

Appendix 10.6.1

Upper Brook Street PBSA Whole of Life Carbon
Assessment Report

Upper Brook Street

Sci-Tech Building Stage 2 Whole Life Carbon Assessment Report

Kadans Science Partners

Job No: 1036881
Doc ref: UBS-CDL-ZZ-XX-RP-SY-70224
Revision: P01
Revision date: 02 May 2023

Project title	Upper Brook Street	Job number
Report title	Sci-Tech Building Stage 2 Whole Life Carbon Assessment Report	1036881

Document revision history

Revision ref	Issue date	Purpose of issue / description of revision
P01	02 May 2023	Stage 2 Issue

Document validation (latest issue)

02/05/2023	02/05/2023	02/05/2023
X 	X 	X 
Principal author	Checked by	Verified by
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Executive Summary

A Whole Life Carbon Assessment has been carried out for the proposed Upper Brook Street Sci-tech Building in Manchester. Primarily, the report seeks to assess the current carbon footprint position against client's aspiration and current industry benchmarks for 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

Institutions such as LETI and RIBA do not cover laboratories in their whole life embodied carbon targets. We suggest developments like this are to aim for best practice and for a low embodied carbon and material use impact in line with the 2020 LETI designed benchmarks for an office new build. The LETI 2020 upfront carbon target is <600 kgCO₂e/m² without sequestration for substructure, superstructure, MEP, façade, and internal finishes. The LETI 2020 whole life carbon target is <970 kgCO₂e/m², sequestration included.

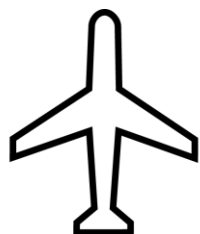
Embodied Carbon Summary

The total representative embodied carbon emissions of Upper Brook Street Sci-Tech Building 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 upon 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.

Upper Brook Street Sci-Tech Building Carbon Emissions	Upfront Embodied Carbon (A1-A5)	Whole Life Embodied Carbon (A-C)
Tonnes CO ₂ e	15,760	25,400
kgCO ₂ e/m ² (GIA)	789	1,271
LETI Rating System	E	E

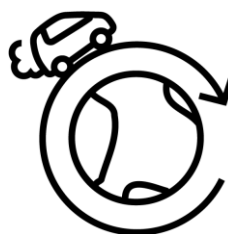
Embodied Carbon Summary (current design)

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



X 5,562

Personal Return flights
London - Hong Kong



X 3,279

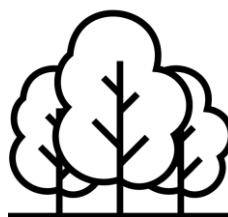
Laps around the globe by car



Energy to make

X 366,080,261

Cups of tea



X 216,597

Trees to absorb

Embodied Carbon Equivalent

Carbon Hotspots

Initial results show that the main focus of carbon emissions comes from the substructure of the building which is the concrete raft foundation due to the high volume of material used. Following second is the superstructure which consists of concrete frame, upper floors, and walls. Furthermore, the building services have high carbon impact and the use of external window with aluminium frame.

Potential Reduction Opportunities

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

1. Consider material carbon footprint data during procurement
2. Local sourcing of concrete – less than 25km.
3. High cement replacement for concrete used for substructure and superstructure
4. Consider high recycled steel (Electric Arc Furnace) from reinforcement, frames, roof, and upper floors
5. Considering timber framed or combi (aluminium clad timber framed) windows
6. Consider the use of reclaimed or high recycled brickwork
7. Consider the use of timber studs walls and partitions
8. Tiles (both porcelain and vinyl) containing recycled content and low carbon
9. Avoid, if possible, the use of suspended ceiling systems.
10. Consider low EC external and internal wall insulation.
11. Consider low EC materials for the landscaping work



If the suggested options were followed, the overall reduction of the project's carbon footprint would be at least 15% which could result in an upfront embodied carbon intensity of less than 623 kg CO₂e/m², and a whole life carbon intensity of around 1,081 kgCO₂e/m², which is above the current good to fair building design as defined by LETI & RIBA targets for office buildings for whole life embodied carbon.

Upper Brook Street Sci-Tech Building Carbon Emissions - Potential	Upfront Embodied Carbon (A1-A5)	Whole Life Embodied Carbon (A-C)
tonnes CO ₂ e	12,448	21,598
kgCO ₂ e/m ² (GIA)	623	1,081
LETI Rating System	D	D

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 is just a small handful of the most impactful suggestions to reduce the upfront and whole life 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.

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1.0

Introduction

1.0 Introduction

Cundall have been commissioned by Kadans Science Partners to conduct a Whole Life-Cycle Carbon Assessment (WLCA) of the proposed design of a Sci-Tech Building development, Upper Brook Street in Manchester. 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

The client has asked Cundall to analyse the current design and offer suggestions on how to reduce the resulting embodied carbon at this stage.

Institutions such as LETI and RIBA do not cover laboratories in their whole life embodied carbon targets. We suggest developments like this are to aim for best practice and for a low embodied carbon and material use impact in line with the 2020 LETI designed benchmarks for an office new build. The LETI 2020 upfront carbon target is <600 kgCO₂e/m² without sequestration for substructure, superstructure, MEP, façade, and internal finishes. The LETI 2020 whole life carbon target is <970 kgCO₂e/m², sequestration included.

Project Aspiration	Target
Upfront embodied carbon (A1-A5)	<600 kgCO ₂ e/m ²
Whole life embodied carbon (A-C)	<970 kgCO ₂ e/m ²

Table 1-1: Embodied Carbon Targets for office Schemes

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 an office building, which are applicable to the project, as shown in Table 1-1.

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
LETI 2030 Design Target	A++	<100	<100	<100	<100
	A+	<225	<200	<200	<200
	A	<350	<300	<300	<300
LETI 2020 Design Target	B	<475	<400	<400	<425
	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
RIBA 2030 Build Target	A++	<150	<150	<125	<125
	A+	<345	<300	<240	<250
	A	<530	<450	<400	<380
	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 1-1 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 1-1) to allow for quick comparison of ambition across various typologies and portfolios. Please find weblink to relevant documents [here](#).

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.

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 Site and Building Description

The proposed Sci-Tech Building development includes the construction of a Sci-Tech Building, located on a plot of land between Kincardine Road and Upper Brook Street in Manchester.

The Sci-Tech Building is 6 to 9 storey located on the southern part of the site. The ground floor comprises of a café, cycle store, incubator space with plant and amenity located at roof level. The proposed Sci-Tech Building, Manchester development will deliver approximately 19,980 m² GIA.

Building Element	Brief Description
Substructure	Raft foundations with insitu concrete bases to the main frame.
Superstructure	Reinforced concrete columns, beams, upper floors, and stairs.
Façade	External walls comprise of a metal panel, solid lintel panels and precast concrete strip. Windows and glazing comprise of aluminium curtain walls.
Walls and Finishes	Wall partition plasterboards. Use of vinyl flooring, paint, carpets and wall tiles.
Landscaping	Precast concrete paving to footpath, kerbs, and external furniture and fittings.

