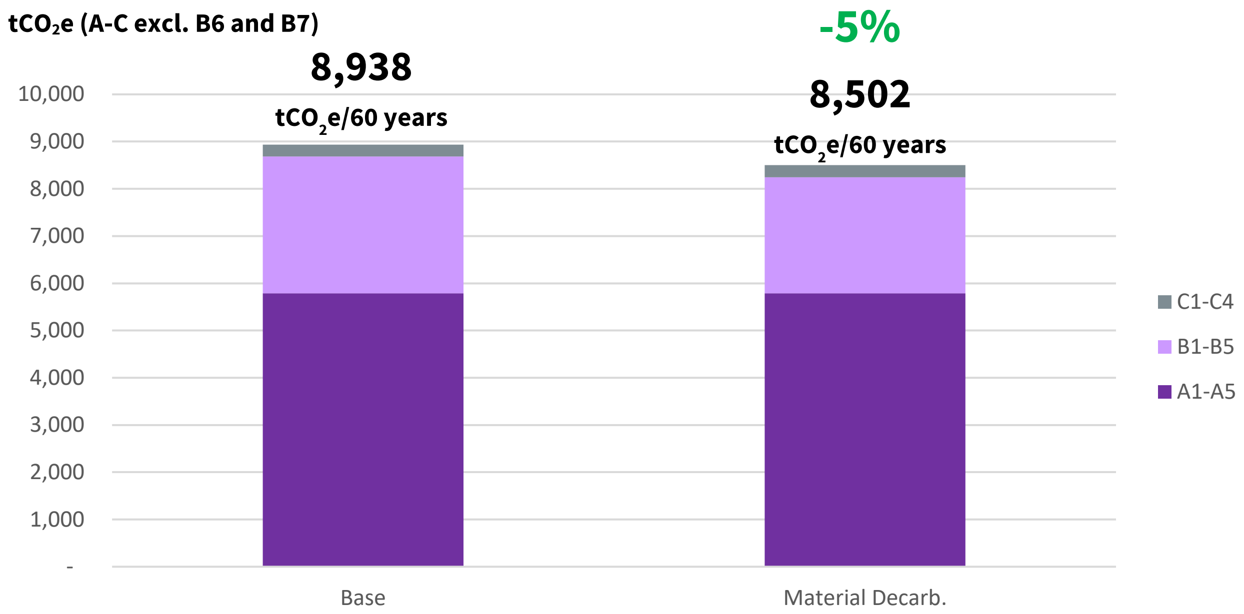
Figure 6.3: graph to compare the non-decarbonisation and decarbonisation operational carbon models for West London Film Studio, based on a 60-year RSP.



Grid decarbonisation will also have an effect on the embodied emissions resulting from the use stage of the building (Module B). As the materials used in refurbishment or replacement activities will be produced in the future changes to the manufacturing process should be accounted for. Therefore, it has been modelled that these processes will decarbonise as part of the transition to a low carbon economy.

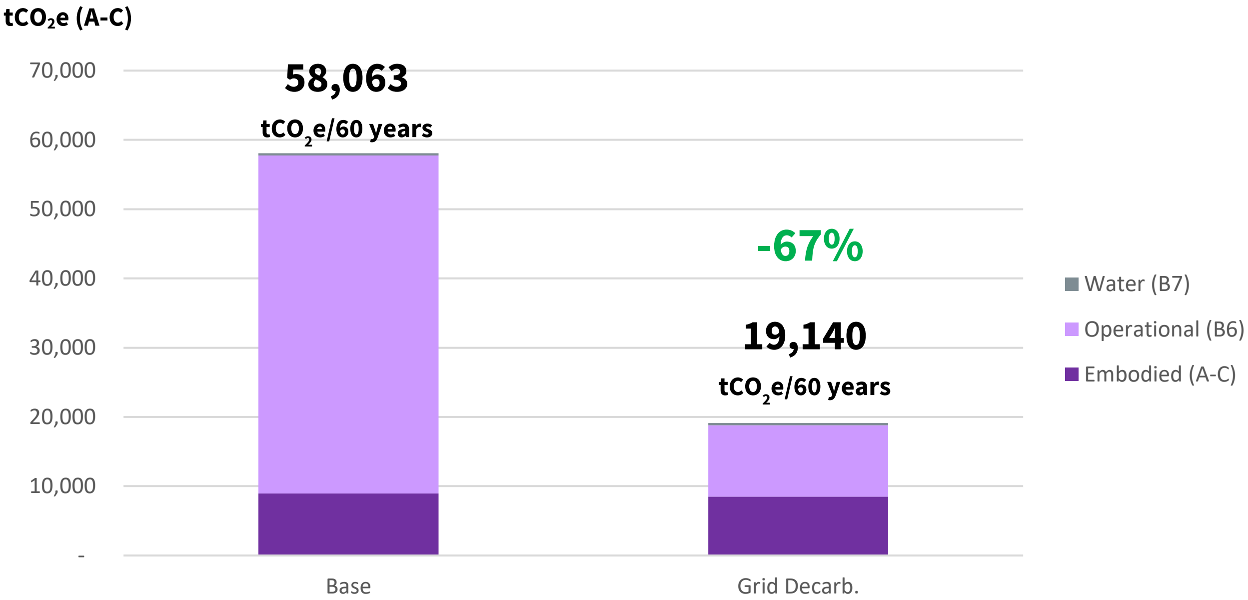
To do this the OneClick LCA methodology has been applied. This assumes that 20% of material impacts from life cycle modules B2-B5 (as well as module D) derive from electricity consumption. As with operational emissions the National Grid's Future Energy Scenarios 'slow progression' scenario is applied to these emissions. The reduction in whole life embodied carbon as a result of this decarbonisation is shown in Figure 6.4.

