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Whole Life Carbon Assessment

Saffron Hill – Office building

For

Saffron Hill Investment holdings

September 2023

Rev F: February 2024

Carbon Plan Engineering Limited (9717995) – 12 St Georges Square, Huddersfield, West Yorkshire, HD1 1JF engineering@carbonplan.co.uk

Revisions schedule		
Issue Date: September 2023		
Report prepared by: Han-Chieh Lee, Consultant, Carbon Plan Engineering		**Date:** 13th September 2023
Checked by: Alan Calcott, Director, Carbon Plan Engineering		**Date:** 15th September 2023
Status	FINAL for Planning	
Revision	**Date**	**Changes**
A	14th October 2023	General Update to include ❑ corrections to quantities of rebar ❑ rationalised steel structure ❑ updated MEP quantities
B	25th October 2023	Updated to match design outcomes from client and planning workshops
C	15th December 2023	Finalised and updated for planning submission
D	4th January 2024	Minor update while design progress
E	15th February 2024	Update with comments and issued for Planning
F	29th February 2024	Update with comments and issued for Planning

Please do not print unless necessary

Please note that the results in this document are high level only and should not be relied upon for financial forecasting as every business will use the building differently.

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Executive Summary

1.1 Introduction / context

This document presents the Whole Life-cycle Carbon Assessment (WLCA) – the combined Embodied Carbon and Operational Carbon emissions – for the proposed development at 45-54 Saffron Hill and 3 Saffron Street. The primary reason for developing the WLCA is to enable an understanding of the impacts of the proposed development at the early stage.

The WLCA is also provided to enable the design team with information that will assist in identifying choices when finalising design solutions to reduce the impacts that we have identified.

- the **Lifecycle Carbon Assessment** (LCA) measures embodied carbon and is based upon the Stage 2 designs with some assumptions while the manufacturers aren't finalised at this stage.

The following item will have more detail assessment at the later stage.

- the **Operational Energy use** – based upon the TM54 operational energy calculations included within the Energy Strategy
- any future potential carbon savings post end-of-life, including savings from reuse and recycling of building structure and materials.

1.2 Methodology

BS EN15978:3011 is the basis for this assessment in alignment with the RICS guidance for Whole Life Carbon Assessment for the built environment (2017) and GLA WLCA Guidance; utilising One click LCA software. The Assessment is also produced in accordance with GLA WLCA Guidance 2022. (Please see section 2.1 for more information)

Life-cycle modules

- Module A1 – A5 (product sourcing and construction stage)
- Module B1 – B7 (use stage)
- Module C1 – C4 (end-of-life stage)
- Module D (benefits and loads beyond the system boundary)

Assumed building life span

The reference study period for the purposes of the assessment **60 years** aligns with the RICS and GLA WLCA Guidance. This is the case even when the design life of the project exceeds or is less than 60 years, the assessment should still be done to 60 years but with an accompanying explanation of the life cycle and end-of-life scenarios for the actual design life.

1.3 Results

The Whole Life Carbon impacts (A1-C4) are calculated according to the EN-15978 as being **15,109,278 $kgCO_2$** including **2,389,018 $kgCO_2$** for Carbon Sequestration with the Upfront Carbon impacts (A1-A5) calculated as **6,570,424 kg CO_2**. Energy consumption in-use (B6) is contributing **5,243,583 $kgCO_2$** while Water consumption in-use (B7) is contributing **861,733 $kgCO_2$**.

Table 1 - WLCA Results

EMBODIED CARBON:	tonnes CO_2e	$kg/CO_2/m^2$
'Upfront' / 'Cradle to Practical Completion' Emissions (A1 – A5)	6,570.42	554.37
Carbon Sequestration	-2,389.02	-201.57
Anticipated Life Cycle 'in use' Embodied Carbon Emissions (B1 – B5)	2,244.95	189.42
Anticipated 'End of Life' Emissions (C1-C4)	2,577.61	217.48
OPERATIONAL CARBON:		
Anticipated Life Cycle Operational Energy and Water Emissions (B6-B7)	6105.32	515.13

