CUNDALL

301 St Vincent Street

Stage 2 Whole Life Embodied Carbon Assessment Report

OCIM Limited

Job No:	1039797
Doc ref:	SVS-CDL-XX-XX-T-SY-70221
Revision:	P02
Revision date:	08 February 2024

Project title	301 St Vincent Street	Job number
Report title	Stage 2 Whole Life Embodied Carbon Assessment Report	1039797

Document revision history

Revision ref	Issue date	Purpose of issue / description of revision
P01	08 February 2024	Issue for comment (Stage 2)
P02	08 March 2024	Updated Client Name

Document validation (latest issue)

08/03/2024

X Fergus Sweeney

Principal author

Signed by: Fergus Sweeney

X [redacted]

Checked by

Signed by: Mar Morales, Alejandro

08/03/2024

X [redacted]

Verified by

Signed by: Kavita Kumari

© Cundall Johnston & Partners LLP ("Cundall") owns the copyright in this report and it has been written for the sole and confidential use of OCIM Limited. It must not be reproduced in whole or in part or relied upon by any third party for any use whatsoever without the express written authorisation of Cundall. If any third party whatsoever comes into possession of this report, they rely on it at their own risk and Cundall accepts no duty or responsibility (including in negligence) to any such third party.

Executive Summary

A Whole Life Embodied Carbon Assessment has been carried out for the proposed 301 St Vincent Street development in Glasgow, Scotland. Primarily, the report seeks to assess the current carbon footprint position against the client's aspirations and current industry benchmarks for the project's planning application submissions and the client's knowledge.

The assessment was carried out according to the recent British Standard BS EN15978:2011 (Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method), and the RICS Professional Statement 'Whole life carbon assessment for the built environment 2017'.

Embodied Carbon Target

OCIM Limited undertook an initial workshop with Cundall to develop embodied carbon targets for this stage of the project design. The targets that were determined included a requirement of achieving an upfront embodied carbon of less than 400kgCO2e/m^2, and a whole life embodied carbon of less than 650kgCO2e/m^2. Aspirations for bettering these requirements were also determined, with aspirations of an upfront embodied carbon of less than 350kgCO2e/m^2, and a whole life embodied carbon of less than 550kgCO2e/m^2.

At this stage of the assessment, the scope of the calculation includes a building refurbishment, strip-out and replacement of the façade, strip-out and replacement of building services and a CAT A fitout. Once more design information is available at the later stages of the project, the calculations will include the emissions associated with a CAT B fitout. CAT B emissions are not included within the scope that will be compared against the targets above or with the RIBA and LETI industry benchmarks; however, it is still best practice to account for these emissions at the later design stages to strive for the lowest carbon design possible.

The current targets set have been used to help drive the design at this stage and to inform the assessment carried out in the development of this report. However, the targets should be revised through a subsequent workshop between Cundall and Osbourne + Co to determine appropriate targets for the following design stages that strive to maximise the client's ambitions with regards to low carbon design.

Embodied Carbon Summary

The total representative embodied carbon emissions of 301 St Vincent Street development for both Upfront Embodied Carbon (excluding sequestration) and Whole Life Embodied Carbon (including sequestration) over a period of 60 years are shown in the table below. This is based on the latest design information received. These results show the project would benefit from upfront embodied carbon reductions to achieve a more successful whole life embodied carbon outcome.

At this stage of the assessment, the scope of the calculation includes a building refurbishment, strip-out and replacement of the façade, strip-out and replacement of building services and a CAT A fitout. Once more design information is available at the later stages of the project, the calculations will include the emissions associated with a CAT B fitout.

301 St Vincent Street Carbon Emissions	Upfront Embodied Carbon (A1-A5)	Whole Life Embodied Carbon (A-C)
Tonnes CO_2e	11,122	24,952
kgCO_2e/m^2 (GIA)	256	573
Cundall's Suggested Requirement (kgCO_2e/m^2 (GIA))	**<400**	**<650**
Cundall's Suggested Aspiration (kgCO_2e/m^2 (GIA))	**<350**	**<550**

Embodied Carbon Summary (current design)

The development's Whole Life Embodied Carbon is the equivalent to:

Embodied Carbon Equivalent

Carbon Hotspots

The new Raised Access Floor (RAF), the replacement of the existing curtain walling system and new building services systems are found to be the largest contributors to the embodied carbon of the project.

To minimise the embodied carbon impact of the RAF, a reused or reclaimed RAF should be considered if available. Alternatively, a new low carbon RAF could be used in the redesign, such as a calcium sulphate product from Lindner group or equivalent.

To help determine the potential carbon savings associated with the curtain wall replacement, two preliminary façade studies were carried out at the early stages of the design. This involved assessing the potential carbon savings by retaining elements of the existing façade, using recycled aluminium, and varying the ratio of glazing to solid across the façade.

The MEP design consisted of various materials, most of which are carbon-intensive by nature, such as refrigerant liquids. Furthermore, various replacement events are to be expected. At this stage, equipment and materials are yet to be specified and specific suppliers have not been confirmed. As such, the results are high level at this stage, mainly considering current costs and initial analysis of the design. It is imperative that specifications of equipment and products can be collected at a subsequent design stage so an accurate representation can be produced.

Potential Reduction Opportunities

The assessment has identified a series of measures that could be applied to the redevelopment to reduce its carbon footprint. To achieve this, we recommend the following changes to the current design be considered:

1. Prioritise the retention or reuse of existing materials over the addition of new products.
2. Consider material carbon footprint data during procurement.
3. Local sourcing of materials, for example: concrete – less than 15km.
4. High cement replacement for concrete used in the superstructure – up to 50% GGBS.
5. Consider the use of reclaimed structural steel for the frames (EMR, Cleveland Steel).Consider the use of highly recycled steel (Electric Arc Furnace) for concrete reinforcement.
6. Consider the use of highly recycled aluminium for curtain wall framing elements – WICONA or equivalent.
7. Consider the use of highly recycled aluminium for façade panels – WICONA or equivalent.
8. Maxime the reuse of furniture, fittings and equipment from the previous building or nearby projects.

9. Use timber studs with plasterboards that have high recycled content such as Fermacell, hemp board or Breathaboard.
10. Consider low-carbon paint, such as Graphenstone paint.
11. Consider a low carbon ceramic tile, offering cradle-to-cradle gold certified.
12. Consider clay-based plaster with very low embodied carbon and low energy manufacturing that is recyclable and reusable.
13. Consider the use of reclaimed Raised Access Flooring from a previous building, nearby projects, or specialized suppliers, i.e. RMF.
14. Ceiling finishes – consider the use of low carbon aluminium for new louvred screen to generator room – Hydro CIRCAL or equivalent.
15. National sourcing of MEP equipment and materials – less than 300km.

If the suggested options were followed, the overall reduction of the project's upfront carbon footprint would be 26%, reducing it to 176 $kgCO2e/m^2$, as well as a reduction in whole life embodied carbon of 29%, reducing to to 423 $kgCO2e/m^2$.

301 St Vincent Street Carbon Emissions - Potential	Upfront Embodied Carbon (A1-A5)	Whole Life Embodied Carbon (A-C)
tonnes CO_2e	7,775	18,676
$kgCO_2e/m^2$ (GIA)	179	429
Cundall's Suggested Requirement ($kgCO_2e/m^2$ (GIA))	**<400**	**<650**
Cundall's Suggested Aspiration ($kgCO_2e/m^2$ (GIA))	**<350**	**<550**

Embodied Carbon Summary (potential)

Next Steps

The options are applied retrospectively and demonstrate in theory how much embodied carbon could potentially be saved. The above are the most impactful suggestions to reduce the upfront and whole life embodied carbon of the project, we could investigate further into the feasibility of these opportunities with the design team and QS as well as investigate additional options to reduce the carbon levels on a more product-by-product level even further. Furthermore, if the Circular Economy Strategy is implemented a further reduction could be expected. Some of the KPIs outlined in the Stage 2 Circular Economy Strategy are likely to bring a reduction in embodied carbon. However, confirmation of circular economy strategies will be confirmed at a later stage.

Contents

1.0

Introduction

1.0 Introduction

Cundall have been commissioned by OCIM Limited to conduct a Whole Life Embodied Carbon Assessment (WLECA) of the proposed design of an office fit-out development, 301 St Vincent Street in Glasgow, Scotland. This report summarises the findings.

The assessment was carried out in accordance with the British Standard BS EN15978:2011 (Sustainability of construction works - Assessment of environmental performance of buildings - Calculation method), and the RICS Professional Statement 'Whole life carbon assessment for the built environment 2017'.

1.1 Embodied Carbon targets

Osbourne + Co are committed to integrating sustainability into their refurbishment projects by minimising the associated embodied carbon of their developments. Cundall have therefore worked with Osbourne + Co to develop targets for both upfront embodied carbon (A1-A5) and whole life embodied carbon (A1-A5, B1-B5, C1-C4).

As a result, the stage 2 design entailed the requirement of achieving an upfront embodied carbon of less than 400kgCO2e/m^2, and a whole life embodied carbon of less than 650kgCO2e/m^2, as shown in Table 1-11. They also set aspirations of bettering these requirements, with aspirations of an upfront embodied carbon of less than 350kgCO2e/m^2, and a whole life embodied carbon of less than 550kgCO2e/m^2.

At this stage of the assessment, the scope of the calculation includes a building refurbishment, strip-out and replacement of the façade, strip-out and replacement of building services and a CAT A fitout. Once more design information is available at the later stages of the project, the calculations will include the emissions associated with a CAT B fitout. CAT B emissions are not included within the scope that will be compared against the targets above or with the RIBA and LETI industry benchmarks. However, it is still best practice to account for these emissions at the later design stages to strive for the lowest carbon design possible.

The current targets set have been used to help drive the design at this stage and to inform the assessment carried out in the development of this report. However, the targets should be revised through a subsequent workshop between Cundall and Osbourne + Co to determine appropriate targets for the following design stages that strive to maximise the client's ambitions with regards to low carbon design.

Objectives	Indicator	Unit	Requirement	Aspiration	Industry Targets/	Responsible	Validation Evidence
Net Zero Carbon	**BREEAM Certification**	Rating	**Outstanding**	**-**	BREEAM	P: BREEAM Assessor (Cundall) S: Project team	Certification
Net Zero Carbon	**Upfront embodied carbon (A1-A5)**	kgCO2e/m² (GIA)	**<400**	**<350**	LETI, GLA	P: WLC specialist (Cundall) S: Design Team	WLC Report - design and as-built
Net Zero Carbon	**Whole Life Embodied Carbon (A1-5, B1-5, C1-4)**	kgCO2e/m² (GIA)	**<650**	**<550**	LETI, RIBA, GLA	P: WLC specialist (Cundall) S: Design Team	WLC Report - design and as-built

Table 1-11 Sustainability Key Performance Indicators for 301 St Vincent Street

1.2

1.2 Industry-wide Targets & Context

Industry-wide targets have been identified by the Royal Institute of British Architects (RIBA) and the London Energy Transformation Initiative (LETI). The industry bodies have set out a series of embodied carbon reduction targets towards whole life net zero. Targets for 2020 and 2030 have been defined for a commercial office which applies to the project, as shown in Figure 1-111.

It should be noted that the RIBA targets are performance targets to be realised in buildings completed in 2020, 2025 and 2030 (known as Built Targets), whereas the LETI targets relate to year of design (known as Design Targets). The RIBA targets also refer to life cycle stages A-C, whereas the LETI targets refer only to life cycle stages A1-A5.

Since LETI first released embodied carbon targets in 2020, LETI has been consulting with industry groups, including CIBSE, RIBA, IStructE, the GLA and the Whole Life Carbon Network to align definitions, scopes, measurement methodologies and targets.

Upfront Embodied Carbon, A1-5 (exc. sequestration)

	Band	Office	Residential (6+ storeys)	Education	Retail
	A++	<100	<100	<100	<100
	A+	<225	<200	<200	<200
LETI 2030 Design Target	A	<350	<300	<300	<300
	B	<475	<400	<400	<425
LETI 2020 Design Target	C	<600	<500	<500	<550
	D	<775	<675	<625	<700
	E	<950	<850	<750	<850
	F	<1100	<1000	<875	<1000
	G	<1300	<1200	<1100	<1200

Life Cycle Embodied Carbon, A1-5, B1-5, C1-4

	Band	Office	Residential (6+ storeys)	Education	Retail
	A++	<150	<150	<125	<125
	A+	<345	<300	<260	<250
	A	<530	<450	<400	<380
RIBA 2030 Build Target	B	<750	<625	<540	<535
	C	<970	<800	<675	<690
	D	<1180	<1000	<835	<870
	E	<1400	<1200	<1000	<1050
	F	<1625	<1400	<1175	<1250
	G	<1900	<1600	<1350	<1450

Figure 1-111 LETI Rating System Bands

In May 2021, LETI released a suite of documents relating to defining and aligning whole life carbon and embodied carbon targets and introduced a letter banding rating system (Figure 1-111) to allow for quick comparison of ambition across various typologies and portfolios. Please find the weblink to the relevant documents here.

While the project's main aspiration is to meet the OCIM Limited targets (see section 1.1), benchmarking against broader industry schemes, such as the LETI Rating System helps identify progress against best practice at the same time. Therefore, the LETI Rating System bandings have been referred to throughout this assessment.

LETI states that current best-practice performance for projects in the design phase is considered to be a "C" rating, while a "B" and above is considered a robust stretch target. However, for refurbished office developments, considerations should be taken to achieve a Band "A" for both upfront and whole-life embodied carbon, which are in line with LETI 2030 design targets.

The purpose of this report is to focus on the actions required to minimise upfront embodied carbon and consider whole life cycle carbon in conjunction with whole life costing for the project.

1.3

1.3 NPF4 Alignment

The Scottish Government have just updated the main spatial planning policy for Scotland. NPF4 has a variety of policies that cover environmental aspects of any developments and there are two policies that relate to the whole embodied carbon assessment.

Figure 1-222 - Scottish Government NPF4 Policy

Policy 1: Tackle Climate and Nature Crisis

Policy Intent: To encourage, promote and facilitate development that minimises emissions and adapts to the current and future impacts of climate change.

The whole life embodied carbon assessment will help the project minimise its embodied carbon emissions over the full design life of the building. The report will also promote low carbon materials with a focus on biogenic materials. These reports and recommendations will help promote a low carbon design and satisfy the principles of a Just Transition.

Policy 2: Climate Mitigation and Adaption

Policy Intent:

a) Development proposals will be sited and designed to minimise lifecycle greenhouse gas emissions as far as possible.

b) Development proposals will be sited and designed to adapt to current and future risks from climate change.

c) Development proposals to retrofit measures to existing developments that reduce emissions or support adaptation to climate change will be supported.

This project aligns with this policy as we are set to reuse the existing building structure. The building is being future proofed by having a new envelope and building services installed. Both will be designed to accommodate the current and future climate. Furthermore, the assessment will look at strategies that will help minimise the embodied carbon emissions of the project.