Table 1-2: Building Description- Upper Brook Street Sci-Tech Building



Figure 1-2: Site View- Upper Brook Street

1.4 Study Background

Whole life-cycle carbon emissions are the total greenhouse gas emissions arising from a 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 are 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 life-time 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.

1.5 Life-cycle modules

The WLC assessment covered all modules A, B and C 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 (module 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 (module A4 to A5):** These carbon impacts arise from transporting the construction products to site, and their subsequent processing and assembly into the building.
- **In-Use Stages (module 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.
- **End of Life Stages (module 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.

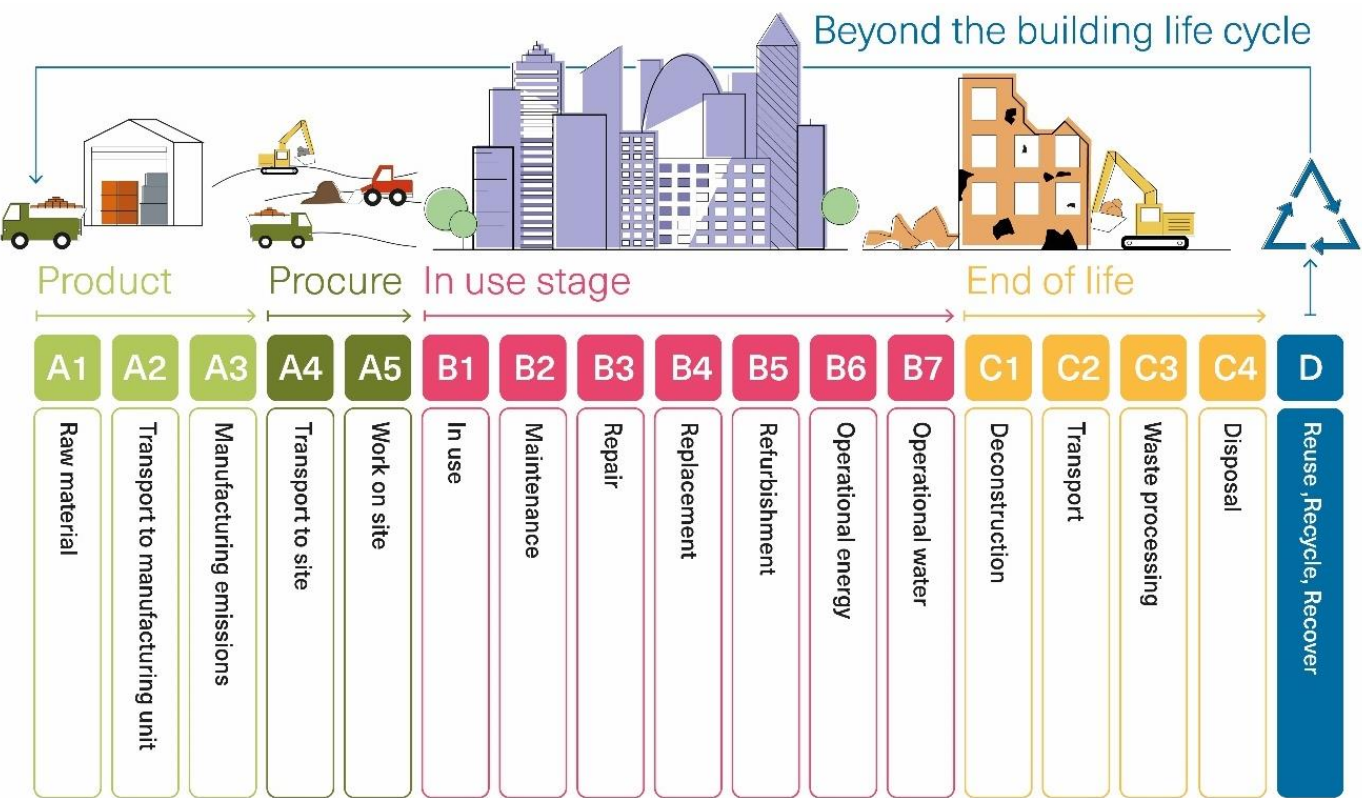


Figure 1-3: Life Cycle Modules as per BS EN 15978

1.6 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.

1.7 Assessment Scope

The building components included in the assessment are illustrated in Figure 1-4.

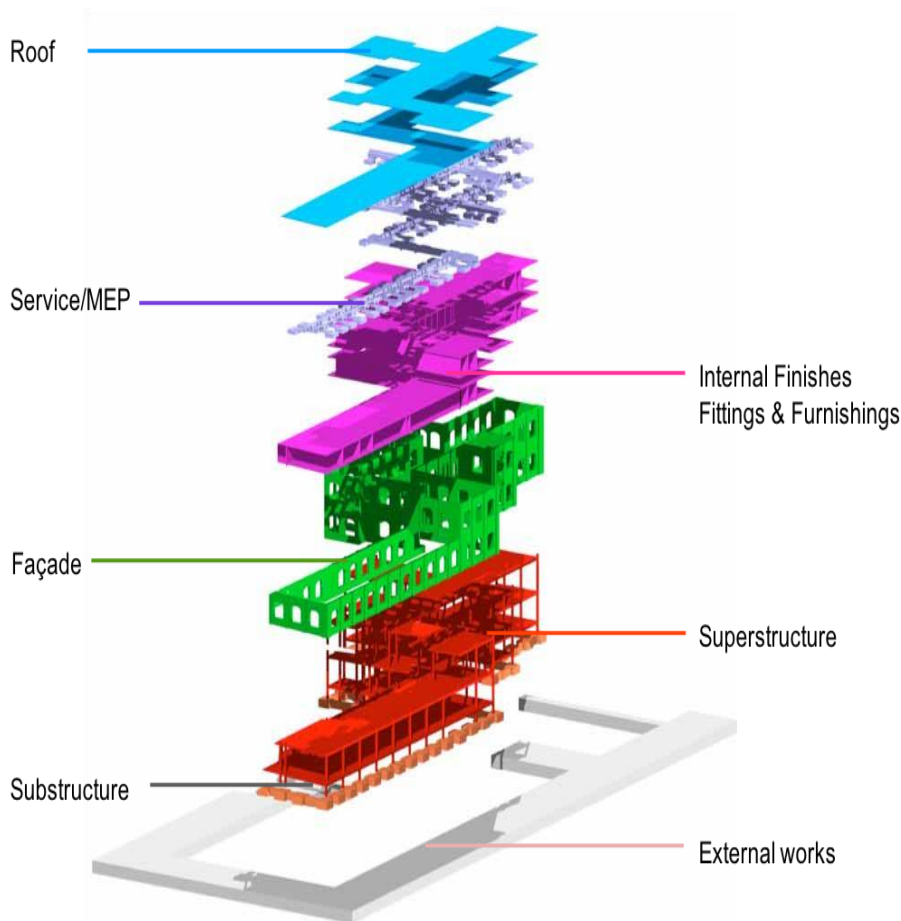


Figure 1-4: Indicative 3D Model of scope of elements analysed for embodied carbon impact

To ensure alignment with the LETI Rating System, External Works, Demolition and F,F&E building element category have been reported separately within the assessment for information. Building element categories as per LETI include Substructure, Superstructure, Façade, Internal Finishes, and Building Services (MEP).