Figure 1 - WLCA result

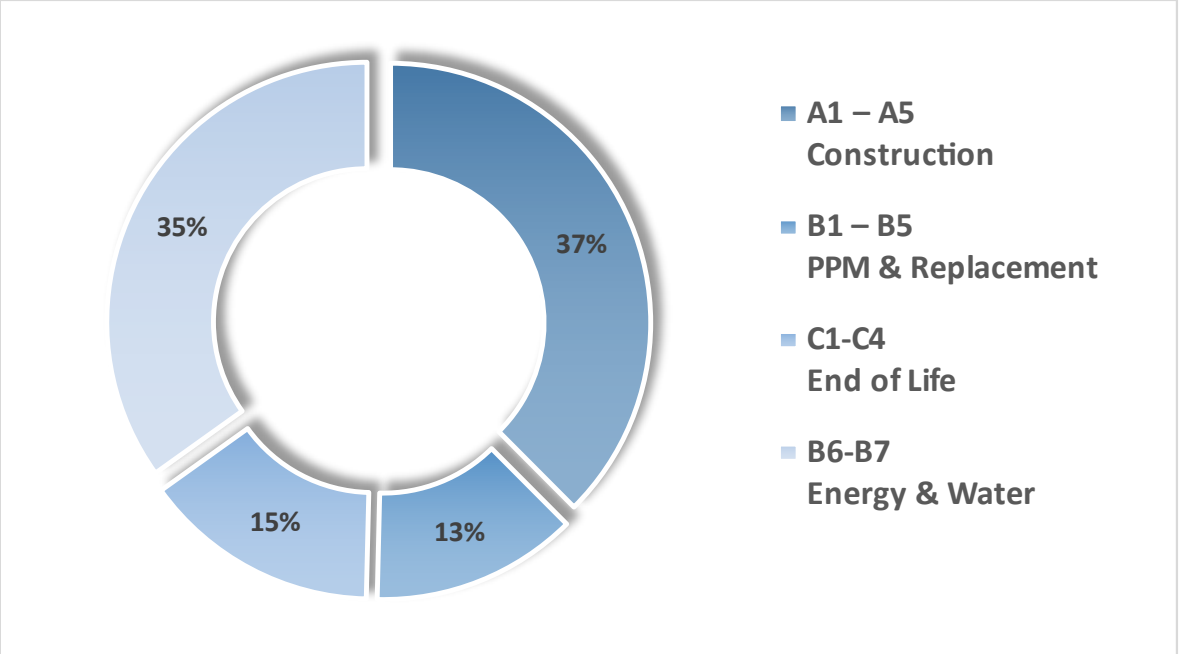