1.4 Site and Building Description

301 St Vincent Street is situated in central Glasgow. It fills an entire city block and is between St Vincent Street, Boswell Street, and the M8 Motorway. The site sits on a steep slope between St Vincent St and Boswell St. The building was built in 1986 as the headquarters for Britoil. It is a concrete framed building with curtain walling and stone cladding. The building has 4 office levels above St Vincent Street with two additional levels that house both back of house space, office space and car parking. The building steps back at upper levels on the East and West ends to provide landscaped areas. There are also internal landscaped courtyard areas at level 1.

There are 3 circulation cores with stairs and lifts in each core. The cores also house the MEP equipment for the building above level 4. This includes the air handling equipment and centralised boilers.

The proposed development is to offer best-in-class grade A office refurbishment, providing up to 308,000 square feet of dynamic space designed to promote collaboration and inclusivity. Redevelopment proposals include the reconfiguration and repurposing of existing spaces to accommodate not only building users and visitors but also the broader community.

The proposal is to retain the building structure with minimal structural alterations. The façade is to be redeveloped and the building services replaced. Both require upgrading due to the age of the building and the shorter lifespan of these elements. The building is to remain as an office space but be generally upgraded to suit modern requirements.

The current plan is to set up an office fit-out with guidance on how to reduce embodied carbon through design and circular economy principles, with a brief design layout explained in Table 1-22 below.

Building Element	Brief Description
Superstructure	New steelwork including sub-frame to auditoria, secondary steelwork to facades, floor infill and to new roof structure. Composite floor slab to new floor infill and existing slab edge extension. New roof coverings, drainage, flashing detail to junctions and replacement soffit cladding.
Facade	New aluminium framed, double-glazed curtain walling with aluminium feature cladding panels and shading fins. New windows to the basement and Lower Ground Floor elevations. Combination of single and double leaf solid doors and roller shutter doors.
Internal walls	New plasterboard linings to inside face of aluminium sandwich panels with foil faced insulation. Addition of glazed partitions, fire shutters and a combination of single and double leaf solid doors.
Finishes	Wall paint, ceramic tiles, carpet tiles, vinyl tiles, skirting boards, and a new raised access floor.
Fixtures, fittings, and equipment	Amenities to main office spaces, amenity areas, reception, toilets and teapoints. Security speed gates at entrances.
Services	New WCs, showers, and sinks. Disposal installations, water installations, space heating and air treatment, electrical installations, and communication installations. Passenger lift, goods lift, and kitchen lift provision.
Landscaping	Paving and planting to courtyards, entrances, and external terraces.

Table 1-22: Building Description- 301 St Vincent Street

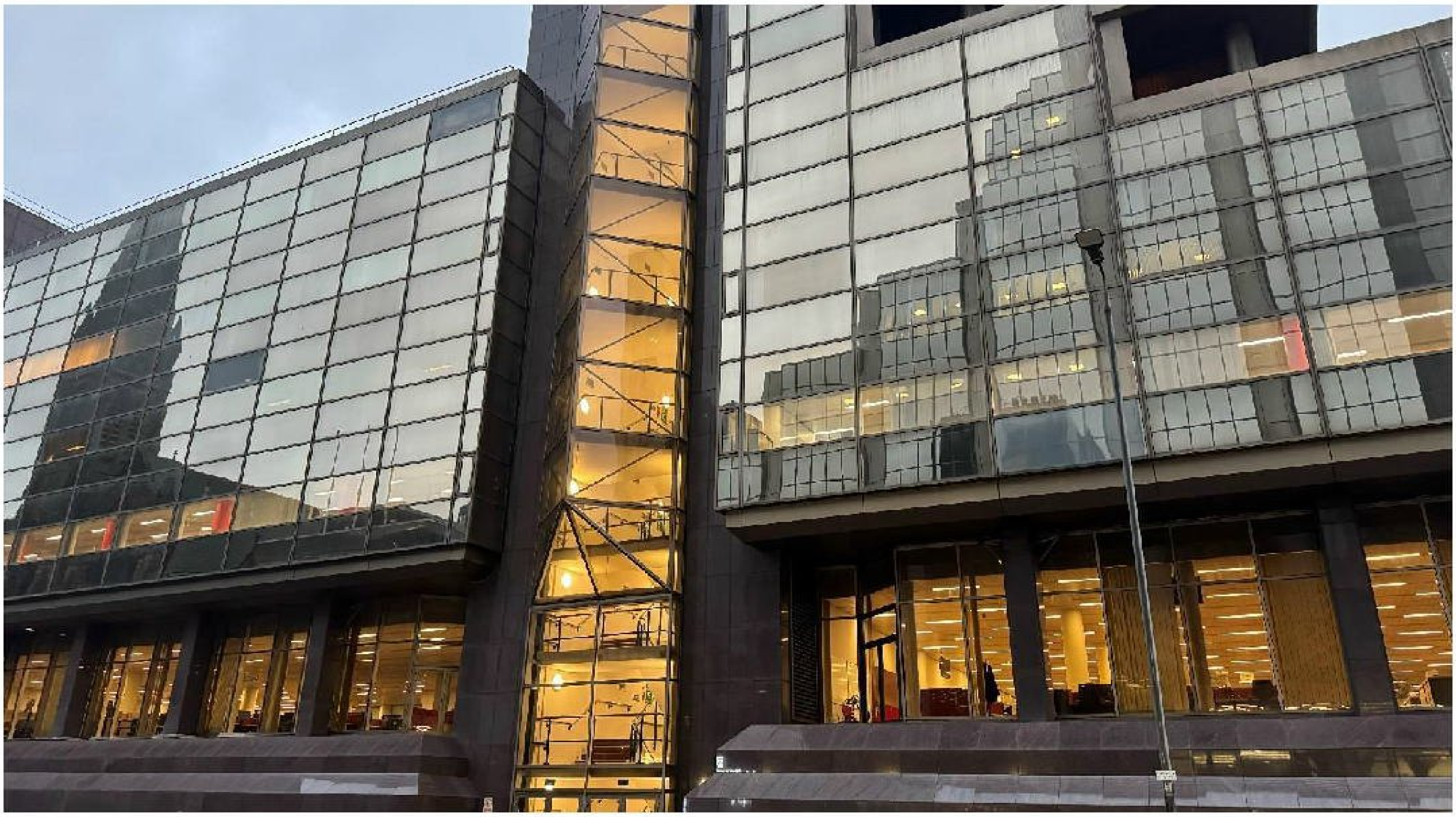

Figure 1-33: Existing Building 301 St Vincent Street

1.5 Study Background

Whole life-cycle carbon emissions are the total greenhouse gas emissions arising from development over its lifetime, from the emissions associated with raw material extraction, the manufacture and transport of building materials, to installation/construction, operation, maintenance, and eventual material disposal.

Operational carbon emissions will make up a declining proportion of a development's whole life carbon emissions as operational carbon targets become more stringent. To fully capture a development's carbon impact, a whole life-cycle approach is needed to capture its unregulated emissions (i.e., those associated with equipment), its embodied emissions (i.e. those associated with raw material extraction, manufacture and transport of building materials, and construction) and emissions associated with maintenance and eventual material disposal.

Calculating and reducing WLC emissions offers a wealth of benefits including:

- Ensuring that a significant source of emissions from the built environment is accounted for, which is necessary in achieving a net zero-carbon city.
- Achieving resource efficiency and cost savings by encouraging the re-use of existing materials instead of new materials and the retrofit and retention of existing structures and fabric over new construction.
- Identifying the carbon benefits of using recycled material and the benefits of designing for future reuse and recycling to reduce waste and support the circular economy.
- Identifying the impact of maintenance, repair, and replacement over a building's life cycle, which improves lifetime resource efficiency and reduces life-cycle costs, contributing to the future-proofing of asset value.
- Encouraging local sourcing of materials and short supply chains, with resulting carbon, social and economic benefits for the local economy.
- Encouraging durable construction and flexible design, both of which contribute to greater longevity, reduced obsolescence of buildings and avoiding carbon emissions associated with demolition and new construction.

1.6 Life-cycle modules

The WLEC assessment covered all modules A, B, C and D as set out in BS EN 15978 and the RICS Professional Statement: Whole Life Carbon assessment for the built environment (referred to as the RICS PS for the remainder of this document). in the life of a typical project described as life-cycle modules. The reference study period (i.e., the assumed building life expectancy) for the purposes of the assessment is 60 years.

To provide a holistic view of the GWP, the whole life carbon assessment accounts for all components relating to the project during all life stages. Embodied Carbon emissions are attributed to four main categories taken from BS EN 15978. The categories are:

- **Product Stages (modules A1 to A3):** The carbon emissions generated at this stage arise from extracting the raw materials from the ground, their transport to a point of manufacture and then the primary energy used (and the associated carbon impacts that arise) from transforming the raw materials into construction products.
- **Construction (modules A4 to A5):** These carbon impacts arise from transporting the construction products to the site, and their subsequent processing and assembly into the building.
- **In-Use Stages (modules B1 to B5):** This covers a wide range of sources from the embodied carbon emissions associated with the operation of the building, including the materials used during maintenance, replacement, and refurbishment. Module B6 and B7 refer to operational emissions and are not included in this assessment.
- **End of Life Stages (modules C1 to C4):** The eventual deconstruction and disposal of the existing building at the end of its life takes account of the on-site activities of the demolition contractors. No 'credit' is taken for any future carbon benefit associated with the reuse or recycling of a material into new products.
- **Benefits and loads beyond the system boundary (module D):** Any potential benefit from the reuse, recovery and recycling potential of a building or a building product. This module has been included within the assessment scope of this study but excluded in the final results.

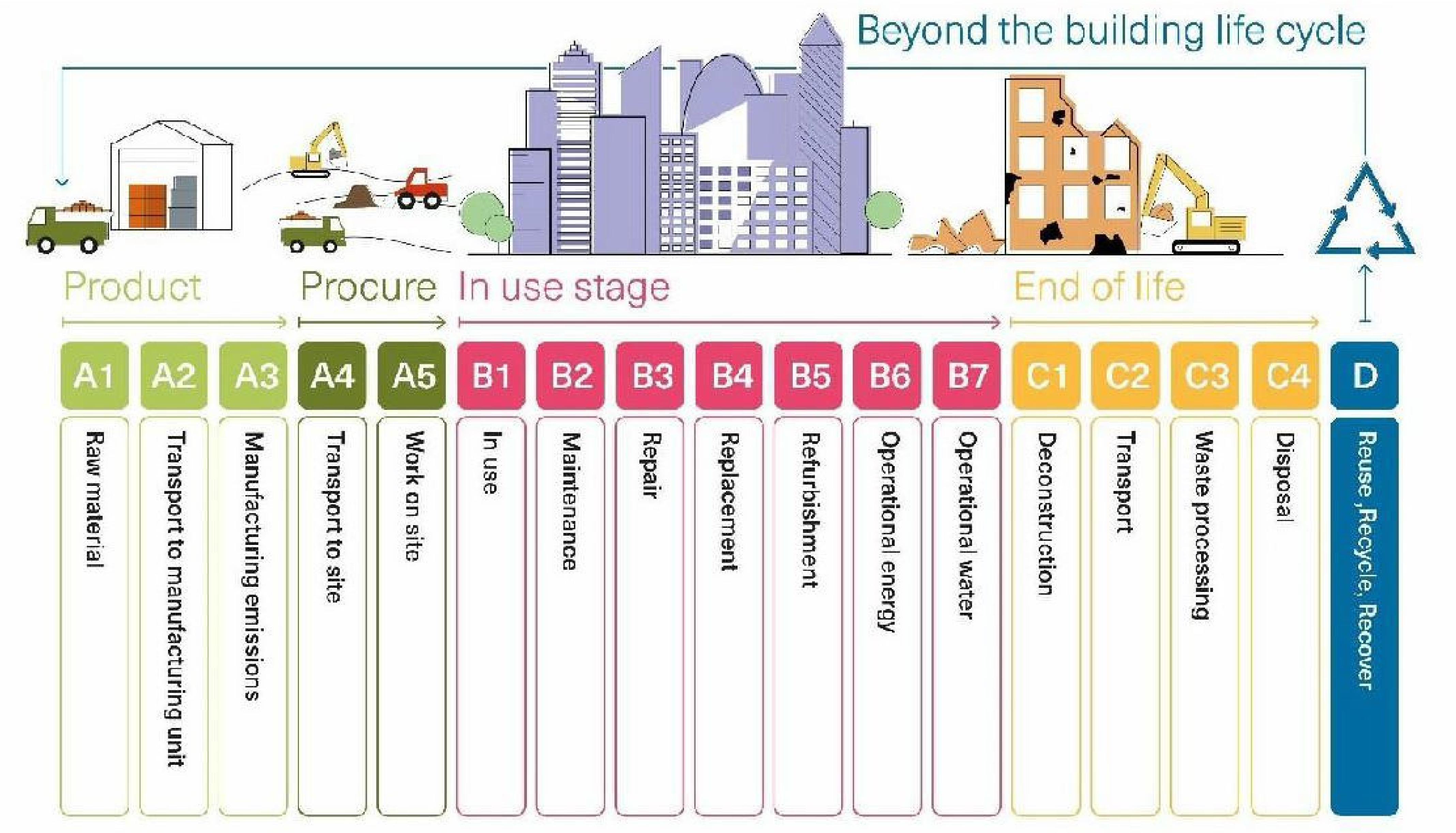

Figure 1-44: Life Cycle Modules as per BS EN 15978

1.7 Methodology

The assessment follows a nationally recognised assessment methodology, namely, BS EN 15978: 2011: (Sustainability of construction works — Assessment of environmental performance of buildings — Calculation method).

Underpinning BS EN 15978 is the RICS Professional Statement: Whole Life Carbon assessment for the built environment (RICS PS). The RICS PS serves as a guide to the practical implementation of the BS EN 15978 principles. It sets out technical details and calculation details and so was used as the methodology for the assessment.

This study covers the following,

- Upfront Embodied Carbon (A1-A5).
- Life cycle Embodied Carbon (B-C).
- Carbon reduction options.

1.8 Assessment Scope

The building components included in the assessment are illustrated in Figure 1-55Figure 1-5.