1.8 Clarifications

The assessment is reflective of the expected level of detail and design information at 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): Quantity estimates of equipment and distribution systems in OneClick LCA applied to the main MEP elements as informed by the cost plan. Once more detailed, project-specific information becomes available, the MEP impact will be quantified using the CIBSE "TM65:2021 Embodied carbon in building services: a calculation methodology" as per current industry guidance.
- There were a lot of assumptions made for some of the building elements that were mentioned in the cost plan which will be investigated in the next stage.

1.9 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 1-3, where these can be considered at a later stage of the project design.

Main Exclusions from assessment	
1	▪ Trees and landscaping vegetation arrangement
2	▪ Fitting, furnishing and equipment
3	▪ External furniture and informal play areas

Table 1-3: Exclusions made for the Whole Life Carbon Assessment

1.10 Data sources

The main data sources used to input the whole life carbon assessment has been provided by Kadans Science Partners, in order to provide an accurate representation of the project's design. These are as followed:

- Project specific information: Main documentation, reports, and drawings specific from the project
- Information has not been provided stage 2 for material specification, as such assumptions were taken from the RICS professional statement guidance were adopted. Please refer to Appendix A -for more information.

1.10.1 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 1-4.

Information	Consultant	Reference
Architectural	Sheppard Robson	▪ Stage 2 architectural GA elevations and layouts (received on 06.03.2023)
Structural	HDRinc	▪ Manchester UBS Stage 2 Cost Plan (received on 05.04.2023)
Building Services	Wallace Whittle	▪ Embodied carbon estimated through cost plan data received: Manchester UBS Stage 2 Cost Plan (received on 05.04.2023)

Landscaping	Re:Form	▪ Manchester UBS Stage 2 Cost Plan (received on 05.04.2023)
Cost estimates	Gardiner & Theobald	▪ Manchester UBS Stage 2 Cost Plan (received on 05.04.2023)
GIA (area) 19,980 m²	Gardiner & Theobald	▪ GIA taken from the cost plan: Manchester UBS Stage 2 Cost Plan (received on 05.04.2023)

Table 1-4: Data Sources

2.0

Whole Life Carbon Assessment

2.0 Whole Life Carbon Assessment

2.1 Assessment Result

2.1.1 Overview

The total embodied carbon emissions for Upper Brook Street Sci-Tech Building for both Upfront Embodied Carbon (excluding sequestration) and Life Cycle Embodied Carbon (including sequestration) over a period of 60 years are shown in Table 2-1. This is based upon the design information received. For the development to reach a band “C” rating, this would require a reduction of the upfront embodied carbon intensity by 24% and whole life embodied carbon intensity of 24%.

Upper Brook 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 ₂ e	15,760	-30	9,760	25,400	-39
kgCO ₂ e/m ² GIA	789	-2	484	1,271	-2
LETI Rating System	E	-	-	E	-

Table 2-1: Embodied Carbon Summary- excluding operational emissions

2.1.2 Embodied Carbon Breakdown

Graphs in below Figure 2-1 show the proportional contribution of the different building element groups to both the upfront and whole life embodied carbon of the development. Table 2-2 shows the embodied carbon breakdown by building element group for the different life cycle modules.

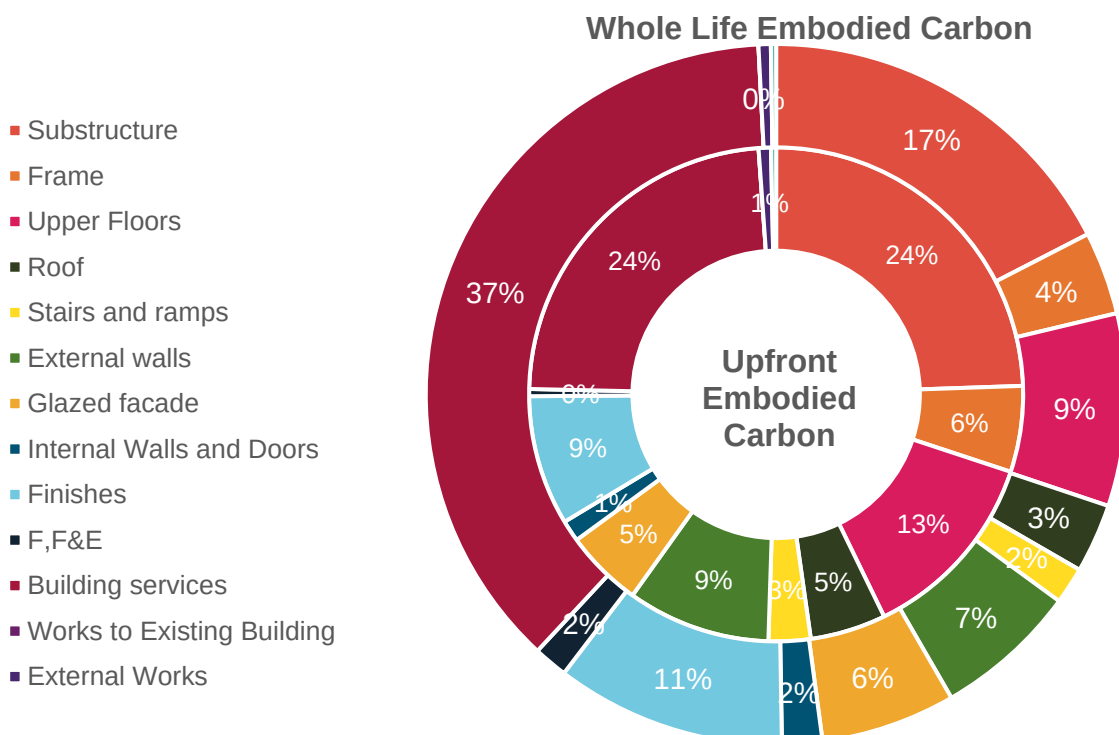


Figure 2-1: Embodied carbon breakdown by Building Element group (Upfront and WL Embodied Carbon)

Key findings:

Upfront Embodied Carbon:

- The carbon emissions occurring from the upfront embodied carbon is 62%
- Substructure ~ 23 %
- Superstructure, frame, and upper floors contribute ~30 %
- Internal Walls and finishes contribute ~10 %

Whole Life Embodied Carbon:

- Substructure, frame, and upper floors contribute ~ 38%
- External Walls and Façade contribute ~ 13%
- Internal walls and finishes contribute ~ 13%
- Building Services contribute ~ 36%
- External Works contribute ~ 1%
- Key emission areas over lifetime of the building: Substructure, Superstructure, External Walls, Finishes and Building Services