Figure 6.4: graph to compare the non-decarbonisation and decarbonisation embodied carbon models for West London Film Studio, based on a 60-year RSP.



Combining the grid decarbonisation impacts from both operational emissions and material replacement results in an overall decrease of X% compared to the base scenario, as shown in Figure 6.5.

Figure 6.5: graph to compare the non-decarbonisation and decarbonisation whole life carbon models for West London Film Studio, based on a 60-year RSP.



7 Conclusion

This report provides the RIBA 4 Whole Life Carbon analysis for the West London Film Studio development on behalf of Elbrook Cash & Carry. The report is constructed to accord with the methodological requirements and reporting of the RICS Professional Statement Whole life carbon analysis for the built environment (2017) publication, which is the methodology required to report against current industry benchmarks and targets. The WLC assessment covers the entire built asset and represents the design at RIBA 4, based on the current quantified materials information set out within the Elbrook Cash & Carry cost estimate and supporting Stage 4 design information from the project team. The reporting covers WLC emissions over the modelled Reference Study Period (RSP) of 60 years.

The report looks to establish a performance for West London Film Studio, developing an assessment for WLC for a building of the same size, shape, and materiality as West London Film Studio, but with no further carbon reduction measures applied. All modelling has been conducted in accordance with the requirements of the RICS Professional Statement, and the results have been reported via Appendix A and B of this report.

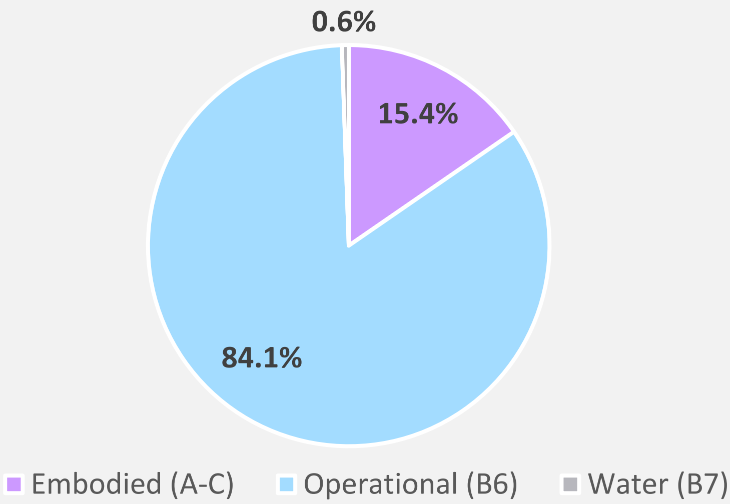
The whole life carbon results for West London Film Studio are as set out below.

58,063

tCO_2e/60 years

7,062

$kgCO_2e/m^2$ GIA



The embodied carbon results have also been analysed and compared to industry benchmarks to understand the project performance. From previous project experience the embodied carbon impact of West London Film Studio is in line with current results commercial buildings. Current industry benchmarks from LETI and UKGBC have been used for comparison but should be taken with care as do not fully apply to the building type. These show the project performance either on or greater than current targets. It acknowledged that the LETI targets are seen as ambitious and require dedication to carbon reduction throughout design whereas the West London Film Studio result represents a performance with no reduction measures taken.