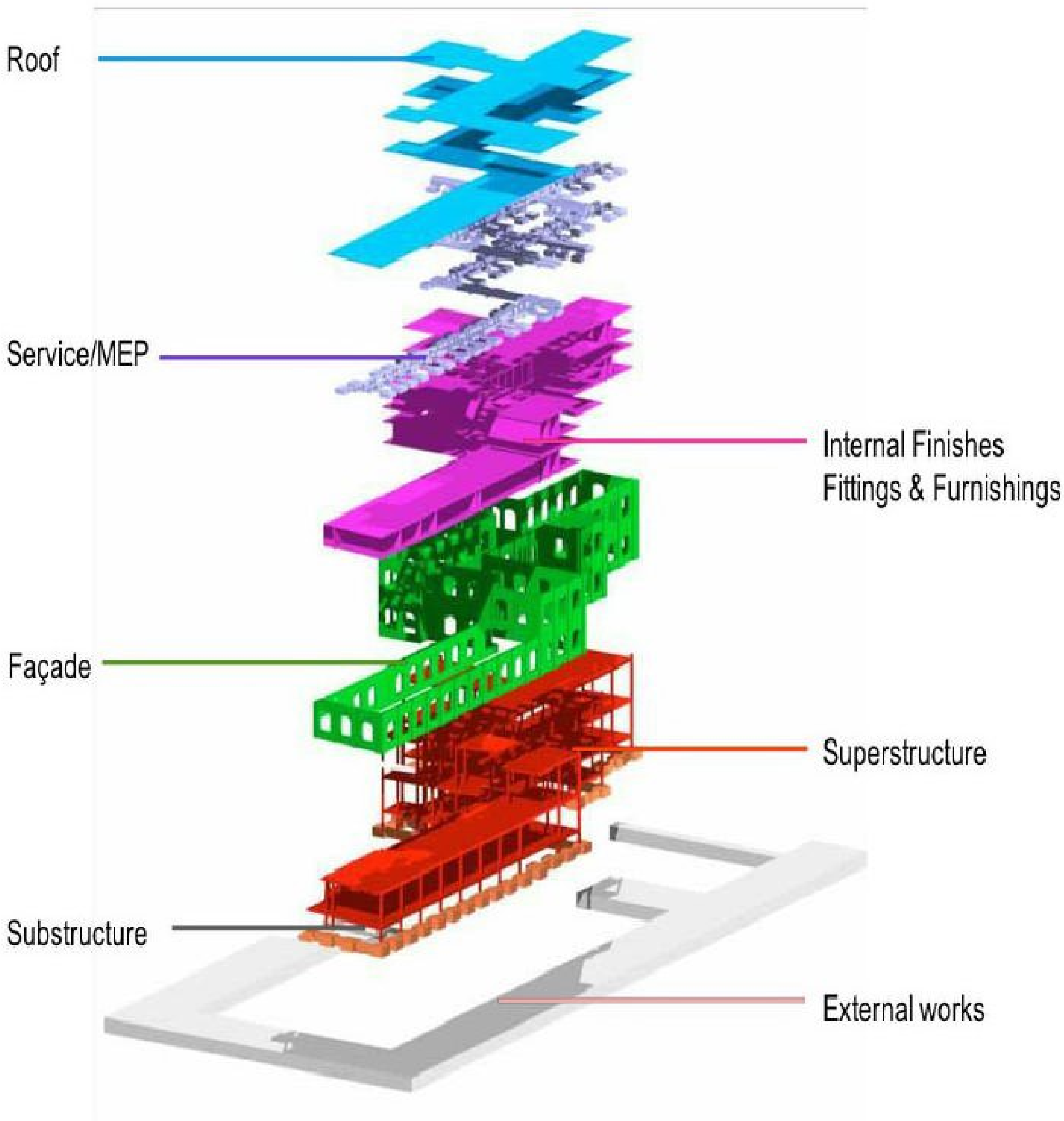

Figure 1-55: Indicative 3D Model of the scope of elements analysed for embodied carbon impact

To ensure alignment with Cundall's proposed targets, the assessment results are for all building elements including Substructure, Superstructure, Façade, Internal Finishes, and Building Services (MEP), External Works, Demolition and F, F&E.

1.9 Clarifications

The assessment is reflective of the expected level of detail and design information in concept design. Therefore, where appropriate, estimations and benchmarks have needed to be applied to ensure a complete assessment. These values will be superseded as more project specific information becomes available in developed design.

Estimations at this stage included:

- Fittings, furnishings, and equipment (FF&E): There was limited information available for FF&E, therefore a benchmark value was applied to uplift the quantification of the information provided in the cost plan.
- Building Services (MEP): Total cost estimates from the stage 2 cost plan have been used and inputted into the carbon tool to produce an estimate result of embodied carbon for the MEP services.
- At this stage of the assessment, the scope of the calculation includes a building refurbishment, strip-out and replacement of the façade, strip-out and replacement of building services and a CAT A fitout. Once more design information is available at the later stages of the project, the calculations will include the emissions associated with a CAT B fitout. CAT B emissions are not included within RIBA and LETI industry benchmarks, however it is still best to account for these emissions during a whole life embodied carbon assessment carried out at the later design stages.

1.10 Exclusions

In addition to the exclusions from the cost plan, additional information provided on stage 2 was excluded from the assessment as quantities or more data was needed, or impact was de minimis. Exclusions can be found in Table 1-33, where these can be considered as the design progresses.

Main Exclusions from assessment	
1.	Allowance for new entrance signage
2.	Allowance for replacement of existing fire curtains at cores
3.	Allowance for shower rail & curtains to DDA showers
4.	Allowance for internal signage
5.	Allowance for health suite changing rooms

Table 1-33: Exclusions made for the Whole Life Embodied Carbon Assessment

Materials that needed further information	
1.	Allowance for external canopy structures to external terraces *(more information is required)*
2.	Allowance for furniture to external terraces *(more information is required)*
3.	Allowance for furniture to courtyards *(more information is required)*
4.	Allowance for new toilet blocks on upper ground floor *(more information is required)*

Table 1-44: Materials that needed further information for the WLEC Assessment

1.11 Data sources

The main data sources used to input the whole life embodied carbon assessment have been provided by OCIM Limited, and the design team, to provide an accurate representation of the project's design. These are as follows:

- Project specific information: Main documentation, reports, and drawings specific to the project

Where information has otherwise not been provided or is unavailable, the assumptions taken from the RICS professional statement guidance were adopted. Please refer to Appendix A -for more information.

1.11.1 Project specific information

The project information (including Gross Internal Area, material quantities and specifications) used to inform this assessment has been gained from the following sources in Table 1-55. Discussions with the client have been held on assumptions and provide clarifications where possible.

Information	Consultant	Reference
Architectural	LOM	▪ WC provision study (301 SVS – WC provision) ▪ Pre-application design consultation (301 SVS – Design Update (Pre-app extract)) ▪ Stage 2 floor-to-floor heights (Floor heights _ Notes MB) ▪ Existing elevations and façade areas (Existing Façade Areas)
Building Services	Cundall MEP	▪ During the early design stages the embodied carbon factors for the building services have been based on the costs found in the Stage 2 cost estimates (Project Kelly High Level Cost Plan (28 Nov 2023))
Cost estimates	Thomas & Adamson	▪ During the early design stages the embodied carbon factors for the building services and other site works have been based on the costs found in the Stage 2 cost estimates (Project Kelly High Level Cost Plan (28 Nov 2023))
GIA (area) **44,640 m^2**	LOM	▪ Stage 2 area schedules provided by LOM (2088 – 301 SVS – Area schedules – GIA)

Table 1-55: Data Sources

2.0

Whole Life Embodied Carbon Assessment

2.0 Whole Life Embodied Carbon Assessment

2.1 Assessment Result

2.1.1 Overview

The total embodied carbon emissions for 301 St Vincent Street development for both Upfront Embodied Carbon (excluding sequestration) and Life Cycle Embodied Carbon (including sequestration) over a period of 60 years are shown in Table 2-11. This is based upon the design information received.

301 St Vincent Street Embodied Carbon Emissions	Upfront Embodied Carbon (Module A1-A5)	Carbon Sequestration (Module A1-A5)	Life Cycle Embodied Carbon (Module B to C excl. B6, B7)	Whole Life Embodied Carbon (Module A-C)	Benefits beyond boundary (Module D)
Tonnes CO_2e	11,122	-250	13,790	24,952	-132
$kgCO_2e/m^2$ GIA	256	-6	317	573	-3
Cundall Suggested Requirement	<400	-	--	<650	--

Table 2-11: Embodied Carbon Summary- excluding operational emissions.

2.1.2 Embodied Carbon Breakdown

Graphs below Figure 2-11 show the proportional contribution of the different building element groups to both the upfront and whole life embodied carbon of the development. Table 2-22 shows the embodied carbon breakdown by building element groups for the different life cycle modules.

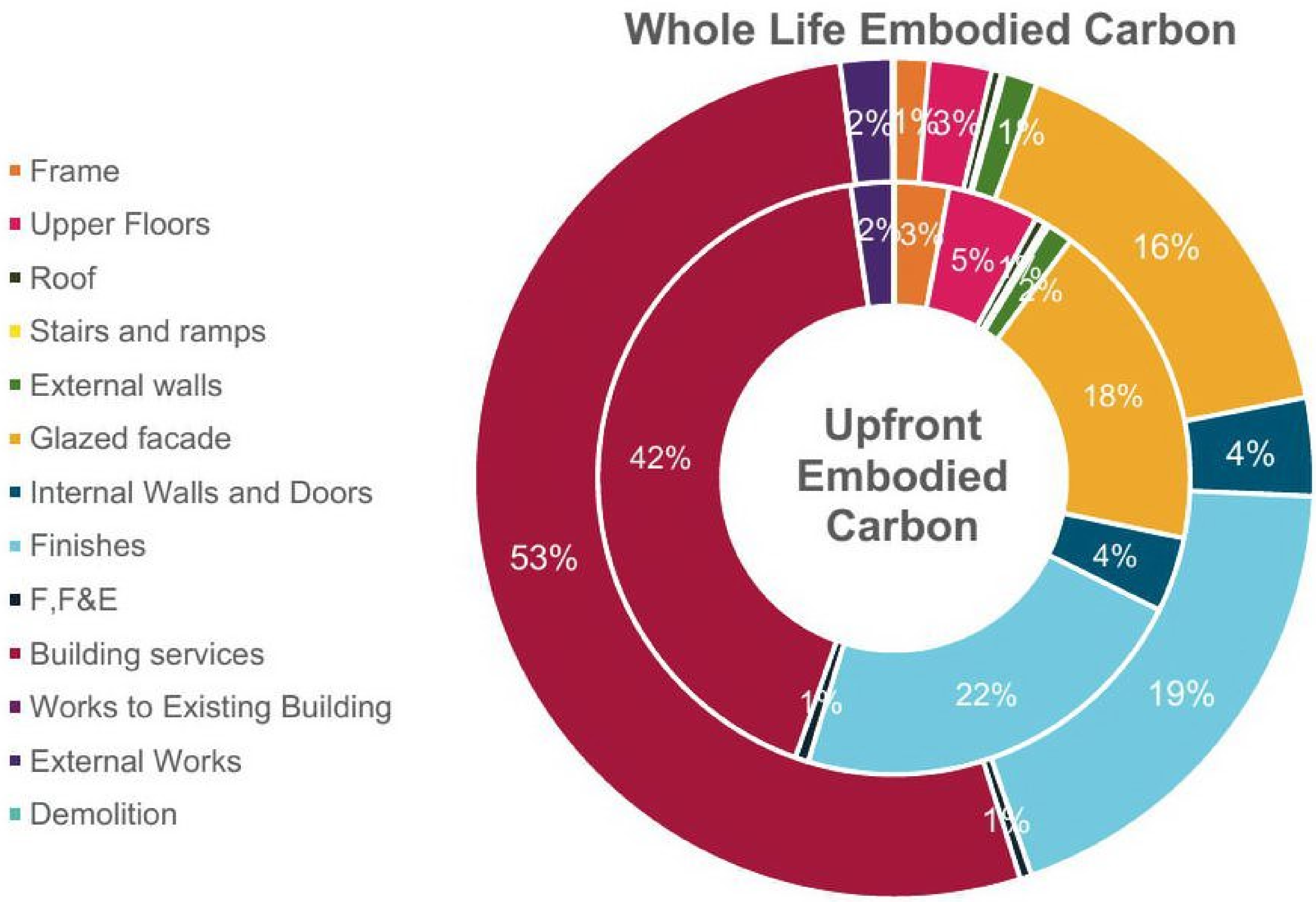

Figure 2-11: Embodied carbon breakdown by Building Element group (Upfront and WL Embodied Carbon).

Key findings:

Upfront Embodied Carbon:

- The carbon emissions occurring from the upfront embodied carbon is 45%
- Building Structure contributes ~ 32%
- Internal Walls and finishes contribute ~ 26%

Whole Life Embodied Carbon:

- Substructure, frame, and upper floors contribute ~ 4%
- External Walls and Façade contribute ~ 18%
- Internal walls and finishes contribute ~ 23%
- Building Services contribute ~ 53%
- External Works contribute ~ 2%
- Key emission areas over the lifetime of the building: Glazed Façade, Finishes and Building Services

Embodied Carbon over Life Cycle (TCO2e) (Aligned with LETI Scope)		**Upfront Carbon [A1-A5]**	**Carbon Sequestration [A1-A5]**	**Life cycle impacts [B2-B5]**	**End of life impacts [C1-C4]**	**Whole Life Embodied Carbon [A-C]**	**Benefits beyond boundary [D]**
Substructure		Not applicable					
Superstructure	Frame	333	0	0	2	335	0
	Upper Floors	553	0	0	47	601	0
	Roof	63	0	32	2	96	-21
	Stairs and ramps	25	0	0	3	28	0
	External walls	157	0	161	3	322	-74
	Glazed façade	2,011	0	2,044	32	4,087	-8
	Internal Walls and Doors	456	0	471	14	941	-13
Finishes		2,485	-221	2,411	69	4,743	-14
Building Services (MEP)		4,698	0	8,396	79	13,172	-2
Works to Existing Building		2	0	0	0	2	0
Total Embodied Carbon (LETI Scope)		**10,782**	**-221**	**13,514**	**251**	**24,326**	**-132**
Embodied Carbon intensity (kg CO_2e/m^2 GIA) (LETI Scope)		**248**	**-5**	**310**	**6**	**559**	**-3**
The below items are not within LETI rating scopes							
F, F & E		80	-29	55	6	112	0
External Works		260	0	221	15	496	0
Demolition		0	0	0	17	17	0

Embodied Carbon over Life Cycle (TCO2e) (Aligned with LETI Scope)	Upfront Carbon [A1-A5]	Carbon Sequestration [A1-A5]	Life cycle impacts [B2-B5]	End of life impacts [C1-C4]	Whole Life Embodied Carbon [A-C]	Benefits beyond boundary [D]
Total Embodied Carbon (Full Scope)	**11,122**	**-250**	**13,790**	**289**	**24,952**	**-132**
Embodied Carbon intensity (kg CO_2e/m^2 GIA) (Full Scope)	**256**	**-6**	**317**	**7**	**573**	**-3**

Table 2-22: Detailed Embodied Carbon Breakdown by Building Element Group

In addition, the PV panels embodied carbon was calculated but excluded from the final results, as renewable generation elements are additional to the building and as such to be kept separate, as per LETI guidance. However, the following information provides an initial result that can support the decision-making process in the following stages of the design and relative operational zero carbon will be reviewed in future updates.