Embodied Carbon over Life Cycle (TCO _{2e}) (Aligned with LETI Scope)		Upfront Carbon	Carbon Sequestration	Life cycle impacts	End of life impacts	Whole Life Carbon	Benefits beyond boundary
		[A1-A5]	[A1-A5]	[B2-B5]	[C1-C4]	(TCO _{2e})	[D]
Substructure		3,650	10	0	660	4,320	0
Superstructure	Frame	1,100	0	0	110	1,210	0
	Upper Floors	2,550	0	0	310	2,860	0
	Roof	740	0	0	50	790	-31
	Stairs and ramps	410	0	5	5	420	0
	External walls	1,400	10	150	80	1,640	-8
	Glazed façade	760	0	770	10	1,540	0
	Internal Walls and Doors	210	-25	260	15	460	0
Finishes		1,420	5	1,480	35	2,940	0
Building Services (MEP)		3,510	0	5,680	40	9,230	0
Works to Existing Building		0	0	0	0	0	0
Total Embodied Carbon		15,760	-30	8,345	1,325	25,400	-39
Embodied Carbon intensity (kg CO_{2e}/m² GIA)		789	-2	418	66	1,271	-2
Below items are not within LETI rating scopes							
F, F & E		70	-5	320	5	390	-31
External Works		120	5	5	10	140	-1
Demolition		50	0	0	10	60	0

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

2.2 Upper Brook Street's Top Material Carbon Impacts

Figure 2-2 shows the top 10 materials with a high upfront embodied carbon coming from the Upper Brook Street Sci-Tech Building. Initial results show that the main focus of carbon emissions comes from the substructure of the building which is the concrete raft foundation due to the high volume of material used. Following second is the superstructure which consists of concrete frame, upper floors, and walls. Furthermore, the building services have high carbon impact and the use of external window with aluminium frame.

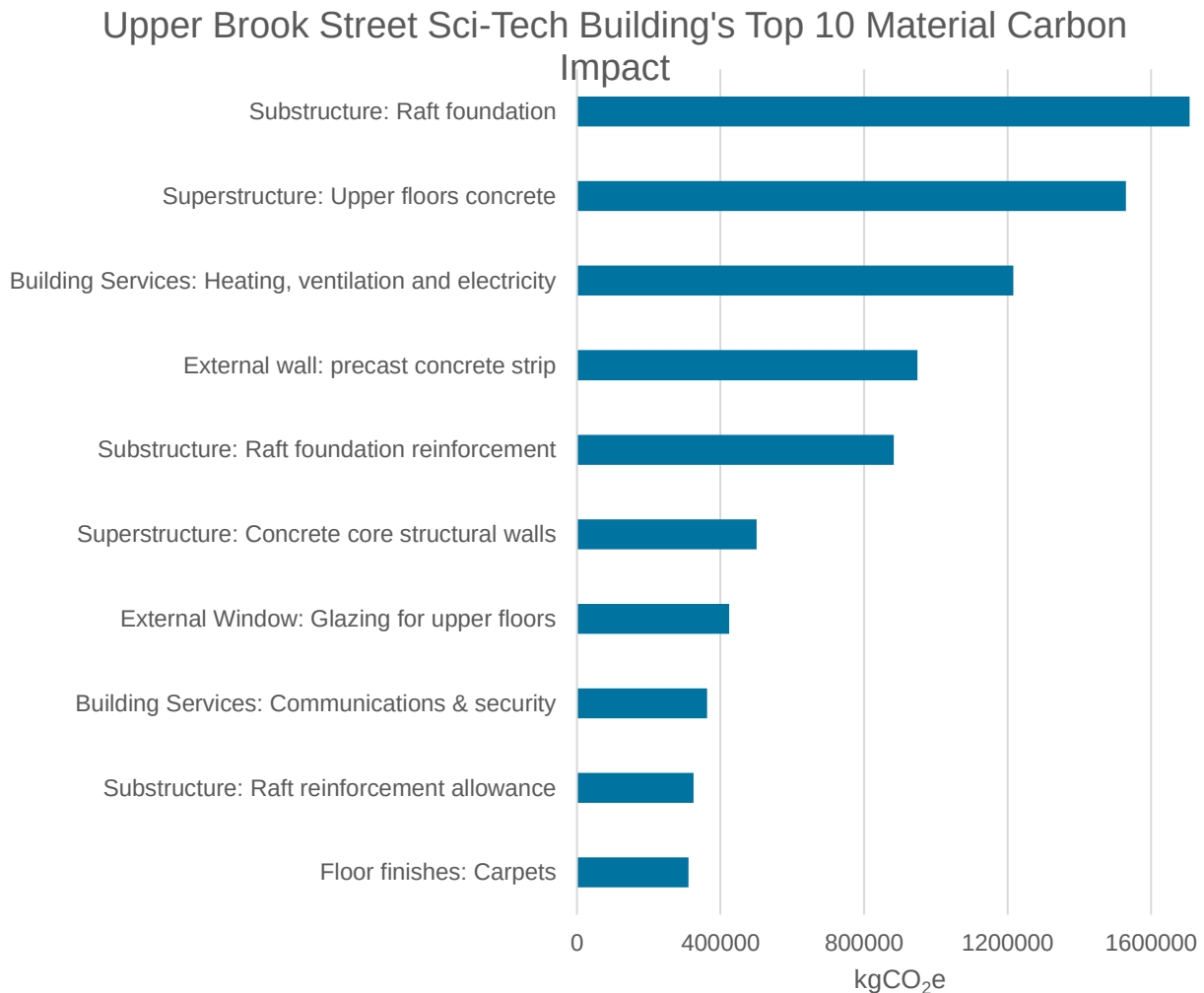


Figure 2-2: Upper Brook Street Upper Brook Street Sci-Tech Building's Top 10 Material Carbon Impact

2.3 Comparison with recent Cundall Laboratory Projects

In the following figure (Figure 2-3), it can be seen the relation between the Upper Brook Street Sci-Tech Building and various recent Cundall projects for similar laboratory buildings. The results given in each whole life carbon assessment show a similarity in the emissions released in each element of the development, highlighting the carbon hotspots: the substructure, the superstructure as a whole and the internal walls and finishes. It should be noted that each development is unique, so results are expected to have some variance.

The main similarity that can be seen from the Sci-Tech Building against the other projects is that the significant source of emissions comes from the structure of the building. Most of the project assessed have seen concrete foundations, frames, and floor slabs, while the trends for finishes and MEP services is also similar to project of this area. The façade, although each project has bespoke design, a pattern can be found that suggest that the development aligns to current construction standards. For the other building elements, most of the breakdown is comparable.