Appendix A

Baseline Building Results Matrix

FULL BUILDING - BASELINE

**Decarbonisation applicable – report decarbonised values alongside non-decarbonised ones*	Global Warming Potential GWP ($kgCO_2e$)																			
		Product Stage			Construction Process Stage		Use Stage							End of Life Stage				TOTAL (A-C)	TOTAL Normal. (A-C) $kgCO_2e/m^2$ GIA	Beyond System
	Biogenic Carbon	A					B							C						D
Building Element Category		A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4			
Demolition [0.1,0.2]														0	0	0	0	**0**	**0**	0
Facilitating Works [0.3, 0.4, 0.5, 0.6]	0	0			0	0	0			0					0	0	0	**0**	**0**	0
Substructure [1]	36312	492158			164990	21910	0			0					16056	38299	0	**733413**	**89**	-343984
Superstructure [2.1, 2.2, 2.3, 2.4]	13886	2666243			64288	111763	0			363001					40272	43049	268	**3288884**	**400**	-2473011
Superstructure [2.5, 2.6]	0	317504			4208	28343	0			274749					3618	2510	175	**631107**	**77**	-215405
Superstructure [2.7, 2.8]	26930	545534			7385	52743	0			545534					9465	27416	654	**1188731**	**145**	-144533
Finishes [3]	592	37333			556	5076	0			158894					373	14513	2	**216747**	**26**	-79782
FF&E [4]	0	0			0	0	0			0					0	0	0	**0**	**0**	0
Services (MEP) & Op. [5]	3452	629844			26341	7320	422000			913233		48805736	319640		7847	10134	122	**51142217**	**6220**	-904409
Prefabricated Buildings [6]																			**0**	
Work to Existing [7]																			**0**	
External Works [8]	0	225117			148215	3402	0			217131					7139	3706	0	**604709**	**74**	-95450
Additions/Early Assumptions A5, C1 etc.	0	0			0	229503	0			0				27955				**257458**	**31**	0
TOTAL	**81173**	**4,913,733**			**415,984**	**460,060**	**422,000**			**2,472,542**		**48,805,736**	**319,640**	**27,955**	**84,768**	**139,627**	**1,222**	**58,063,267**		**-4256574**
TOTAL (Normalised) $kgCO_2e/m^2$ GIA	**10**	**598**			**51**	**56**	**51**			**301**		**5936**	**39**	**3**	**10**	**17**	**0**		**7062**	**-518**

: minimum calculation requirements for a Whole Life Carbon study

8222 : Building GIA used for study

Appendix B

Baseline Building Results Matrix (with grid decarb.)

FULL BUILDING - BASELINE (WITH GRID DECARBONISATION APPLIED TO Module B and D)

*Decarbonisation applicable – report decarbonised values alongside non-decarbonised ones	Global Warming Potential GWP ($kgCO_2e$)																			
	Product Stage				Construction Process Stage		Use Stage							End of Life Stage				TOTAL (A-C)	TOTAL Normal. (A-C) $kgCO_2e/m^2$ GIA	Beyond System
	Biogenic Carbon	A					B							C						D
Building Element Category		A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4			
Demolition [0.1,0.2]														0	0	0	0	**0**	**0**	0
Facilitating Works [0.3, 0.4, 0.5, 0.6]	0	0			0	0	0			0					0	0	0	**0**	**0**	0
Substructure [1]	36312	492158			164990	21910	0			0					16056	38299	0	**733413**	**89**	-285269
Superstructure [2.1, 2.2, 2.3, 2.4]	13886	2666243			64288	111763	0			298700					40272	43049	268	**3224583**	**392**	-2045414
Superstructure [2.5, 2.6]	0	317504			4208	28343	0			225565					3618	2510	175	**581923**	**71**	-177929
Superstructure [2.7, 2.8]	26930	545534			7385	52743	0			447875					9465	27416	654	**1091072**	**133**	-119819
Finishes [3]	592	37333			556	5076	0			132108					373	14513	2	**189961**	**23**	-66393
FF&E [4]	0	0			0	0	0			0					0	0	0	**0**	**0**	0
Services (MEP) & Op. [5]	3452	629844			26341	7320	422000			753494		10319016	319640		7847	10134	122	**12495758**	**1520**	-744112
Prefabricated Buildings [6]																			**0**	
Work to Existing [7]																			**0**	
External Works [8]	0	225117			148215	3402	0			178450					7139	3706	0	**566029**	**69**	-78936
Additions/Early Assumptions A5, C1 etc.	0	0			0	229503	0			0				27955				**257458**	**31**	0
TOTAL	**81173**	**4,913,733**			**415,984**	**460,060**	**422,000**			**2,036,192**		**10,319,016**	**319,640**	**27,955**	**84,768**	**139,627**	**1,222**	**19,140,197**		**-3517872**
TOTAL (Normalised) $kgCO_2e/m^2$ GIA	**10**	**598**			**51**	**56**	**51**			**248**		**1255**	**39**	**3**	**10**	**17**	**0**		**2328**	**-428**

: minimum calculation requirements for a Whole Life Carbon study

8222 : Building GIA used for study