Embodied Carbon over Life Cycle	Upfront Carbon (exc. c/seq) [A1-A5]	Carbon Sequestration [A1-A5]	Life cycle impacts [B2-B5]	End of life impacts [C1-C4]	Whole Life Embodied Carbon (inc. c/seq)	Benefits beyond boundary [D]
PV Panels: Total Embodied Carbon (tCO2)	124	0	124	0	247	-50
PV Panels: Embodied Carbon intensity (kg CO2e/m2 GIA)	3	0	3	0	6	-1

Table 2-33: Embodied Carbon Breakdown for 301 St Vincent Street's PV Panels

2.2 301 St Vincent Street's Top Material Carbon Impacts

Figure 2-22 shows the top 10 materials with a high upfront embodied carbon coming from the 301 St Vincent Street. The new Raised Access Floor (RAF), the replacement of the existing curtain walling system and new building services systems are found to be the largest contributors to the embodied carbon of the project.

To minimise the embodied carbon impact of the RAF, a reused or reclaimed RAF should be considered if available. Alternatively, a new low carbon RAF could be used in the redesign, such as a calcium sulphate product from Lindner group or equivalent.

To help determine the potential carbon savings associated with the curtain wall replacement, two preliminary façade studies were carried out at the early stages of the design. This involved assessing the potential carbon savings by retaining elements of the existing façade, using recycled aluminium, and varying the ratio of glazing to solid across the façade.

The MEP design consisted of various materials, most of which are carbon-intensive by nature, such as refrigerant liquids. Furthermore, various replacement events are to be expected. At this stage, equipment and materials are yet to be specified and specific suppliers have not been confirmed. As such, the results are high level at this stage, mainly considering current costs and initial analysis of the design. It is imperative that specifications of equipment and products can be collected at a subsequent design stage so an accurate representation can be produced.

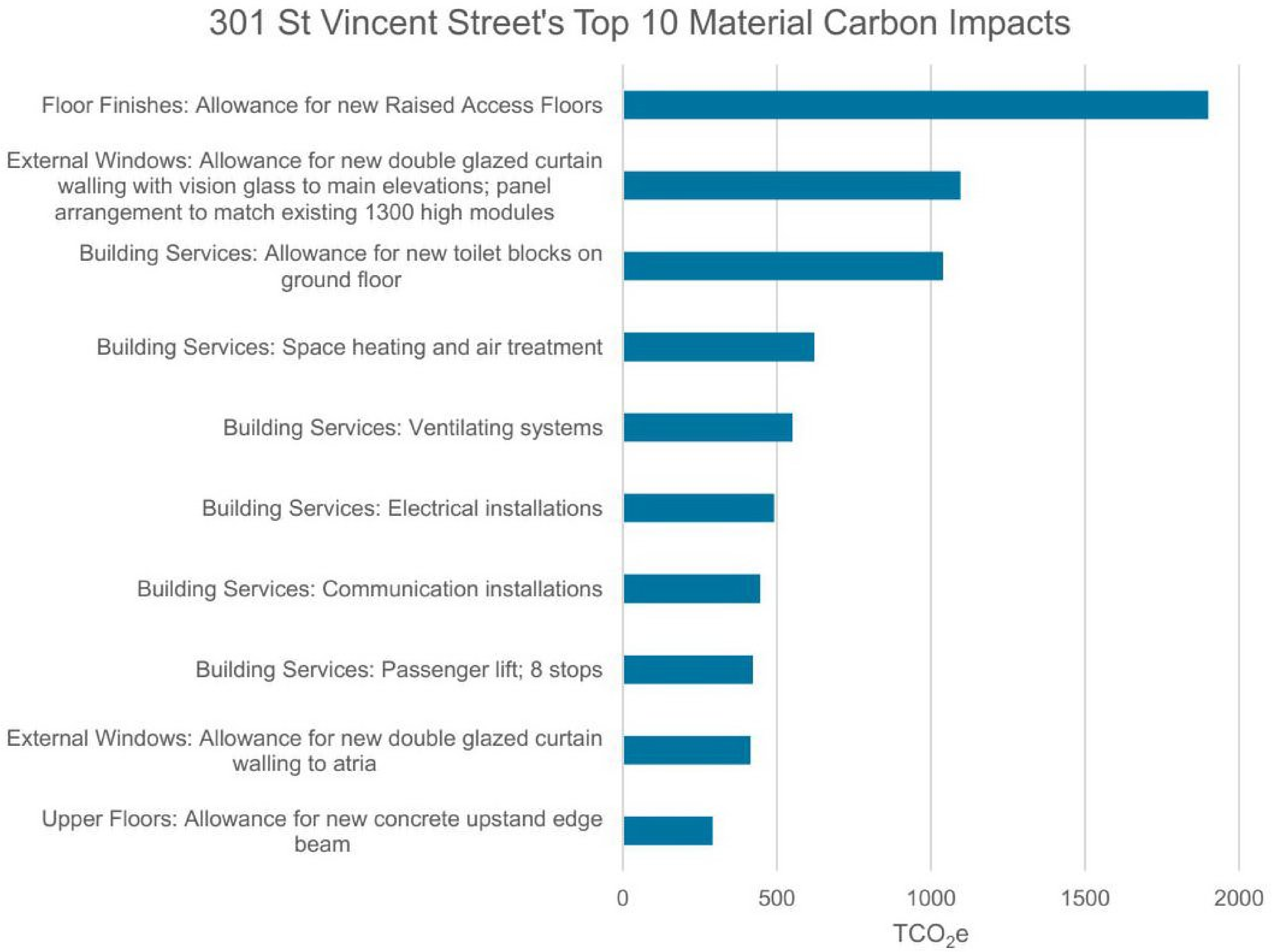

Figure 2-22: 301 St Vincent Street's Top 10 Material Carbon Impact

2.3 Comparison with recent Cundall Office Refurbishment Projects

In the following figure (Figure 2-33), the relation between 301 St Vincent Street and other Cundall projects for similar office refurbishments can be seen. Building services formed the majority of the upfront emissions, aligning with other past projects of similar emission footprints. Although each project has a bespoke design for the façade, a pattern can also be found that suggests that the development aligns with current construction standards.

The project achieved an upfront embodied carbon target of below its requirement target of 400 kgCO2/m^2, as well as achieving a relatively low embodied carbon compared to other Cundall projects of this type. However, it is important to note that both the upfront embodied carbon emissions and the whole life embodied carbon emissions are expected to rise with the inclusion of the CAT B fit-out elements during the later design stages, and therefore opportunities to reduce the embodied carbon of the current design should still be targeted.

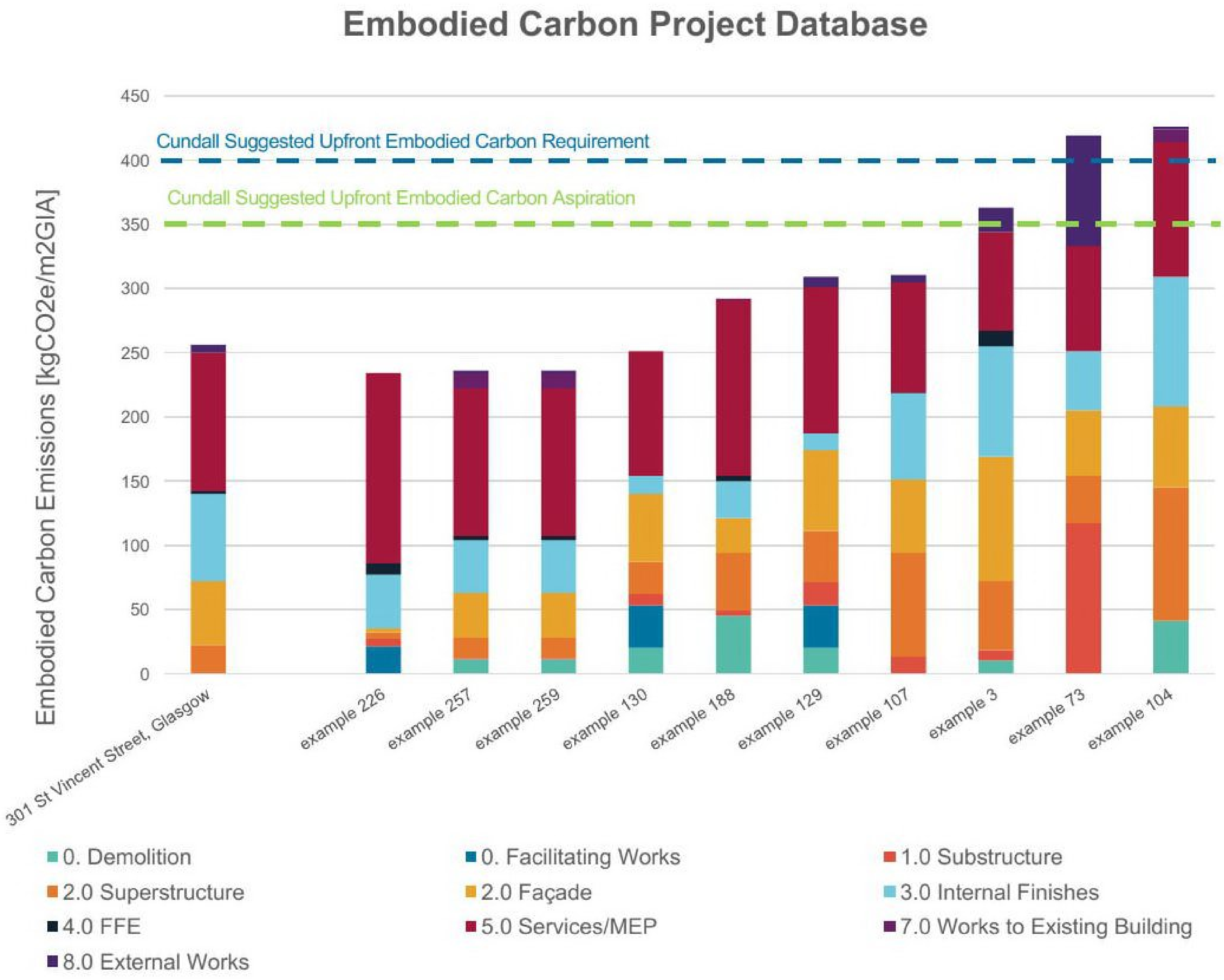

Figure 2-33: Upfront carbon breakdown by Building Element group from past Cundall projects

2.4 301 St Vincent Street CAT B Office Benchmark

At Stage 2 of the project, the scope of the calculation includes a building refurbishment, strip-out and replacement of the façade, strip-out and replacement of building services and a CAT A fitout. The emissions associated with the CAT B fitout have been excluded due to insufficient design information being available at this stage.

Table 2-44 and Figure 2-44 below show the overall results for embodied carbon assessment of 301 St Vincent Street with a projected benchmark uplift if the CAT B elements are included within the design output. Once more design information is available at the later stages of the project, the calculations will include the emissions associated with a CAT B fitout in the overall results.

	Calculated Embodied Carbon Emissions		Projected Benchmark Emissions

RIBA Stage 2	kgCO2/m²
Substructure	0
Superstructure	22
Façade	50
Internal walls and finishes	68
Internal walls and finishes (CAT B)	95
FF&E	2
FF&E (CAT B)	10
Building services	108
Building services (CAT B)	30
External works	6
Total Upfront Embodied Carbon	**391**

Table 2-44: Embodied carbon projected uplift with CAT B benchmark elements included.

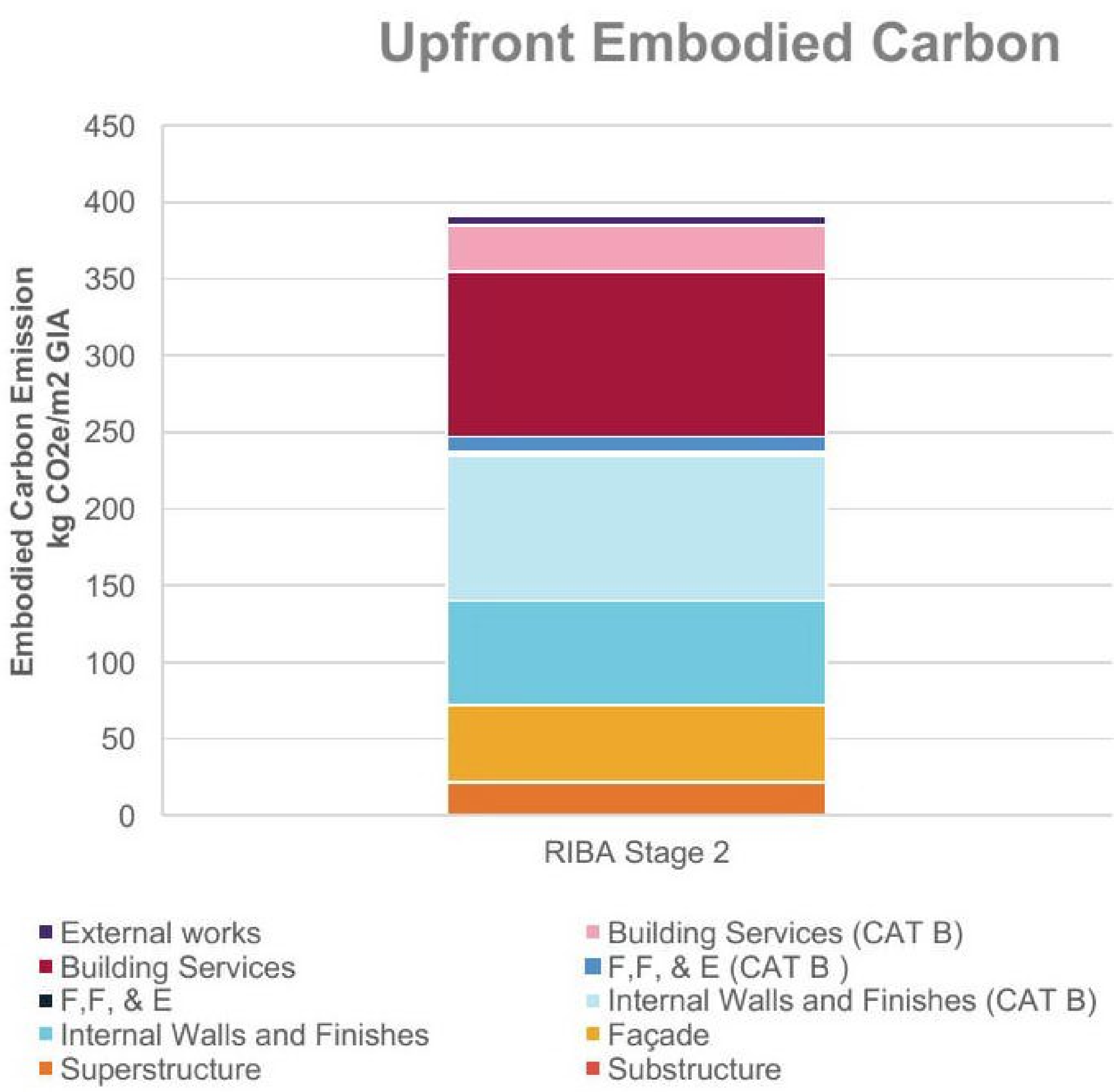

Figure 2-44: Embodied carbon projected uplift with CAT B benchmark elements included.