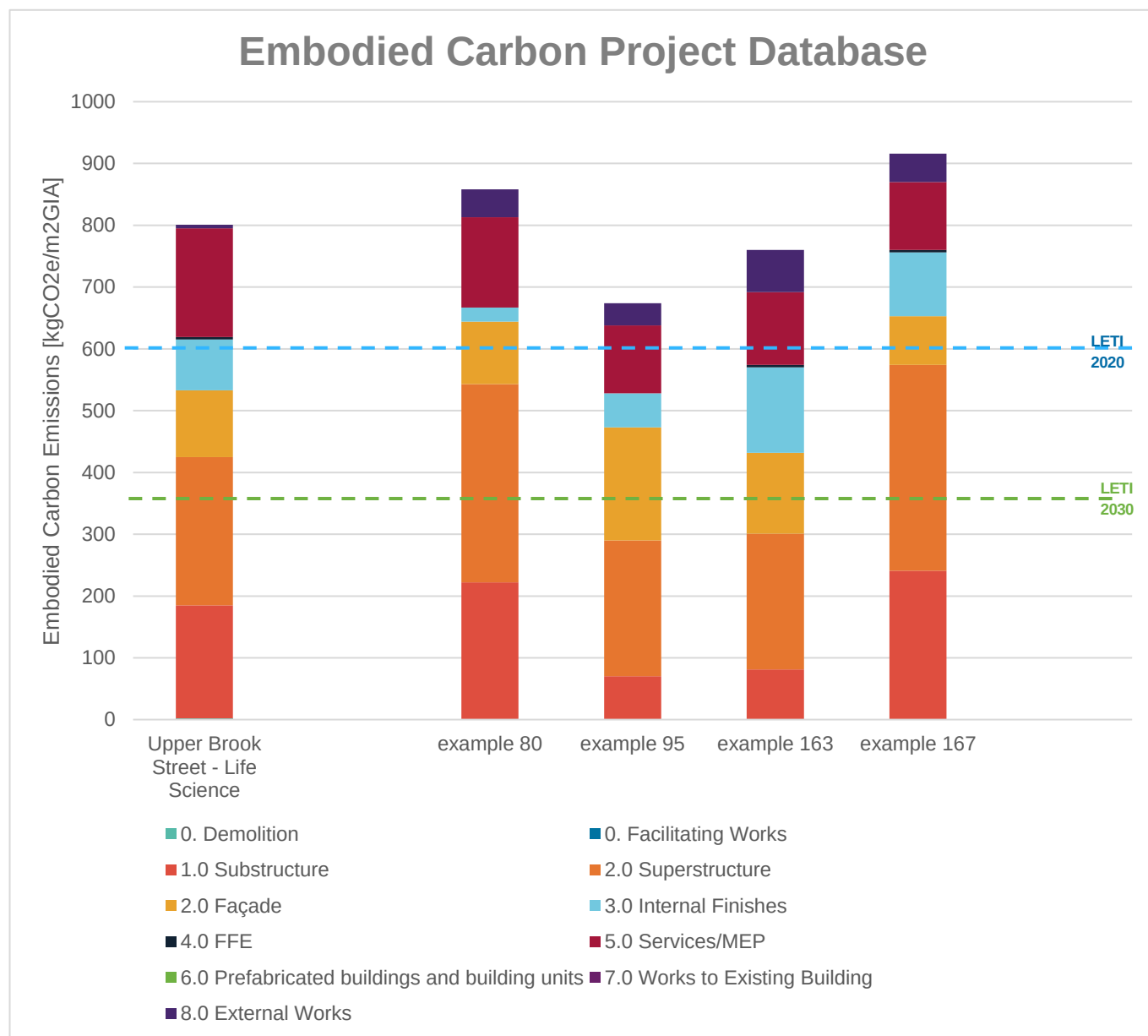


Figure 2-3: Upfront carbon breakdown by Building Element group from past Cundall projects

3.0

Whole Life Carbon Reduction Options

3.0 Whole Life Carbon Reduction Options

3.1 Overview

The reduction of the upfront embodied carbon is recommended through considering the following reduction options during Stage 2 design development.

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

- Substructure
- Frame
- External Façade
- Building Services

The options are applied retrospectively and demonstrate in theory how much embodied carbon could potentially be saved. This could 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 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 be realised by increasing cement replacement. Considering high cement replacement content with GGBS (Ground Granulated Blast-furnace Slag), FA (Fly Ash), SILICA FUME or powdered limes could deliver great carbon savings. For instance, having 50% GGBS cement replacement would reduce the carbon footprint of the concrete by around 40-45%.

Another consideration factor is the transportation of concrete. If in-situ concrete could be sourced from a nearby concrete plant (i.e. 10-25 km away), this could further reduce the carbon impact of the concrete.

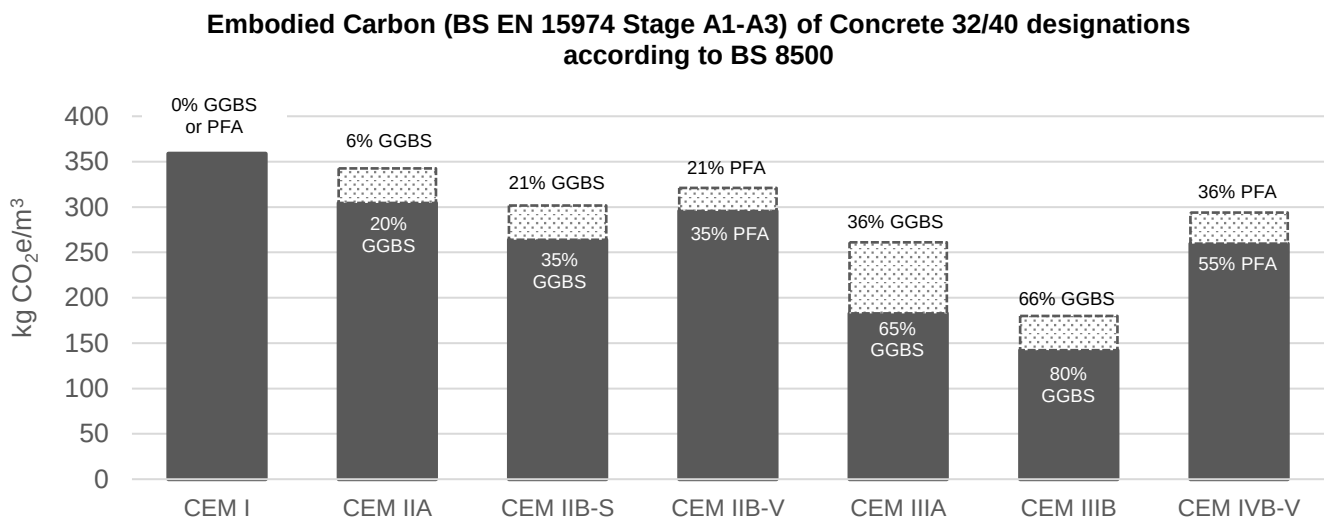


Figure 3-1 Embodied carbon of concrete with different cement replacement

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. Since some of the lowest carbon solutions may have an impact on the construction programme, client support may be required to align carbon objectives with other project requirements, such as cost and time on site. Early and ongoing collaboration with manufacturers and contractors will help determine the lowest carbon solutions available in concrete for that project.

Additionally, considerations can be required in a specification or to look out for concrete during procurement:

- Use the appropriate concrete strength
- Consider specifying 56 day or 90-day strength were appropriate
- Allow the use of admixtures
- Do not use small aggregate unless necessary, keep to 20mm maximum



Main recommendation for the carbon reduction of concrete should be considering the local sourcing of the product (less than 10 km) and the use of concrete with high % GGBS replacement (50 -70%). If all options are included, the total upfront carbon savings will be of **41.63 kgCO₂e/m²**

3.2.2 Steel

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

Structural steel with high recycled content is achieved through the Electric Arc Furnace (EAF) process, which uses scrap steel melted down. Therefore, a recycled content of 100% is possible. In terms of the steel market, around 20% steel plants in the UK use EAF, which makes it more challenging to source nationally. Early involvement of steel contractor is recommended to identify appropriate EAF procurement strategy. EAF-produced steel is more likely to come from European countries, however the carbon saved in production significantly outweighs any carbon increase from transportation.