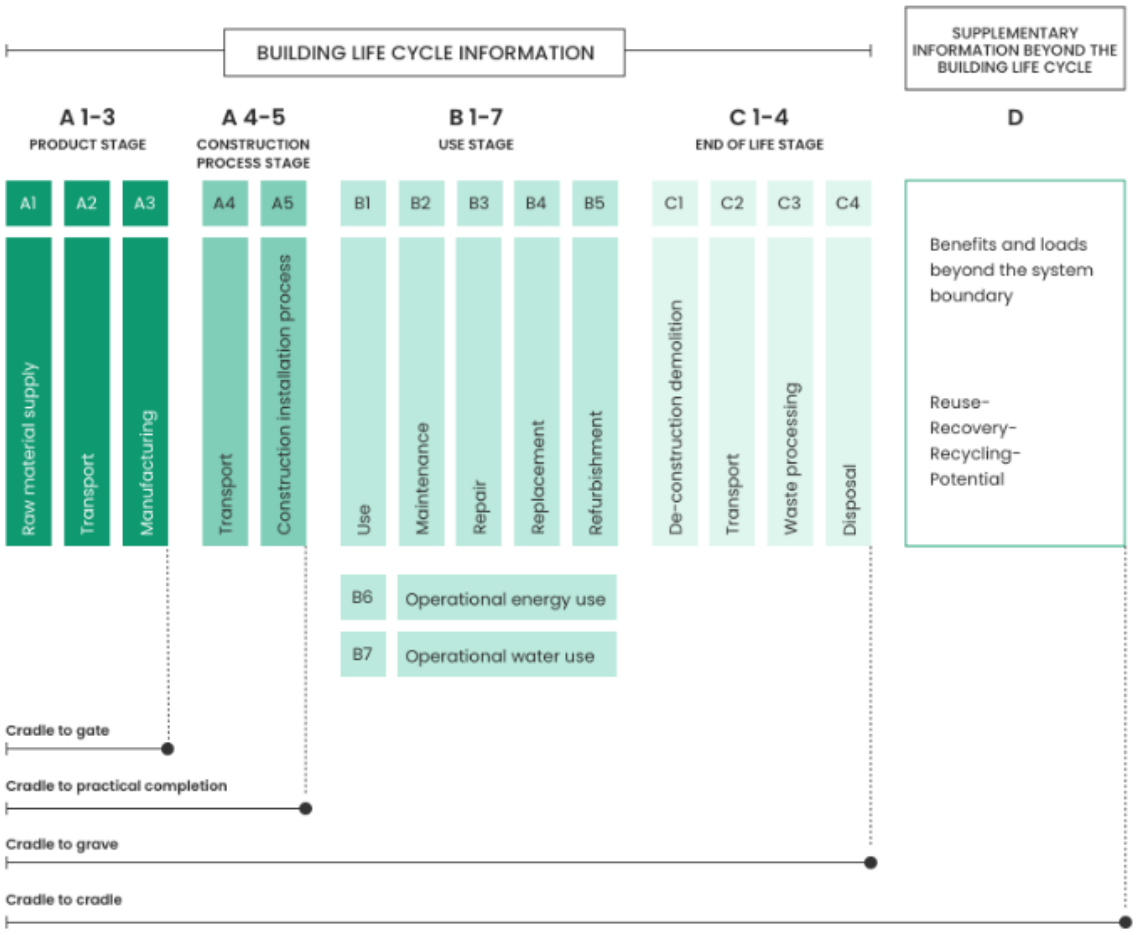
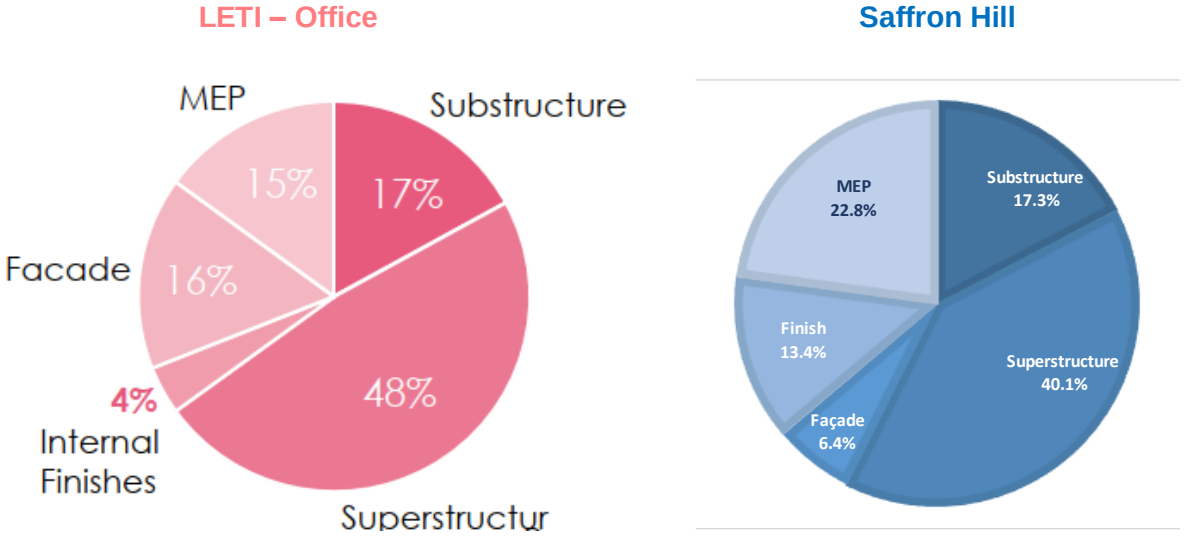