3.0

Whole Life Embodied Carbon Reduction Options

3.0 Whole Life Embodied Carbon Reduction Options

3.1 Overview

The reduction of the upfront embodied carbon is recommended by considering the following reduction options during Stage 3 design development.

The reduction options relate to the 'carbon hotspots' identified in the assessment:

- Superstructure
- Frame
- Curtain walling
- Internal walls
- Finishes
- Building services

The options are applied retrospectively and demonstrate in theory how much embodied carbon could potentially be saved. This could also serve as guidance for future projects. It should be noted that these carbon reduction material suggestions have been considered about carbon embodiment only, and other influencing factors, such as fire safety, costs and aesthetics must be taken into account and assessed by suitably qualified team members before adoption in the design.

3.2 Carbon Reduction Options

3.2.1 Steel

Structural steel is another 'carbon hotspot' identified in the structural solution; sourcing steel made from recycled or reclaimed material could reduce its impact significantly.

Figure 3-111 Reclaimed Steel

Reclaimed structural steel elements are the cheapest (and most sustainable) option in the current market. Structural steel is now commonly being marked with QR codes to help inform future re-use potential. After its end of life, this structural steel can be rigorously checked, cleaned, and prepared for re-use (Figure 3-1). UK Suppliers such as EMR and Cleveland Steel provide reclaimed structural steel that can be adapted to the necessity of the project. This is because the steel is tested before being de-fabricated, cut to length before being shot-blasted, and delivered for incorporation into the final structure. Suppliers also offer the storage and management of reusable steel to provide clients with sustainable building material on the market. Using reclaimed steel will significantly reduce the carbon emissions of the current design while creating a circular economy narrative for the project. Reference can be made to the HTS Stockmatcher tool if there is a database from a steel stockist on existing sections that could be used.

Due to the relatively small quantities of steel used in the refurbishment compared to a new build development for example, sourcing reclaimed steel for use in the redevelopment could be a feasible option and should therefore be explored.

If reclaimed steel is not available, then steel with a high recycled content should be considered. This is achieved through the Electric Arc Furnace (EAF) process, which utilises scrap steel that is melted down. Therefore, a recycled content of 100% is possible. In terms of the steel market, around 20% of steel plants in the UK use EAF, which makes it more challenging to source nationally. Early involvement of steel contractors is recommended to identify an appropriate EAF procurement strategy. EAF-produced steel is more likely to come from mainland European countries, however the carbon saved in production significantly outweighs any carbon increase from transportation. Additionally, XCarb steel is made from high levels of recycled steel using 100% renewable electricity in an Electric Arc Furnace. Against traditional BOF steel there could be 66% reduction on the frames section of the building if using XCarb Steel, and against EAF this is a 43% embodied carbon reduction. Table 3-1 shows the embodied carbon of the steel produced by different furnace types.

Furnace type	Recycled Content	Embodied Carbon (Product stage A1-A3)
Basic Oxygen Furnace (BOF)	20%	2.51 kg CO2/kg
Electric Arc Furnace (EAF)	80%	0.97 kg CO2/kg
XCarb Steel	80% with 100% renewable electricity	0.54 kg CO2/kg

Table 3-11: Embodied carbon of steel made from different furnace types

EAF steel for the reinforcement of concrete elements can also be found within the current market, such as with the CELSA Group, which can reduce the embodied carbon of rebar by up to 55% against the current market version. EAF-produced rebar should therefore be considered for use in the new composite floor slab at 301 St Vincent Street.

3.2.2 Concrete

Concrete is the second most widely used material on the planet after water. It is therefore imperative to use, specify and procure concrete responsibly. There is a huge variation in how concrete can be used and specified, with a wide range of associated embodied carbon. This versatility, however, also offers opportunity to significantly reduce embodied carbon through considered design and specification.

Improvements beyond the baseline option could first be realised through the local sourcing of concrete. Reducing the transportation distance by sourcing in-situ concrete from a nearby concrete plant (i.e. 10-25 km away) could have a significant impact on reducing the impact of concrete and should therefore be considered throughout the project.

The embodied carbon of concrete can also be reduced through the use of high cement replacement, such as GGBS (Ground Granulated Blast-furnace Slag), FA (Fly Ash), SILICA FUME or powdered limes. For instance, having 50% GGBS would reduce the carbon footprint of the concrete by around 40-45%.

Since concrete may be used for different aspects of a building it is useful to allocate a carbon budget to different packages of work e.g. ground works or superstructure. Reducing the volume of concrete required for each application is the first priority, before producing the specification. With the concrete used in the design of the 301 SVS redevelopment mainly concentrated in the superstructure, a GGBS replacement of up to 50% should be considered.

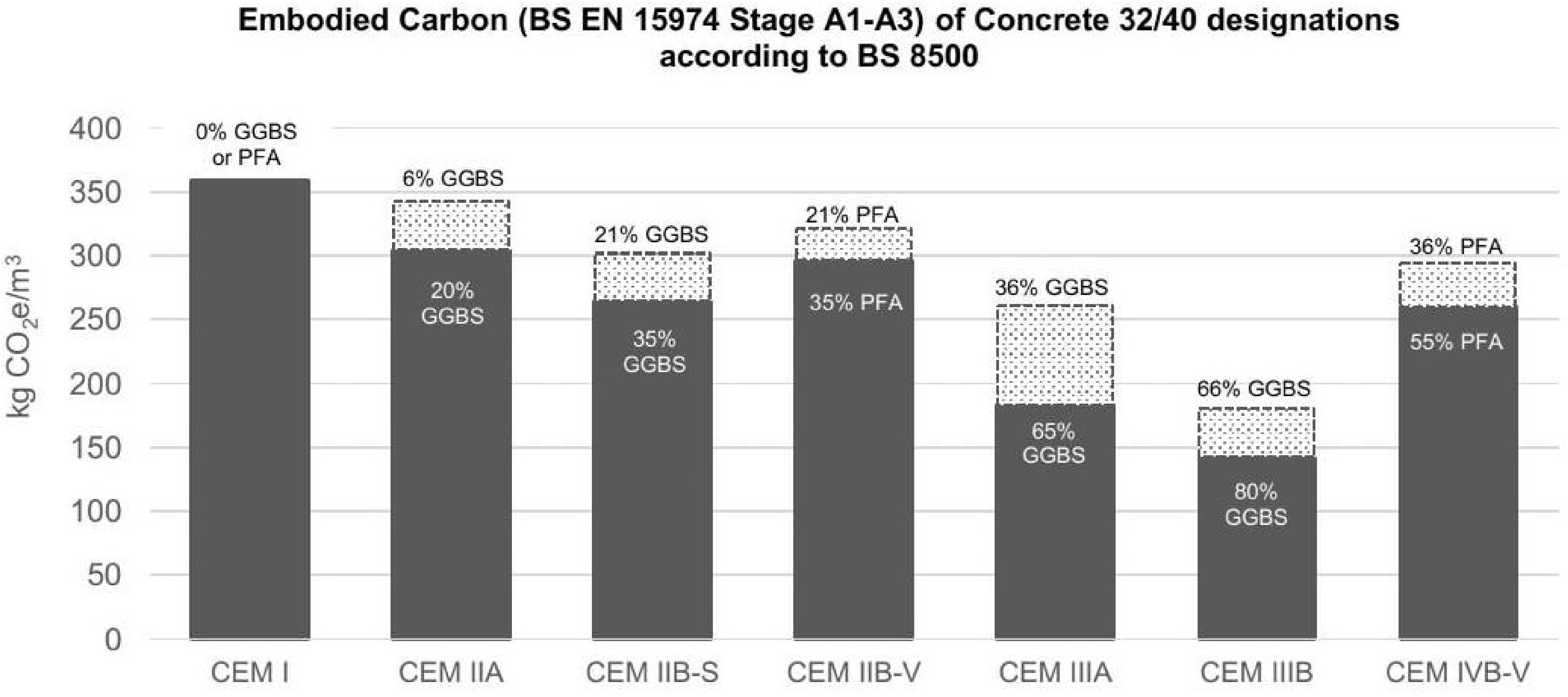

Figure 3-22 Embodied carbon of concrete with different cement replacement

Main recommendations for the carbon reduction of concrete include the local sourcing of products (less than 25km) and the use of concrete with a high %GGBS replacement (up to 50%). If all options are included, the total upfront carbon savings will be of **3 kgCO_2e/m^2**

3.2.3 Windows and Glazing

The curtain walling has the second highest embodied carbon contribution of any single building element for the redevelopment. In the baseline Whole Life Embodied Carbon Assessment, a standard aluminium curtain walling system has been modelled, however there are significant opportunities for reducing the embodied carbon of the curtain walling as part of the redesign. Initially, the use of a combined aluminium/timber framed window was considered. However, this was discarded as an option due to fire hazards and infection control considerations. As a result, two preliminary façade studies were carried out to calculate the potential embodied carbon savings of different façade options.

3.2.3.1 Preliminary Façade Study 1 – Retention of existing subframe

The first study aimed to assess the potential carbon savings associated with retaining the existing subframe, as well as the potential savings from using recycled aluminium for the framing system. Four options were therefore modelled as part of the assessment:

- Option 1: A full new façade system with standard aluminium (31% recycled content).
- Option 2: Retention of the existing subframe, with standard aluminium used for the new elements.
- Option 3: A full new façade system with CIRCAL aluminium (75% recycled content).
- Option 4: Retention of the existing subframe with CIRCAL aluminium used for the new elements.

To enable the four options to be calculated, the breakdown of individual materials in a typical curtain walling system were modelled using the breakdown from the WICTEC SG Hydro curtain walling system EPD, before extrapolating out across the whole façade area provided by the architects.

Designation	Value	Unit
EPDM	8.37	kg
Aluminium	2.47	kg
Stainless steel screw	0.74	kg
Polyamid 66 GF	0.28	kg
Zinc cast alloy	1.95	kg
PE foam	0.12	kg
Glas, Float	343.63	kg
CIRCAL 75	58.19	kg
Powder coating	1.22	kg
ABS	5.99	kg
REDUXA	6.81	kg
Anodizing	0.00	kg
Hardware components	0.39	kg
Total Weight	430.17	kg

Figure 3-33: Material breakdown of the WICTEC SG Hydro curtain walling system per 4000mmx3000mm unit

To calculate the baseline emissions of a full new façade system (option 1), an IStructE standard aluminium EPD was used as recommended by the RICS guidance. To calculate the potential saving from retaining elements of the subframe (option 2), the quantity of aluminium included in the buildup was reduced accordingly. At this stage of the design, the architects were not able to provide specific quantities for retention, however they advised that they were considering a design in which 80% of the existing frame would be retained. This enabled the embodied carbon saving from doing so to be calculated.

Finally, to calculate the potential carbon savings associated with using recycled aluminium for the new frame elements (options 3 and 4), the standard Aluminium EPD used in options 1 and 2 was simply swapped out for a low carbon alternative, in this case Hydro CIRCAL.

The results of the first façade study can be seen in Figure 3-44 and Table 3-22 below.

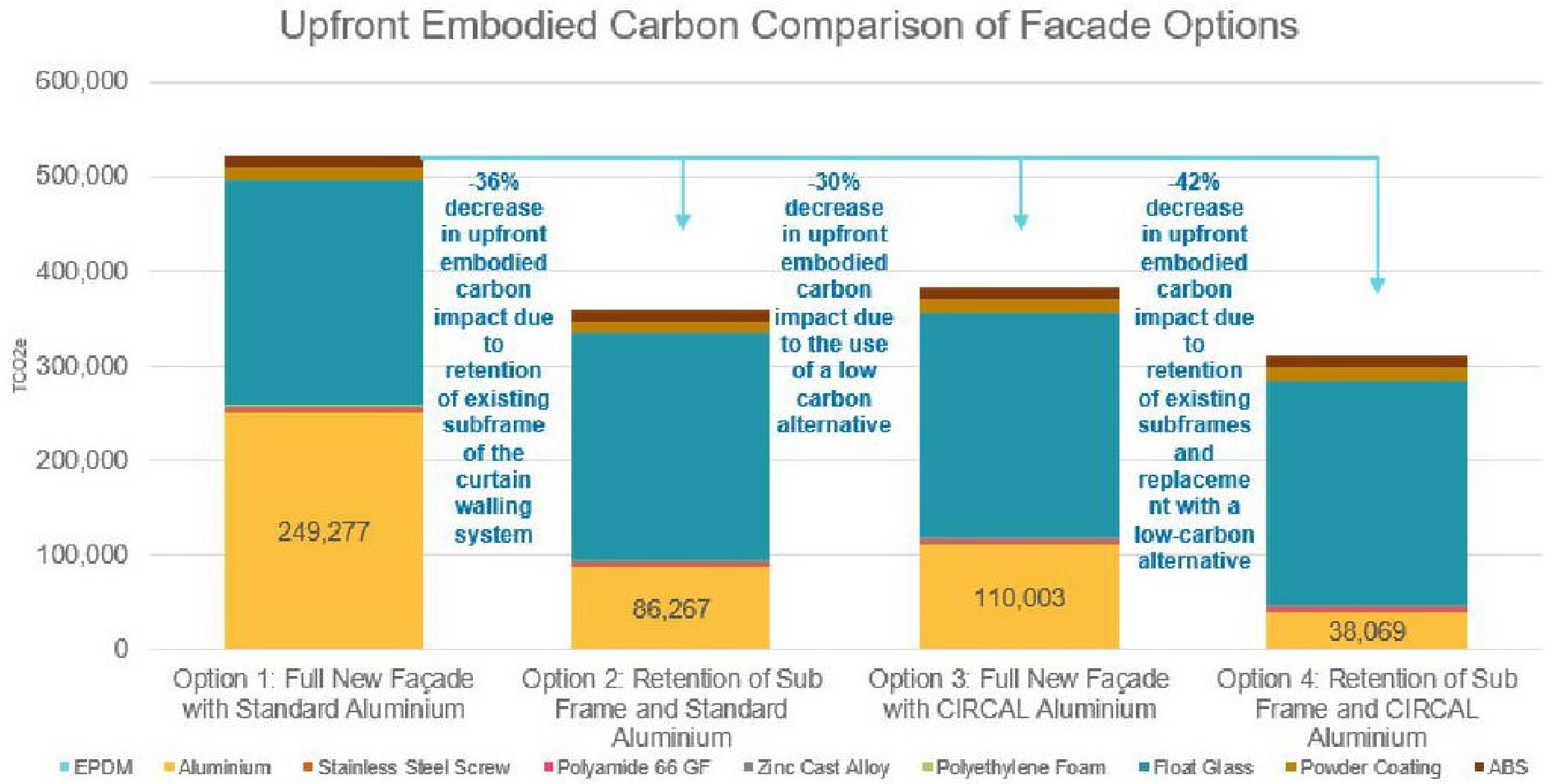

Figure 3-44: Results of Preliminary Façade Study 1 for 301 St Vincent Street

	Option 1	Option 2	Option 3	Option 4
Description	A full new façade system with standard aluminium.	Retention of the existing subframe, with standard aluminium used for the new elements.	A full new façade system with CIRCAL aluminium.	Retention of the existing subframe with CIRCAL aluminium used for the new elements.
Aluminium type	IStructE standard Aluminium	IStructE standard Aluminium	Hydro CIRCAL low carbon Aluminium	Hydro CIRCAL low carbon Aluminium
% of existing subframe retained	100% replaced. 0% retained.	20% replaced. 80% retained.	100% replaced. 0% retained.	20% replaced. 80% retained.
Upfront embodied carbon (A1-A5)	**17 kgCO2e/m²**	**11 kgCO2/m²**	**12 kgCO2/m²**	**10 kgCO2/m²**

Table 3-22: Results of Preliminary Façade Study 1 for 301 St Vincent Street

The study suggested that retaining the aluminium subframe would have the potential to save 36% of the total upfront embodied carbon of the façade. It was also found that the potential carbon savings could be increased further through the adoption of a low carbon Aluminium product such as Hydro CIRCAL for the new frame elements. This was found to have a potential upfront carbon saving to up to 42%.