Figure 3-2 CELSA Steel

Re-use of existing steel elements is the cheapest (and most sustainable) option but may be difficult in practice. Currently the project will retain up 20% of existing elements which also include the steel frames from the lower floor levels. There are currently a number of websites listing structural steel sections and other products available for re-use. As re-used steel becomes more available this should be the highest priority. Structural steel is now commonly being marked with QR codes to help inform future re-use potential.

Furthermore, EAF reinforcement to concrete can also be found within the current market, such as with the CELSA Group which reduce the carbon out of rebar by 55% against the current market version (Figure 3-1).

Table 3-1 below 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 CO ₂ /kg
Electric Arc Furnace (EAF)	80%	0.97 kg CO ₂ /kg

Table 3-1: Embodied carbon of steel from different furnace types



Main recommendation for the carbon reduction of steel should be considering the use of products made from Electric Arc Furnace. If all options are included, the total upfront carbon savings will be of **16.22 kgCO₂e/m²**

3.2.3 Insulation

There are many different insulation material types on the market, with varying thermal performance levels, so when trying to compare embodied carbon, several factors need to be considered to ensure you are comparing like-for-like and are making the right choice (see Figure 3-3). For a low carbon option, it should be considered the use of insulation made from natural materials. In the market there are various options to be considered which are as followed:

- Woodwool or wood fibre insulation (from sawmill residue and forestry cuttings bound with polyolefin fibres and added ammonium phosphate)
- Cellulose (made from recycled newspapers treated with boric acid and borax) in sprayed or slab form)
- Expanded cork insulation (made from bark harvested from the Quercus suber- Cork oak trees and can be in slab or board form)
- Hemp
- Sheep's wool
- Flax

Also, it is good practice consider the lifespan of insulation materials. Some materials are inert (e.g. glass fibre slabs), with a long lifespan and when loose laid and undamaged can be re-used at the end of the building's lifespan without loss of performance, whereas others are limited to single use applications.

Furthermore, start to consider insulation requirements and sustainability aspirations for projects early on in the process to allow for required build-ups in the design. Make sure requirements are communicated clearly in the specification to allow contractors to price and source accordingly.

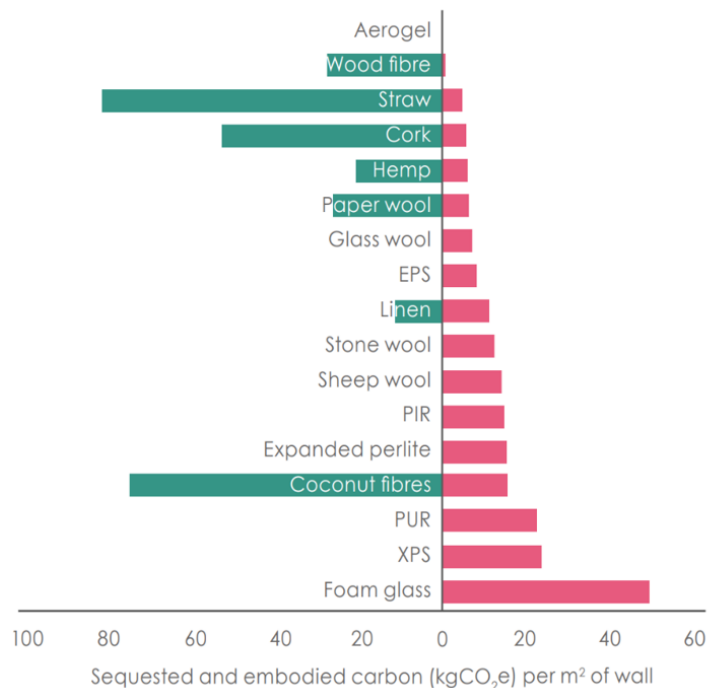


Figure 10: Insulation Carbon Options



Main recommendation for the carbon reduction of insulation should be considering the use of products made from natural materials such as hemp or wood fibre. If all options are included, the total upfront carbon savings will be of **0.70 kgCO₂e/m²**

3.3 Façade

The façade is expected to be a 'carbon hotspot' of the design, both in terms of its upfront embodied carbon, but also that over the life cycle of the building due to high levels of maintenance required and replacement events. Improvement could be sought in the following areas:

- Considering timber framed or combi (aluminium clad timber framed) or low carbon aluminium curtain walling and windows. Composite timber windows are understood to be the current baseline of the scheme.
- Sourcing brickwork locally, or using reclaimed/recycled bricks, where possible.

- Applying low carbon blockwork for façade build up.



Summary of recommendations from windows. If all options are included, the total upfront carbon savings will be of **0.78 kgCO₂e/m²**

3.3.1 Material from Finishes

The internal finishes contribute increased emissions over the lifetime of the building, due to high replacement events, therefore, to reduce the carbon impact, improvement could be expected when switching to reused and recycled materials, for example:

- Low carbon ceramic and vinyl tiles containing high recycled content
- Low carbon carpet tiles containing high recycled content
- Low carbon paint, which requires reapplication on average every 10 years



Summary of recommendations from finishes. If all options are included, the total upfront carbon savings will be of **20.75 kgCO₂e/m²**