Figure 2 - Building life-cycle module according to the EN-15978



A1 to A3 Up front impacts total **5,999,060kgCO_2** and are broken down and compared with the LETI figures as shown in figure 3.

Figure 3 – Up Front impacts – compared by type



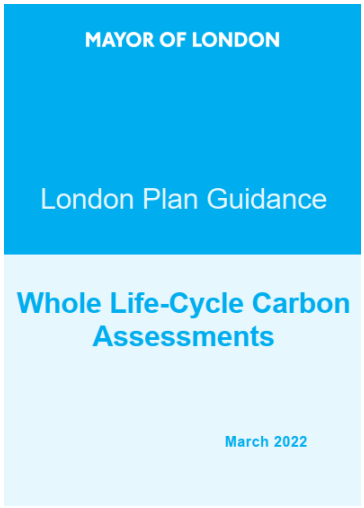
2 Detailed Analysis

This section sets out the detailed results of the WLCA along with assumption and qualifications on the data quality.

2.1 Policy Context

This section summarises the applicable planning policies that influence the Whole Lift-cycle carbon Assessment for the proposed development. The planning criteria is generally set out within the following:

- Whole Life-Cycle Carbon Assessments Guidance – GLA Guidance on preparing WLCA (2022)
- GLA New London Plan (2021)



Whole Life-Cycle Carbon Assessment Guidance (2022)

The Greater London Authority published in March 2022 an update to their guidance document which sets out how to prepare the WLCA to accompany strategic planning applications in London.

Whole Life-Cycle Carbon (WLC) assessment in line with Policy SI 2 F of the London Plan 2021 using the WLC assessment template. Policy SI 2 F applies to planning applications which are referred to the mayor. However, WLC assessments are also supported and encouraged on major applications that are not referable to the Mayor.

This guidance explains how to calculate WLC emissions and the information that needs to be submitted to comply with the policy. It also includes information on design principles and WLC benchmarks to aid planning applicants in designing buildings that have low operational carbon and low embodied carbon.

2.1.1 GLA WLCA Guidance – to include policy context.

The WLC assessment template would include all the information listed in **GLA WLCA Guidance Section 3.2.2 Box 4** (brief mentioned below), please see the template included in Appendix A for more detail information.

- Project and assessment details: please see the introduction and this assessment is carried out by One Click LCA and EPDs according to both EN15804 amendments, A1 and A2
- The Bill of Quantities / Cost Plan has confirmed that the assessment accounts for a minimum of 95 per cent of the capital cost allocated to each building element category. (Section 2.1.1)
- The third-party mechanisms – This will be considered in the later stage while the design develops.

- The Estimated total WLC emissions ($kgCO_{2e}$ and $kgCO_{2e}/m^2$ GIA) for each life-cycle module are reported in the report (Section 2.5) and the template.
- The options for retaining existing buildings and structures have been fully explored and reported in the Pre-Redevelopment Audit, Pre-Demolition Audit and Circular Economy.
- The carbon emissions associated with pre-construction demolition are included in the One Click LCA model and reported in the template.
- There is 60% of the foundation would be the existing structure.
- Summary of key actions to achieve the WLC emissions reported and the emission reductions they are expected to achieve. – proposed key materials with recycled content.
- Opportunities to reduce the development's WLC emissions further – considering procured the longer life span and lower emission raised access floor.
- Completion of the 'material quantities and end-of-life scenarios' table covering all building element categories. Please see the table in the template is included in the Appendix B.
- Completion of the 'GWP of all life-cycle modules' table.

2.2 WLCA Inputs and assumptions

2.2.1 Building elements

Table 2 - Building Elements included in assessment

RICS #	BUILDING ELEMENTS	Coverage %
0	0.1 temporary work	N/A
1	1.1 Substructure	100%
2	2.1 Superstructure: Frame	100%
	2.2 Superstructure: Upper Floors	100%
	2.3 Superstructure: Roof	100%
	2.4 Superstructure: Stair and ramps	100%
	2.5 Superstructure: External wall	100%
	2.6 Superstructure: Windows and External Door	100%
	2.7 Superstructure: Internal Walls and Partitions	100%
3	3.1 Wall Finishes	0%
	3.2 Floor Finishes	95%
	3.3 Ceiling finishes	N/A
4	4. Fittings, furnishings, and equipment	N/A
5	5.1. Sanitary installations	95%
	5.3 Foul drainage above the ground	100%
	5.4 Water installation	95%
	5.6 Space heating and air conditioning	95%
	5.7 Ventilation systems	95%
	5.8 Lighting installation	95%
	5.10 Lift and conveyor installation/system	95%
	5.11 Fire and Lightning Protection	95%

Note: This project is an Office building and will be a Cat A fitout which means most of the finishes won't be included in the scope as that will be fitted by the future tenant.