3.2.3.2 Preliminary Façade Study 2 - Glazing-Solid Frame Ratio

Another way to reduce the embodied carbon of a façade is by changing the glazing-solid ratios of its curtain walling system. A second preliminary façade study was therefore carried out to assess three different façade ratios:

- Option 1: 40/60 façade ratio (40% to 60% glass to solid ratio of aluminium glazed curtain walling)
- Option 2: 50/50 façade ratio (50% to 50% glass to solid ratio of aluminium glazed curtain walling)
- Option 3: 100% façade ratio (100% to 0% glass to solid ratio with insulated panelling to opaque sections)

As the ratios of glass to solid varied across the three design options, the quantity of aluminium varied significantly. This is due to each option having a different design with regards to projecting aluminium profiles in the buildup.

Option 1 entailed a combination of vertical projecting profiles, horizontal projecting profiles and a projecting fin profile. Option 2 entailed the same vertical and horizontal profiles, but without the presence of a projecting fin. Option 3 did not include any projecting profiles, only the secondary aluminium frame that sits behind it. As a result, the total upfront embodied carbon of each option decreased relative to the quantity of aluminium present in these projecting profiles.

The other main elements that varied across the three options were the areas of glass faced spandrel panels and glazing present in each option. Option 1 contained the smallest area of both glazing and spandrel, due to the projecting horizontal and vertical aluminium profiles, and the projecting shading fins present between them. Option 2 then had a slightly larger area of both spandrel and glazing, due to the removal of these projecting fins. Then finally option 3 contained the largest areas of both spandrel panel and glazing due to the additional removal of the horizional and vertical profiles, leaving just the glazing, spandrel panels and the secondary aluminium frame behind.

The results of Façade Study 2 can be seen in Figure 3-55 and Table 3-33 below.

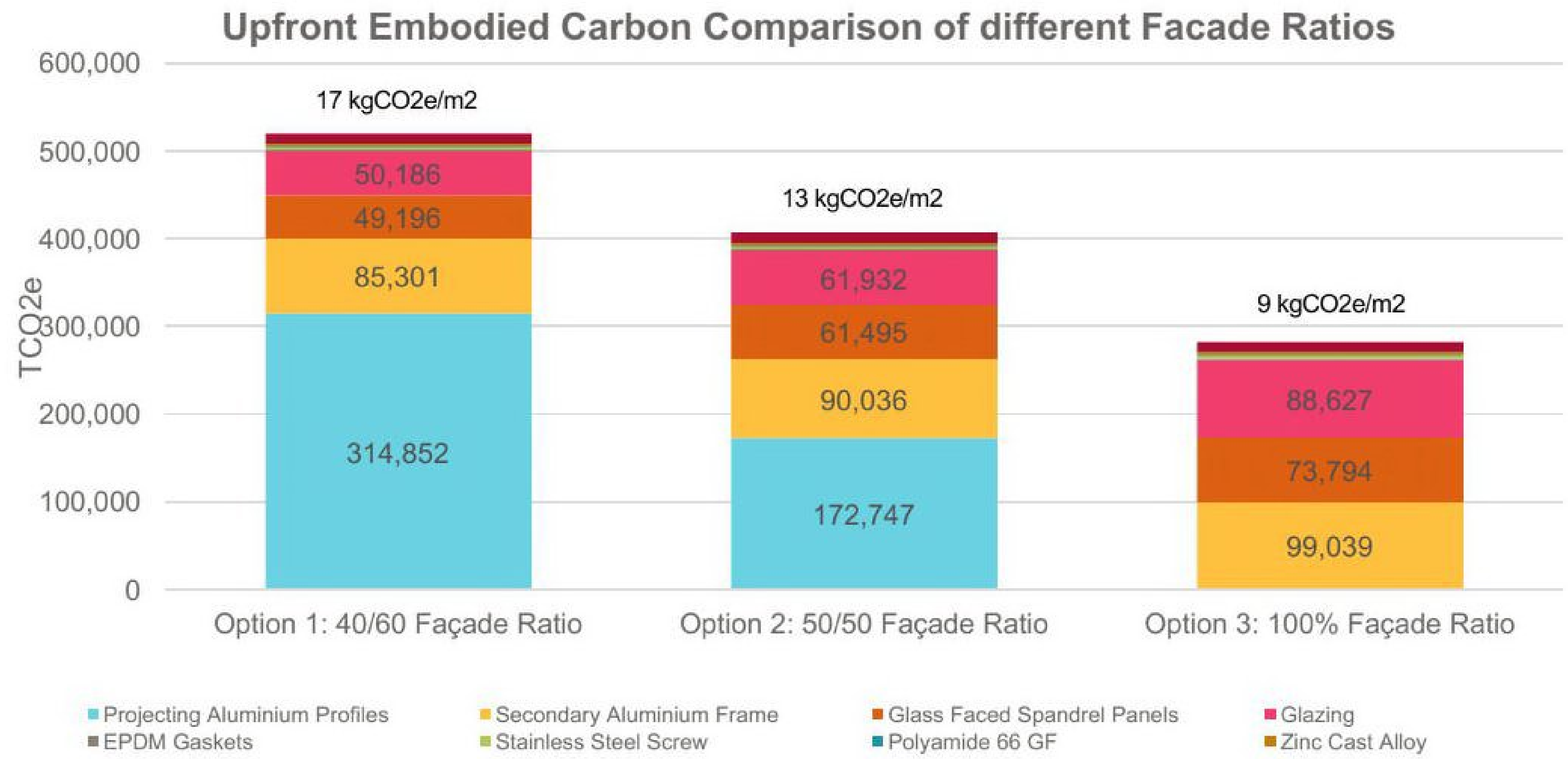

Figure 3-55: Results of Preliminary Façade Study 2 for 301 St Vincent Street

	Option 1	Option 2	Option 3
Description	40% to 60% glass to solid ratio of Aluminium glazed	50% to 50% glass to solid ratio of Aluminium glazed	100% glazing with insulated panelling to opaque sections

	curtain walling with glass faced spandrel panels	curtain walling with glass-faced spandrel panels	
Aluminium type	IStructE standard Aluminium	IStructE standard Aluminium	IStructE standard Aluminium
Upfront embodied carbon (A1-A5)	520 tonnes CO2e	407 tonnes CO2e	282 tonnes CO2e
Upfront embodied carbon (A1-A5)	**17 kgCO2e/m^2**	**13 kgCO2/m^2**	**9 kgCO2/m^2**

Table 3-33: Results of Preliminary Façade Study 2 for 301 St Vincent Street

The main embodied carbon hotspots of a curtain walling system tend to be the aluminium and glass components, with aluminium usually being the highest emitter. The results of the Preliminary Façade Study 2 therefore suggested that as the ratio of aluminium decreases, a potential embodied carbon reduction could be achieved.

The same assessment was carried out to calculate the potential savings of the different glazing ratios but when using low carbon Hydro CIRCAL Aluminium for the frame. This assessment revealed the same trend but with larger embodied carbon savings. The results for those options can be seen in Figure 3-66 and Table 3-44 below.

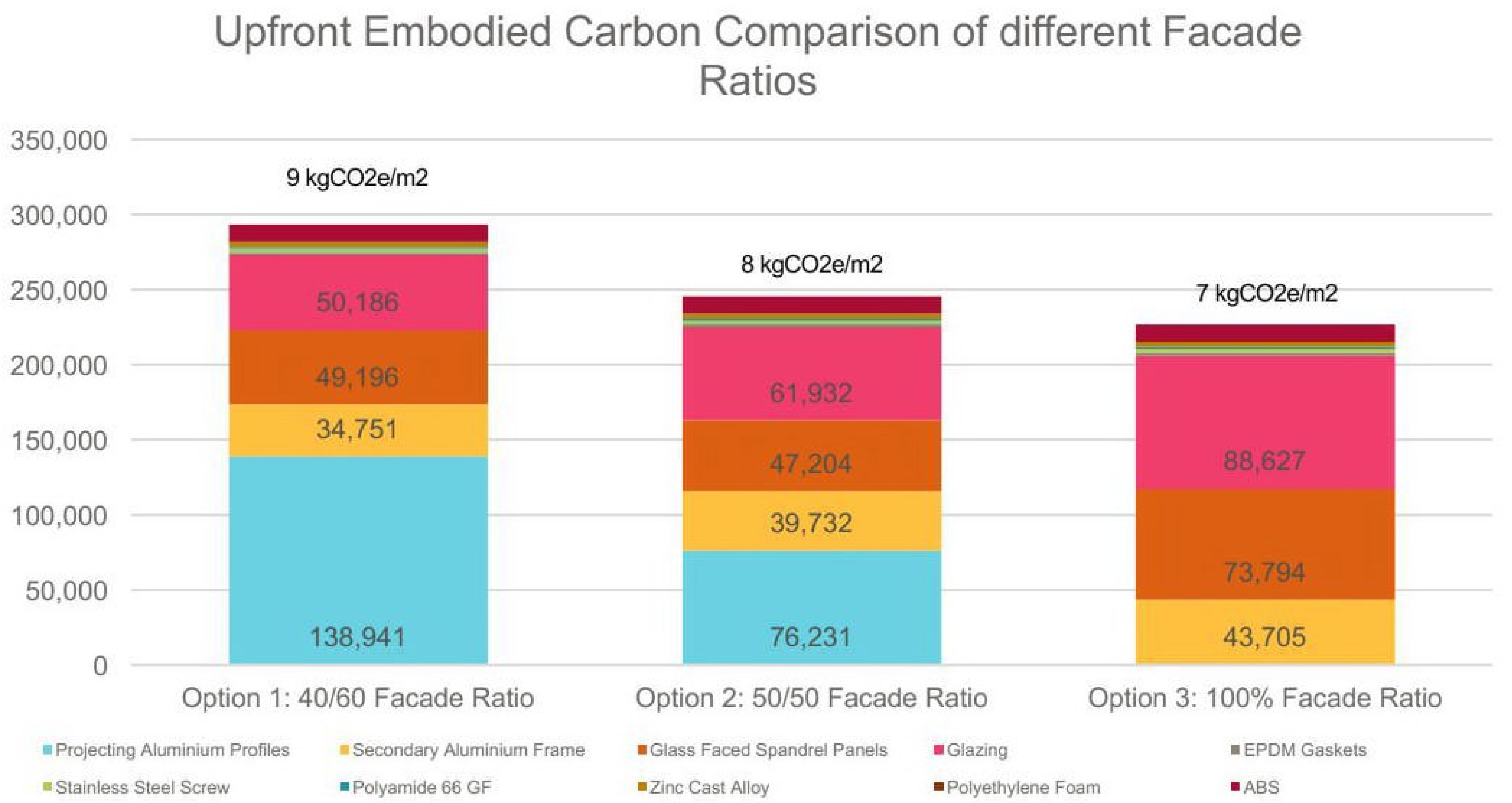

Figure 3-66: Results of Preliminary Façade Study 2 (Hydro CIRCAL Aluminium) for 301 St Vincent Street

	Option 1	Option 2	Option 3
Description	40% to 60% glass to solid ratio of Aluminium glazed curtain walling with glass faced spandrel panels	50% to 50% glass to solid ratio of Aluminium glazed curtain walling with glass-faced spandrel panels	100% glazing with insulated panelling to opaque sections

Aluminium type	Hydro CIRCAL low carbon Aluminium	Hydro CIRCAL low carbon Aluminium	Hydro CIRCAL low carbon aluminium
Upfront embodied carbon (A1-A5)	293 tonnes CO2e	245 tonnes CO2e	226 tonnes CO2e
Upfront embodied carbon (A1-A5)	**9 kgCO2e/m²**	**18 kgCO2/m²**	**7 kgCO2/m²**

Table 3-44: Results of Preliminary Façade Study 2 (recycled Aluminium) for 301 St Vincent Street

It is concluded that in terms of embodied carbon, 100% glazing curtain walling with insulated panelling to opaque sections could provide the lowest embodied carbon design. However both of these studies are informative only, used to help guide the architect's design at that stage of the project. No design decisions will be made solely on the results of these studies, as several other design considerations need to be made including impacts on operational energy requirements, air tightness and air permeability among other factors.

For the stage 2 Whole Life Embodied Carbon assessment, the adoption of the WICONA high recycled Aluminium curtain walling system was modelled as a carbon reduction opportunity for the Stage 2 design, with the results outlined in Section 3.3.

The main recommendation for the windows and glazing is to consider the use of highly recycled aluminium framed curtain walling. If all options are included, the total upfront carbon savings will be of 15 **$kgCO_2e/m^2$**

3.2.4 Aluminium

After cement and steel, aluminium manufacturing is the third highest source of greenhouse gas emissions in the construction materials sector. Aluminium is an essential construction material with unique properties, including light weight, ease of extrusion to any shape, and excellent durability. It can typically be found in façade, cladding, windows, panels, and partition walls. Currently, the project considers the use of aluminium within their façade profiles, sills, and louvred panels, which given the size of the development could be a significant carbon output.

Figure 3-77 Aluminium specifications, made from Hydro Power

As such the main recommendation for carbon reduction should be to source materials with high recycled content that can be used for those specific purposes. The UK produces around 10m tonnes of recycled metal each year. Whilst Aluminium materials are on the market with up to 82% recycled content (1.5 -2.3 kgCO2 e per kilogram of aluminium), around 75% of all aluminium produced is still in use today and the recycled material supply chain does not currently offer enough material to cover the demand. An alternative to recycled material is offered by several aluminium producers, who provide a low-carbon primary smelted product. Most of these products are manufactured using renewable energy, especially hydropower (i.e. Hydro CIRCAL, Hydro REDUXA).