3.4 Carbon Reduction Summary

3.4.1 Upper Brook Street Sci-Tech Building's Carbon Savings

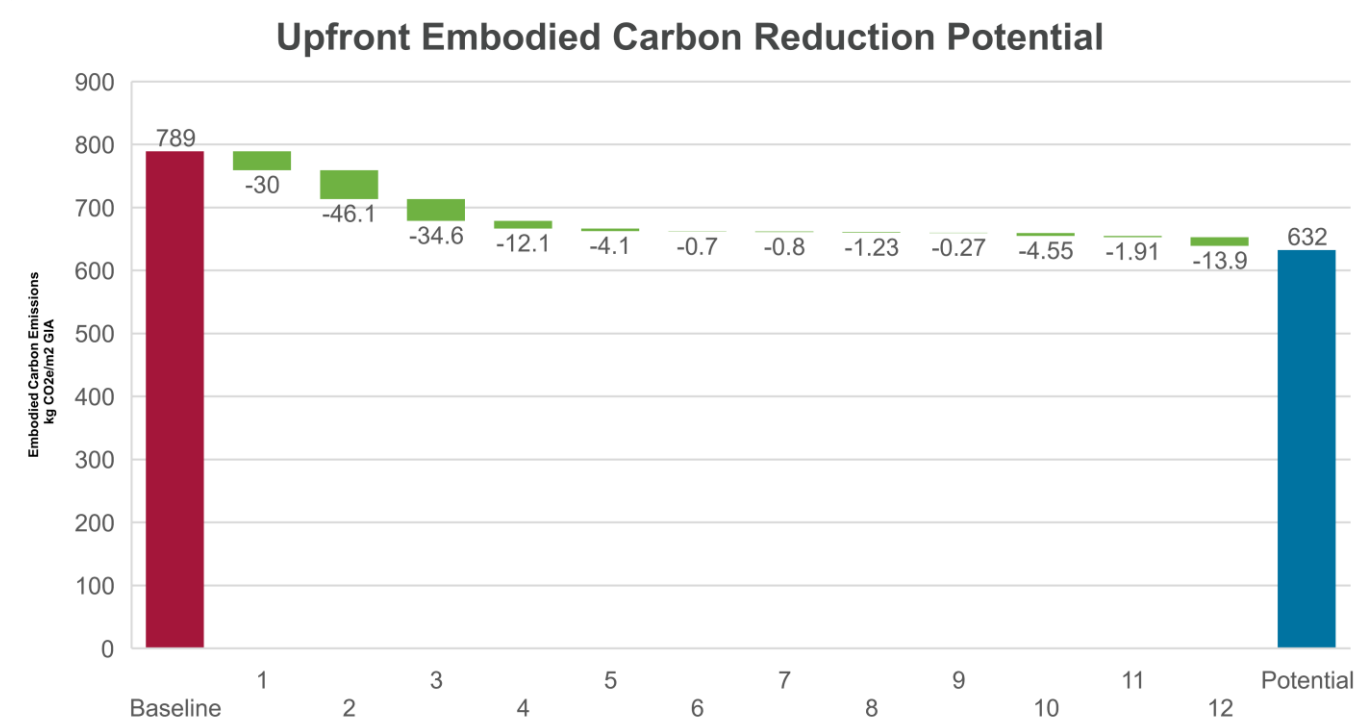


Figure 3-4: Upfront Embodied Carbon Reduction for Upper Brook Street if recommendations are applied

Option	Material	Building Element	Specification	Potential carbon saving for the project (Upfront Embodied Carbon)	
				tonnes CO ₂ e	kgCO ₂ e/m ²
1	Concrete	Substructure/ Superstructure	Locally sourced Concrete – within 10-25km	600.1	30.0
2		Substructure	GGBS (70%) – High Cement replacement content	920.3	46.1
3		Superstructure	GGBS (50%) – High Cement replacement content	691.8	34.6
4	Steel	Stairs	EAF steel	242.6	12.1
5		Concrete frame support	EAF steel	81.5	4.1
6	Insulation	Superstructure	Low carbon insulation / Rockwool insulation	13.9	0.7
7	Bricks	External walls	Use of recycled or reclaimed brickwork	15.6	0.8
8	Plasterboard	Internal Walls	Fermacell plasterboard	24.5	1.23

9	Finishes	Finishes	Low carbon paint	5.3	0.27
10			Low carbon vinyl	100.0	4.55
11			Low carbon screed	38.1	1.91
12				278.3	13.9
Total Upfront Embodied Carbon saving				3316.7	166.0
Additional Life-cycle Embodied Carbon saving				479.5	24.0

Table 3-2: 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 **3,796.2 tonne CO₂e**, which is an 15% reduction from the current position. The reductions would lead to an upfront embodied carbon value saving of **166 kgCO₂e/m²**.

3.5 Whole Life Carbon: Baseline v. Potential

Whole Life Carbon Comparison

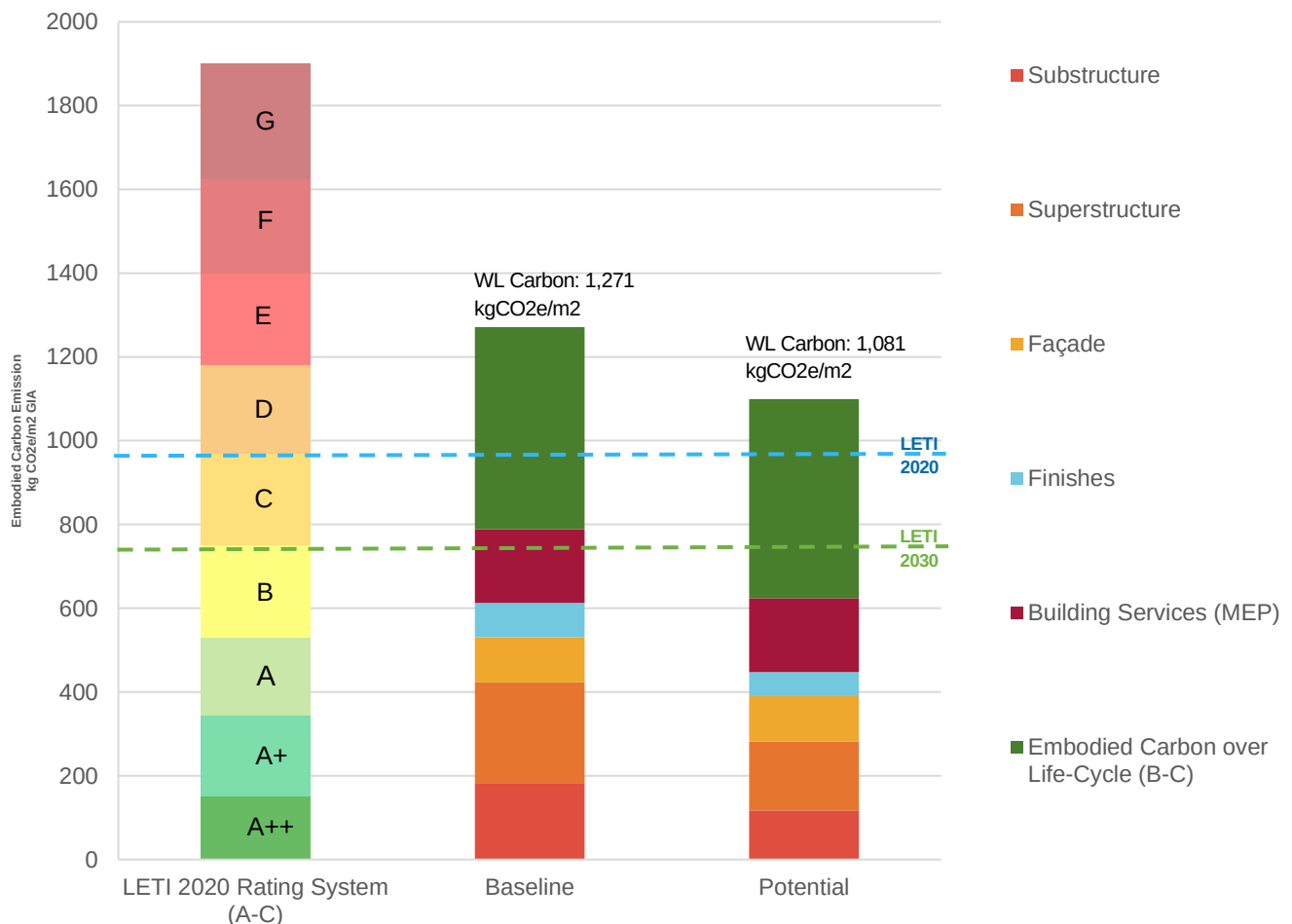


Figure 5 Whole Life Carbon Reduction Potential against the LETI office development embodied carbon intensity targets

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 ₂ e	15,760	25,400	12,447	21,598
kgCO ₂ e/m ² GIA	789	1,271	623	1,081
LETI Rating System Banding	E	E	D	D