Furthermore, Aluminium should be specified from a source that uses less carbon-intensive production methods, i.e. has a high recycled content and/or is produced using renewable energy. The average global recycled content in aluminium is 62%.

The main recommendation for aluminium is to consider the use of high recycled content product. If all options are included, the total upfront carbon savings will be of **16 kgCO_2e/m^2**

3.2.5 Internal Walls

The current design for the office refurbishment includes internal walls with plasterboard layers, double-glazed partition systems, metal studs' abutments to walls, and moveable room dividers. The overall embodied carbon associated with this building element could be reduced by switching to reused and recycled materials, as follows:

- Consider the use of highly recycled or reused timber studs and partitions.
- Prioritise plasterboards that have high recycled content such as Fermacell or more innovative products such as Hempboard or Breathaboard-Breathable Plasterboard (Figure 3-8).
- Consider a highly recycled aluminium glazed partition system, such as Moelven Modus, OPTIMA systems or Lindner Groups.

Figure 3-88 Breathaboard

The main recommendations for the internal walls are to consider the use of timber studs, mineral wool insulation and fermacell partition boards. If all options are included, the total upfront carbon savings would be **4 kgCO_2e/m^2**

3.2.6 Internal Finishes

For the finishes within the walls, floors, and ceilings, the priority should be to minimise the use of materials included in the design. However, improvements could be expected when including reused and materials with high recycled content for the rest of the walls, floors, and ceiling finishes. The following options for carbon reduction should be considered:

- Plasterboards that have high recycled content such as Fermacell. Check the reuse and recycled content of the material selected.
- Consider the use of timber, cork or marmoleum tiles for the flooring.
- Consider low-carbon carpet if retention is not achievable. Products such as Tarkett: AirMaster, Interface's Embodied Beauty (Carbon negative), or Sedna's ECONYL regenerated nylon are recommended. Furthermore, schemes such as Carpet Recycling UK can be taken into consideration, enabling the reuse of carpets in good condition from other developments.
- Cradle-to-cradle certified products.
- Consider low carbon porcelain tiles containing high recycled content eg. Mosa Tiles.

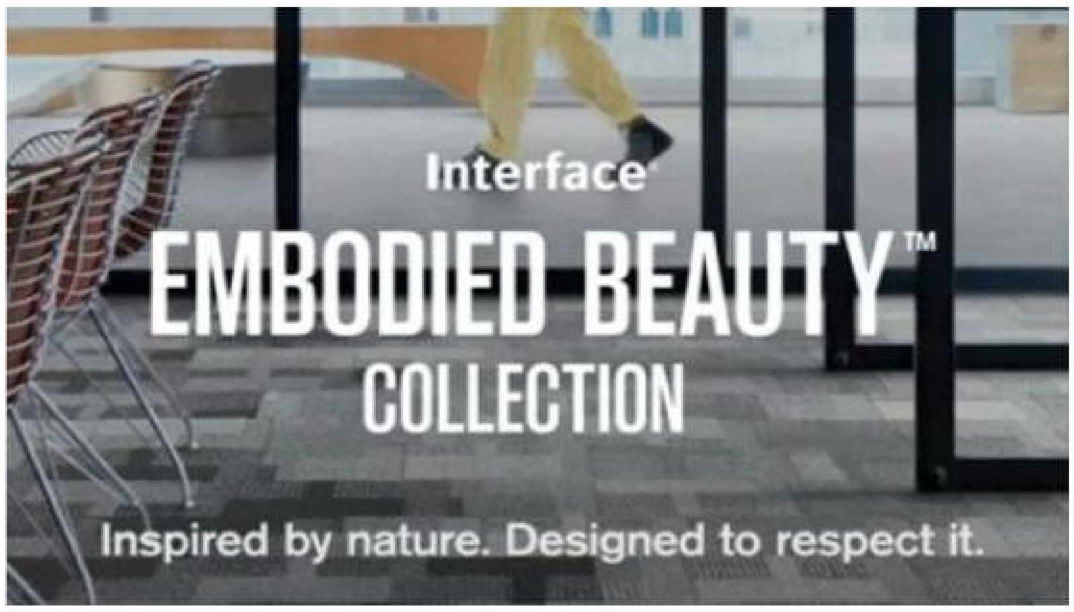

Figure 3-99 Low Carbon Carpet Options

- Consider low carbon paint, such as Dulux Trade Supermatt, COAT Paints, Graphenstone and CONSCIENT paints.
- Consider the use of Hydro CIRCAL low carbon aluminium for new Louvred Screen to Generator room.
- The use of refurbished raised access flooring could also be considered. Raised modular flooring (RMF) facilitates reclamation of material at the end of life, recycling and enabling circularity for the product. RMF reduces carbon emissions coming from the end of life as usually, RAF would end up in landfill. Additionally, according to the UKGBC, there could be a cost saving of 20%. Upfront carbon can be significantly reduced by using refurbished raised access flooring.

The main recommendations for internal finishes are to consider low carbon paint, ceramic tiles, clay plaster, carpet tiles, marmoleum tiles and a refurbished raised access floor. If all options are included, the total upfront carbon savings will be of **45 kgCO_2e/m^2**

3.2.7 Furniture, Fittings & Equipment

As an office CAT A/ CAT B development, furniture, fittings, and equipment are some of the main fitted elements that contribute significantly to the building's emissions. Currently, the client is assessing the reuse of furniture in their current offices. This approach will allow the reduction of new elements added to the new office design, thus minimising the overall embodied carbon output. Where new elements have to be included, the following points need to be considered:

- Promote zero waste to landfill in new furniture packaging.
- Consider the use of second-hand and refurbished furniture or furniture with high recycled content materials and long lifespan use.
- Target all manufactured furniture products nationally- within 300km.
- Consider products with sustainable certifications, such as B Corp, Cradle-to-Cradle, or Natureplus.

3.2.8 Building Services

The building services have the highest contribution to both the upfront and life cycle embodied carbon over the lifetime of the building. Improvements can be achieved by retaining and reusing parts of the existing MEP components where possible. Furthermore, procuring low-carbon materials with high recycled content will further reduce the carbon impact.

Below are some proposed reduction options:

- Consider national sourcing of equipment and materials - less than 300 km.
- Minimise ductwork crossovers, and consider low-carbon ducts, such as EcoDuct.
- Procure low-carbon insulation.
- Avoid having long refrigerant pipework running through the building as it creates higher leakage and maintenance events through the life cycle.
- Retain and reuse the existing equipment where possible, including tanks and risers.
- Use LED drivers that are replaceable and upgradable throughout the life of the fittings.
- Specify low GWP refrigerants and reduce overall refrigerant charge.
- Implement regular maintenance schedules and leak detection programs to promptly identify and fix any leaks in the refrigeration system.
- Consider selecting factory-sealed equipment to reduce the risk of refrigerant leaks.
- Ensure low leakage rates for refrigerants and ensure refrigerants are recoverable at the end of life.
- Ask the manufacturer for product data sheets and input into the embodied carbon impact of equipment. Specifically, ask whether the product has an EPD (Environmental Product Declaration) to ensure transparency of carbon impact.

- Specify equipment with longer lifespans.
- Consider installing exposed services independently from other construction layers to facilitate maintenance and replacement of individual components without causing damage to other elements or construction layers.

Furthermore, refrigerant use and leakage can significantly contribute to the overall carbon footprint of development, posing harm to the environment. It's advisable to avoid refrigerant use in the building's design and construction where possible. If necessary, closely monitor its use and specify refrigerants with the lowest environmental impact according to leading industry guidance, aiming for a Global Warming Potential of Zero or as close to Zero as reasonably possible.

Where the use of environmentally harmful refrigerants is unavoidable, a leak detection system should be specified. This should be capable of continuously monitoring for leaks and have an alert and management function to help mitigate the impact of any leaks.

3.3 Carbon Reduction Summary

3.3.1 301 St Vincent Street's Carbon Savings

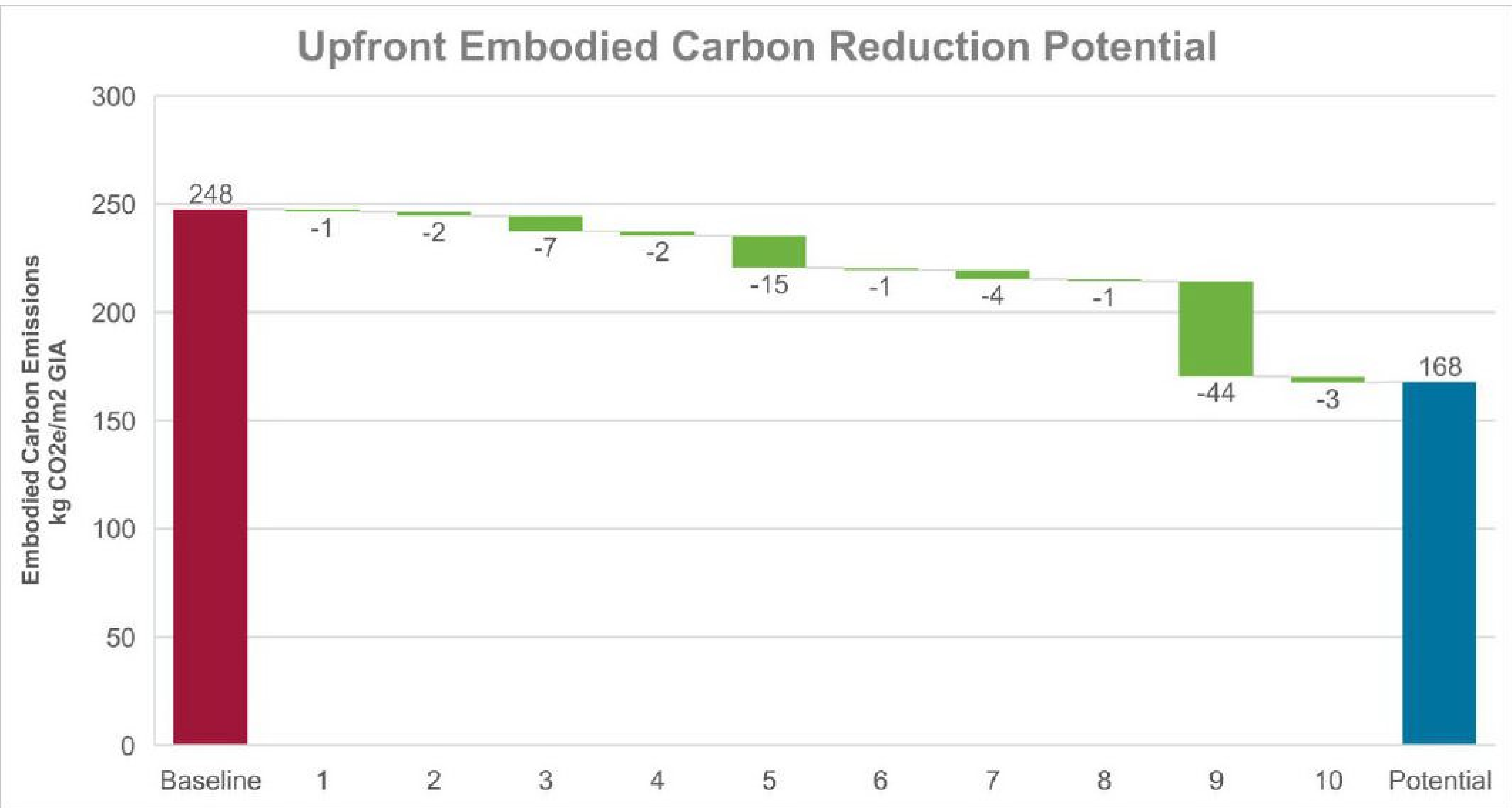

Figure 3-1010: Upfront Embodied Carbon Reduction for 301 St Vincent Street if recommendations are applied

Option	Material	Building Element	Specification	Potential carbon saving for the project (Upfront Embodied Carbon)	
				tonnes CO_2e	$kgCO_2e/m^2$
1	Concrete	Superstructure	Local sourcing of concrete – less than 15km	45	1
2	Concrete	Superstructure	GGBS (50%) – High Cement replacement content	98	2
3	Steel	Frames	Use of reclaimed steel	315	7
4	Rebar	Superstructure	Use of low carbon rebar (Electric Arc Furnace and renewable energy made)	60	2
5	Curtain Walling	Façade	Consider the use of high recycled aluminium for curtain wall framing elements – WICONA or equivalent	683	15
6	Aluminium	Façade	Consider the use of high recycled aluminium for façade panels – Hydro CIRCAL or equivalent.	50	1

7	Partitions	Walls	Low carbon internal partitions (timber studs, Fermacell and mineral wool insulation)	145	4
8	Finishes	Walls	Low carbon wall finishes (low carbon paint, ceramic tiles, clay plaster)	33	<1
9	Finishes	Floors	Low carbon floor finishes (refurbished RAF, low carbon carpet tiles, marmoleum tiles)	1,885	44
10	MEP	Building Services	National sourcing of MEP equipment and materials – less than 300km	157	3
Total Upfront Embodied Carbon saving				**3,471**	**79**
Additional Life-cycle Embodied Carbon saving				**3,052**	**71**

Table 3-55: Embodied Carbon reduction options (life cycle savings are also possible due to replacement events)*

If all the options could be adopted, the life cycle emissions (A-C) of the project could be reduced by about **6,523 tonne CO_2e**, which is an **26%** reduction from the current position. The reductions would lead to an upfront embodied carbon value saving of **79 kgCO_2e/m^2**.

3.4 Whole Life Embodied Carbon: Baseline v. Potential

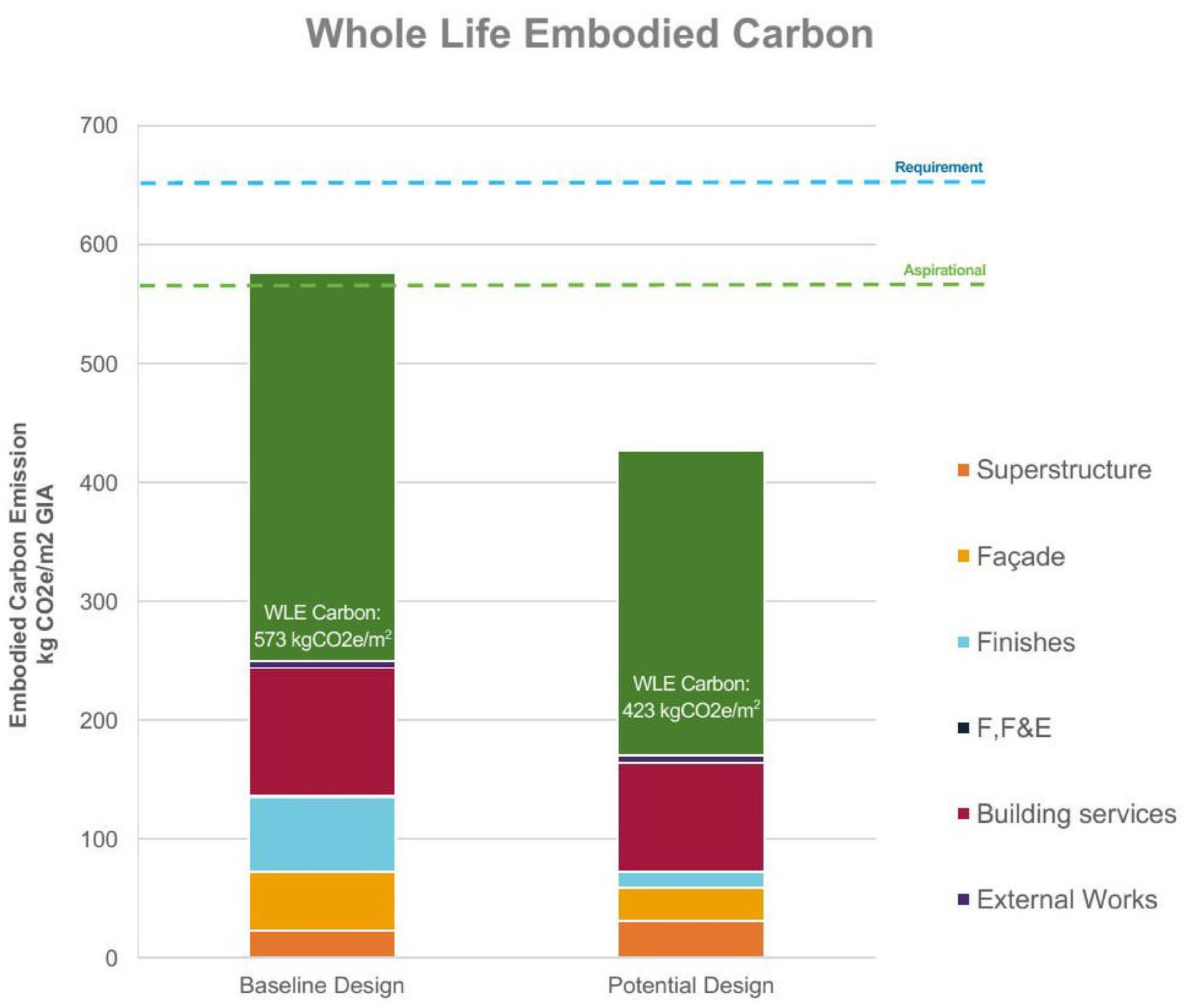

Figure 3-1111 Whole Life Embodied Carbon reduction potential against the baseline design calculation.

Total Embodied Carbon	Baseline Design		Potential	
	Upfront Embodied Carbon (A1-A5)	Whole Life Embodied Carbon (A-C)	Upfront Embodied Carbon (A1-A5)	Whole Life Embodied Carbon (A-C)
Tonnes CO_2e	11,122	24,952	7,661	18,412
$kgCO_2e/m^2$ GIA	256	573	176	423
Cundall's Suggested Requirement ($kgCO_2e/m^2$ (GIA))	<400	<650	<400	<650
Cundall's Suggested Aspiration ($kgCO_2e/m^2$ (GIA))	<350	<550	<350	<550

Table 3-66: Whole life embodied carbon comparison of baseline with potential improvement

4.0 Conclusion

4.0 Conclusion

4.1 Summary

This assessment reviewed the representative carbon footprint data for the proposed 301 St Vincent Street development in Glasgow, Scotland. The total embodied carbon emissions for 301 St Vincent Street for both Upfront Embodied Carbon and Whole Life Embodied Carbon over a period of 60 years were found to be:

- Upfront Embodied Carbon = **256** kg CO_2e/m^2 (11,122 tonnes CO_2e)
- Whole Life Embodied Carbon = **573** kg CO_2e/m^2 (24,952 tonnes CO_2e)

4.2 Reduction Options

The assessment has identified a series of material alternatives that could be applied to the development to reduce its carbon footprint. The reductions were calculations that provided an estimated carbon saving and forecasting a potential carbon output of the project on the pathway to achieve aspirational targets. To achieve this, we recommend the following changes to the current design be considered:

1. Local sourcing of concrete – less than 15km.
2. High cement replacement for concrete used in the superstructure – up to 50% GGBS.
3. Consider the use of reclaimed steel for structural elements.
4. Consider the use of high recycled steel (Electric Arc Furnace) for concrete reinforcement.
5. Consider the use of high recycled aluminium for curtain wall framing elements – Hydro CIRCAL or equivalent.
6. Consider the use of high recycled aluminium for façade panels – Hydro CIRCAL or equivalent.
7. Consider the use of low carbon internal partitions e.g. timber studs, Fermacell and mineral wool insulation.
8. Consider the use of low carbon wall finishes (low carbon paint, ceramic tiles, clay plaster)
9. Floor finishes – consider the use of a refurbished RAF, as well as low carbon carpet tiles and marmoleum instead of vinyl.
10. Ceiling finishes – consider the use of low carbon aluminium for new louvred screen to generator room – Hydro CIRCAL or equivalent.
11. National sourcing of MEP equipment and materials – less than 300km.

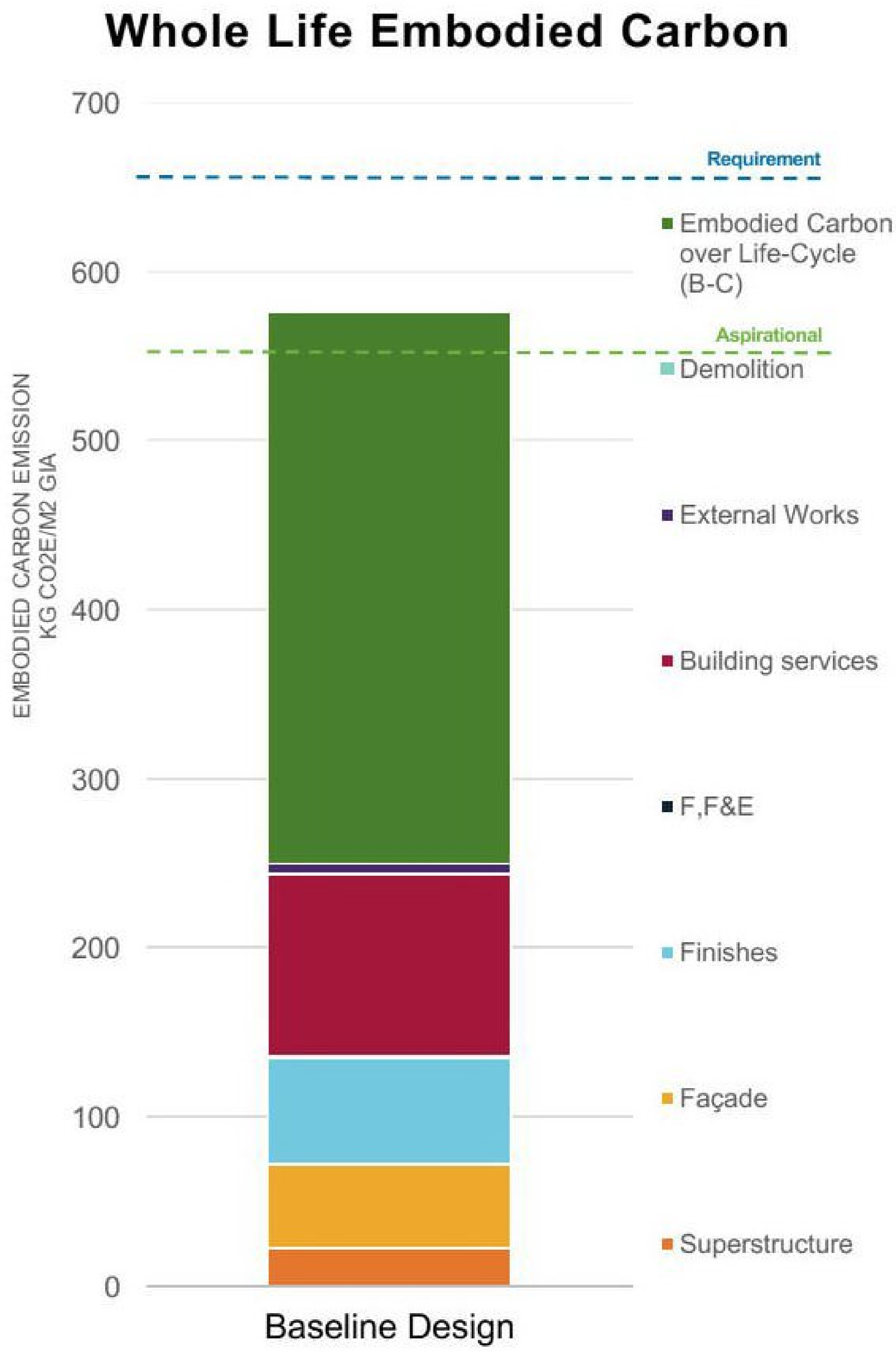

Figure 4-111 WLE Carbon of 301 St Vincent Street against suggested embodied carbon intensity targets

If the suggested options were followed, the overall reduction of the project's carbon footprint would be at least 26%, which would result in an upfront embodied carbon intensity of less 350 kg CO_2e/m^2, and a whole life embodied carbon intensity of less than 550 $kgCO_2e/m^2$, Cundall's suggested aspirational targets for the project. However, it should be noted that the impact would have vary based upon manufacturer and product type selection.

	Stage 2 Baseline	Design Potential
Upfront embodied carbon (A1-A5) kgCO2e/m^2	256	176
Cundall's Suggested Requirement (kgCO2e/m^2)	<400	<400
Cundall's Suggested Aspiration (kgCO2e/m^2)	<350	<350
Whole life embodied carbon (A1-A5, B1-B5, C1-C4) kgCO_2e/m^2	573	423
Cundall's Suggested Requirement (kgCO2e/m^2)	<650	<650
Cundall's Suggested Aspiration (kgCO2e/m^2)	<550	<550

Table 4-1: Upfront Embodied Carbon Comparison of Baseline and Potential

It's important to note that integrating circular economy principles into the project has the potential to significantly reduce carbon emissions and help achieve the aspirational targets. A circular economy strategy can substantially cut both upfront and embodied carbon emissions for the project.

Appendices

Appendices

Appendix A - RICS Professional Statement Guidance Information

Where information has otherwise not been provided or is unavailable, the assumptions taken from the RICS professional statement guidance were adopted, as displayed in the tables below.

Material	Details	Specification
Concrete	Piling	C32/40 20% cement replacement
	Substructure	C32/40 20% cement replacement
	Superstructure	C32/40 20% cement replacement
	Generic concrete	C16/20 0% cement replacement
Steel	Reinforcement bars	97% Recycled Content
	Structural steel sections	20% Recycled Content
	Studwork/Support frames	Galvanised steel, 15% Recycled Content
Blockwork	Precast concrete blocks	Lightweight blocks for building envelope
	Precast concrete blocks	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, 35% Recycled Content
	Glazing frames	Aluminium sheet, 35% Recycled Content
Plasterboard	Partitioning/Ceilings	Min. 60% Recycled Content
Insulation	To floors, roofs & external walls	PIR

Default specifications for main building materials

Transport scenario	km by road	km by sea
Locally manufactured e.g., concrete, aggregate, earth	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

Default transport scenarios for UK projects

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
Façade	Opaque modular cladding e.g. rain screens, timber panels	30 years
	Glazed cladding/Curtain walling	35 years
	Windows and external doors	30 years

Default life span assumptions

Appendix B - Additional Options for Carbon Reduction

Develop a strategy for ongoing monitoring and disclosure of carbon emissions

The project's public disclosure strategy should focus on ensuring that annual operational and Whole Life carbon emissions are tracked, verified by a third-party auditor, and communicated to relevant stakeholders and shareholders.

The approach to disclosure should ensure that emissions arising from the building's use are reported publicly to an appropriate database and that the disclosure clearly identifies the amount and source of any offsets used.

Monitoring

A robust monitoring system should be in place for all operational carbon emissions and for whole life carbon emissions that recur through use and disposal stages.

For operational energy data, a metering system should be in place which collects and reports energy consumption data. A data management system should be in place that allows for the collection of five years' worth of half-hourly data.

For embodied and in-use carbon, disclosure via the RICS Building Carbon Database (formerly the WRAP database) should be maintained on an annual basis.

Carbon Offsetting

To reach carbon neutrality the purchase of carbon offsets should be viewed as a last resort and only considered after the adoption of improvement actions and the purchase of renewable energy. Carbon offsetting is a short-term fix, not a long-term solution.

The annual residual carbon footprint for the estate should be offset annually as part of the OCIM Limited's overall carbon neutral strategy.

Verification

Data for disclosure should undergo verification by an independent, third-party auditor. The purpose of this process is to ensure that no data is lost and that the accuracy of the data reported meets international standards.

Public disclosure

The disclosure strategy must identify the approach to communication of carbon performance. The disclosure should be publicly accessible and form part of the annual report to shareholders. The annual reports should be made publicly available summarising past and current carbon emissions. The methods and the quality of the data used to calculate emissions should be clearly communicated and verified by an independent third-party auditor.

Public disclosure of carbon performance is the final step to becoming Net Zero Carbon. Disclosure ensures:

- Targets are tracked and met.
- The extent of reliance on offsite renewables and carbon offsetting schemes is clear to stakeholders.
- The project is recognised for its work in reducing emissions.

RIBA 2030 Climate Challenge

The Royal Institute of British Architects (RIBA) have set operational energy and whole life embodied carbon targets for domestic and non-domestic buildings as part of their '*2030 Challenge*', using a similar methodology and stepped trajectory. These align with the UKGBC energy intensity target and also include target metrics relating to Potable Water Use.

LETI's 'Climate Emergency Design Guide'

To understand the implications of these energy intensity targets at a building level, the London Energy Transformation Initiative (LETI) combined top-down modelling with bottom-up modelling. This has helped establish achievable building performance specifications to facilitate the zero-carbon operation of the buildings. For operational energy, these align with the UKGBC and the RIBA 2030 challenge.

For embodied carbon LETI have however focused on the upfront embodied carbon associated with the construction of the building, not the whole life embodied carbon as per RIBA. This aligns with the UKGBC framework which requires developments to report their upfront embodied carbon on practical completion after meeting local carbon intensity targets and offset all residual emissions.

Cundall Johnston & Partners LLP
Exchange Place One 1 Semple Street Edinburgh
EH3 8BL Tel:+44 (0)131 524 3500
Asia Australia Europe MENA UK and Ireland
www.cundall.com

ZERO CARBON DESIGN 2030