Table 3-3: Whole life 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 Upper Brook Street Sci-Tech Building development in Manchester. The total embodied carbon emissions for Upper Brook Street Sci-Tech Building for both Upfront Embodied Carbon and Whole Life Embodied Carbon over a period of 60 years were found to be:

- Upfront Embodied Carbon = **789** kg CO₂e/m² (20,100 tonnes CO₂e)
- Whole Life Embodied Carbon = **1,271** kg CO₂e/m² (26,050 tonnes CO₂e)

Upfront and Whole Life Carbon Results

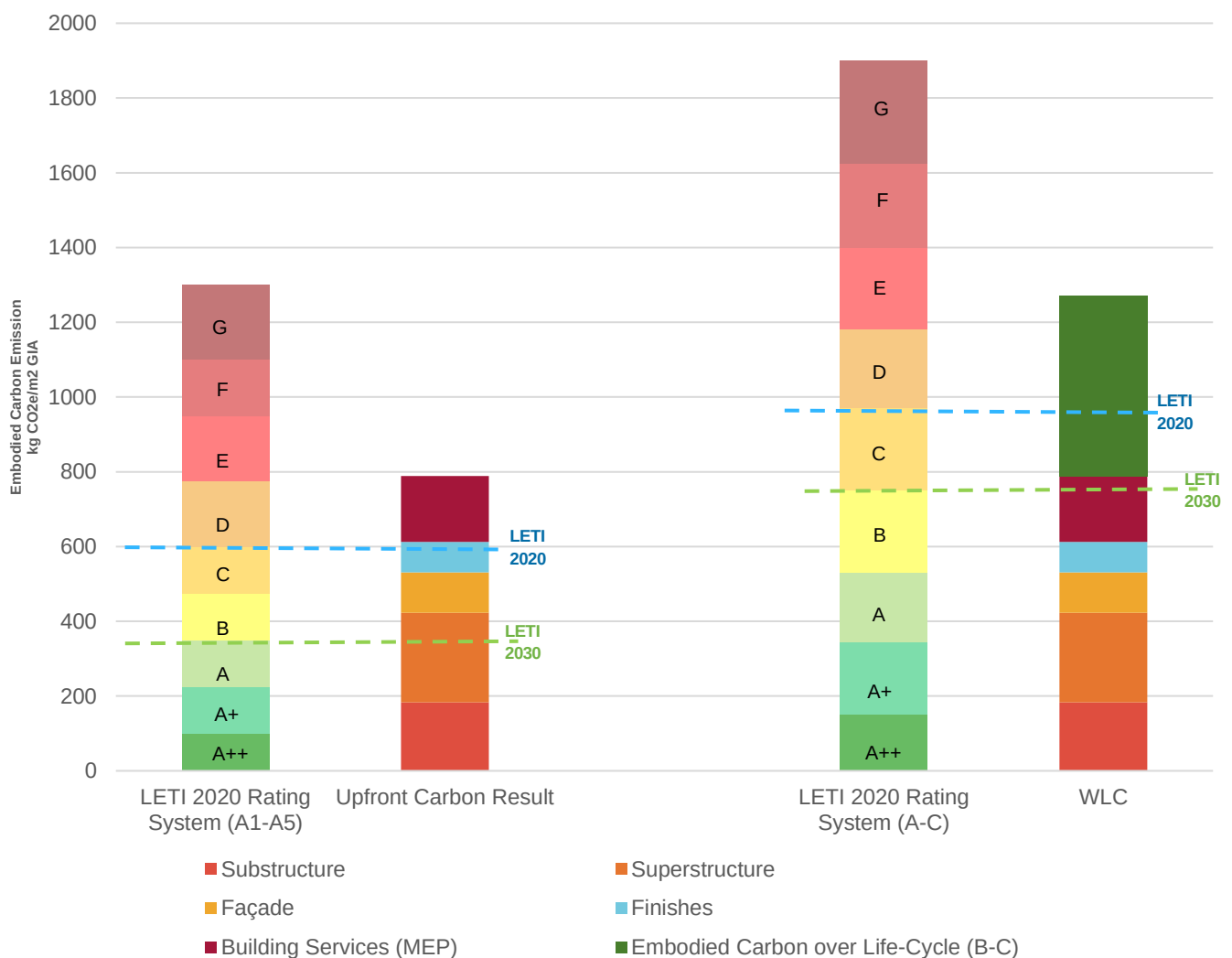


Figure 4-1: Upfront and WL Carbon of Upper Brook Street against the LETI office development embodied carbon intensity targets Reduction Options

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

1. Consider material carbon footprint data during procurement
2. Local sourcing of concrete – less than 25km.
3. High cement replacement for concrete used for substructure and superstructure

4. Consider high recycled steel (Electric Arc Furnace) from reinforcement, frames, roof, and upper floors
5. Considering timber framed or combi (aluminium clad timber framed) windows
6. Consider the use of reclaimed or high recycled brickwork
7. Tiles (both porcelain and vinyl) containing recycled content and low carbon
8. Avoid, if possible, the use of suspended ceiling systems
9. Consider low EC external and internal wall insulation
10. Consider low EC materials for the landscaping work

If the suggested options were followed, the overall reduction of the project's carbon footprint would be at least 15% which could result in an upfront embodied carbon intensity of less than 623 kg CO₂e/m², and a whole life carbon intensity of around 1,081 kgCO₂e/m², equalling current good to fair building design as defined by LETI & RIBA targets for office buildings. 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) kgCO ₂ e/m ²	787	623
LETI Rating System Banding	E	D

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

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

Table 4-1: 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 shareholder.

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 which allows for 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 Kadans Science Partners'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 includes target metrics relating to Potable Water Use.

RIBA 2030 Climate Challenge target metrics for domestic / residential

RIBA Sustainable Outcome Metrics	Business as usual (new build, compliance approach)	2025 Targets	2030 Targets	Notes
Operational Energy kWh/m ² /y 	120 kWh/m ² /y	< 60 kWh/m ² /y	< 35 kWh/m ² /y	Targets based on GIA. Figures include regulated & unregulated energy consumption irrespective of source (grid/renewables). BAU based on median all electric across housing typologies in CIBSE benchmarking tool. 1. Use a 'Fabric First' approach 2. Minimise energy demand. Use efficient services and low carbon heat 3. Maximise onsite renewables
Embodied Carbon kgCO ₂ e/m ² 	1200 kgCO ₂ e/m ²	< 800 kgCO ₂ e/m ²	< 625 kgCO ₂ e/m ²	Use RICS Whole Life Carbon (modules A1-A5, B1-B5, C1-C4 incl sequestration). Analysis should include minimum of 95% of cost, include substructure, superstructure, finishes, fixed FF&E, building services and associated refrigerant leakage. 1. Whole Life Carbon Analysis 2. Use circular economy strategies 3. Minimise offsetting & use as last resort. Use accredited, verifiable schemes (see checklist). BAU aligned with LETI band E; 2025 target aligned with LETI band C and 2030 target aligned with LETI band B.
Potable Water Use Litres/person/day 	125 l/p/day (Building Regulations England and Wales)	< 95 l/p/day	< 75 l/p/day	CIBSE Guide G.

RIBA 2030 Climate Challenge targets for domestic buildings (updated 2021 version)

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.