2.2.2 EN 15978 Module Coverage and life span

BS EN15978:3011 is the basis for this assessment in alignment with the RICS guidance for Whole life Carbon Assessment for the built environment (2017); utilising One click LCA software.

Life-cycle modules

- Module A1 – A5 (product sourcing and construction stage)
- Module B1 – B7 (use stage)
- Module C1 – C4 (end-of-life stage)
- Module D (benefits and loads beyond the system boundary)

This assessment has included the A1-A5, B1, B3, B4, B6, B7, C1-C4, and D (not included in the result).

Assumed building life span

The reference study period for the purposes of the assessment is **60 years** which the building target and anticipated to last. Where the design life of the project exceeds or is less than 60 years, the assessment should still be done to 60 years but with an accompanying explanation of the life cycle and end-of-life scenarios for the actual design life.

2.2.3 Data, measurement source and assumption

As per EN15978-2011 section 9.1stated that ..." *The quantification of all material and products is determined based upon the design description of the object of assessment (new building or refurbishment of an existing building) or with the actual quantities (existing buildings, post-refurbishment) and the scenarios for each module of the life cycle of the object of assessment."*

Floor area

The assessment has taken the floor area from the Exigere document *2023-12-13-Area Measurement Report - Stage 2 Design Freeze.pdf* document – GIA 11,852m^2.

Materials quantity, selection, and assumptions

Generally we have followed the Bill of Quantities provided by Exigere which has been accompanied by measurements and specific data provided by various consultants.

- **Structure**: Quantity schedule *2929-Saffron Hill, Stage 2 Structural Feasibility Report* issued by Structural Engineer - HTS - included Quantity and specifications.
- **Architecture:** AHMM planning drawings document on 20240209 issued for building detail and GA plan.
- **MEP**: Sanitaryware quantity as GA plans
- **Cost Plan/ Bill of Quantities**: "Saffron Hill CATO Excel Export" from cost consultant - Exigere.

Please see more information in the Appendix B for more information of the quality assuring process and quality data sourcing table.

Excluded from this assessment

- Most internal handrail, brackets, and balustrade
- Any finishes and fitting outside of core areas.
- All fixed and fitting within the café and reception at this stage.

2.2.4 Tools and embodied carbon data

To assess the embodied carbon for the project, a Life Cycle Assessment (LCA) tool – One Click LCA – has been used to make allocations for the anticipated materials quantities. Material carbon data is based on One Click LCA database which utilises EPDs in accordance with EN 15804, and Material specification, transport assumptions, lifespan assumption, and end-of-life scenarios is based on RICS Professional Statement.

Unless noted below we have used standard values for service lifespans and transport.

Module A4 Transport Assumptions

No specific changes

Module B4 Service Life Assumptions

RICS whole life carbon assessment for the built environment guidance state that …"*It should be assumed that items are being replaced on a like-for-like basis and full replacement (100 per cent) of the items is assumed once the specified lifespan is reached.*"

No changes have been made to any One Click LCA datapoints' default value (RICS Professional Statement Table 9) except all the cabinet would have a 20-year life span instead of 12 years, due to the improvement of technology and materials compare to 2017. However, this will have to be updated at As-build stage with more accurate figure with the manufacturer/supplier O&M Manual or specified product EPD.

2.3 LCA Results

2.3.1 Main LCA impacts

The top 15 Material categories make up **83.7% of total A1 – A3 impact of materials** and within this:

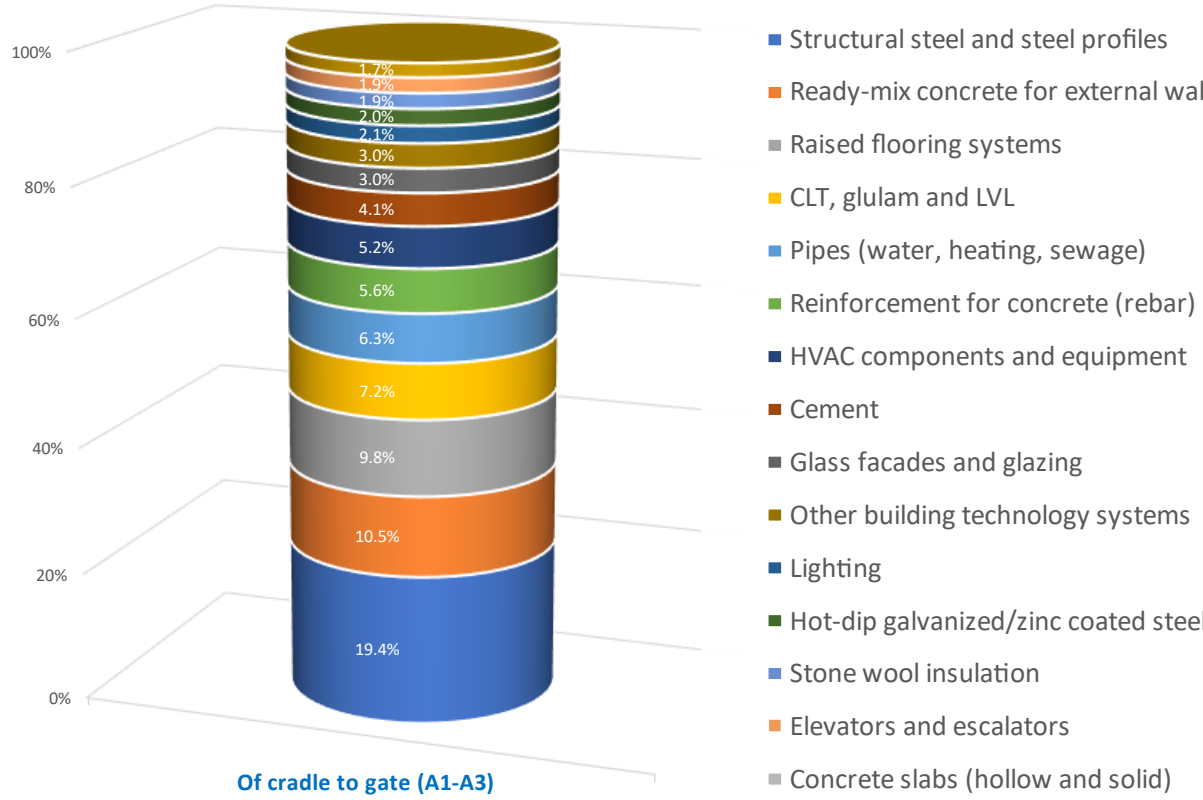
- Steel Frame = **~25% of total materials impact**.
- Raised Access flooring = **9.8% of total materials impact**.
- MEP services materials have **22.8% of total materials impact**.

Table 3 - The top 25 materials

	Resource / Material / Product	Cradle to gate impacts (A1-A3)	Of cradle to gate (A1-A3)
1	Structural steel and steel profiles	1,162.75	19.4%
2	Ready-mix concrete for external walls and floors	627.34	10.5%
3	Raised flooring systems	589.85	9.8%
4	CLT, glulam and LVL	429.25	7.2%
5	Pipes (water, heating, sewage)	375.00	6.3%
6	Reinforcement for concrete (rebar)	335.35	5.6%
7	HVAC components and equipment	312.72	5.2%
8	Cement	245.87	4.1%
9	Glass facades and glazing	181.63	3.0%
10	Other building technology systems	180.43	3.0%
11	Lighting	128.74	2.1%
12	Hot-dip galvanized/zinc coated steel	121.71	2.0%
13	Stone wool insulation	112.80	1.9%
14	Elevators and escalators	112.65	1.9%
15	Concrete slabs (hollow and solid)	104.60	1.7%
16	Ventilation ducts and channels	97.42	1.6%
17	Sealants (silicone and others)	95.69	1.6%
18	Aluminium	84.51	1.4%
19	HVAC equipment with refrigerant	75.10	1.3%
20	Specialty gypsum board	62.38	1.0%
21	Other precast concrete products	61.52	1.0%
22	Regular gypsum board	55.26	0.9%
23	EPS (expanded polystyrene) insulation	45.97	0.8%
24	Other metals	45.80	0.8%
25	Acoustic insulation panels	41.08	0.7%

The top 15 materials are represented in the chart below.

Figure 4 - The top 15 materials



The following charts shows the material flows over the lifespan of the building and how this is broken down by Lifecycle stage and within the RICS categories.

Figure 5 – Material flows over lifespan of the building

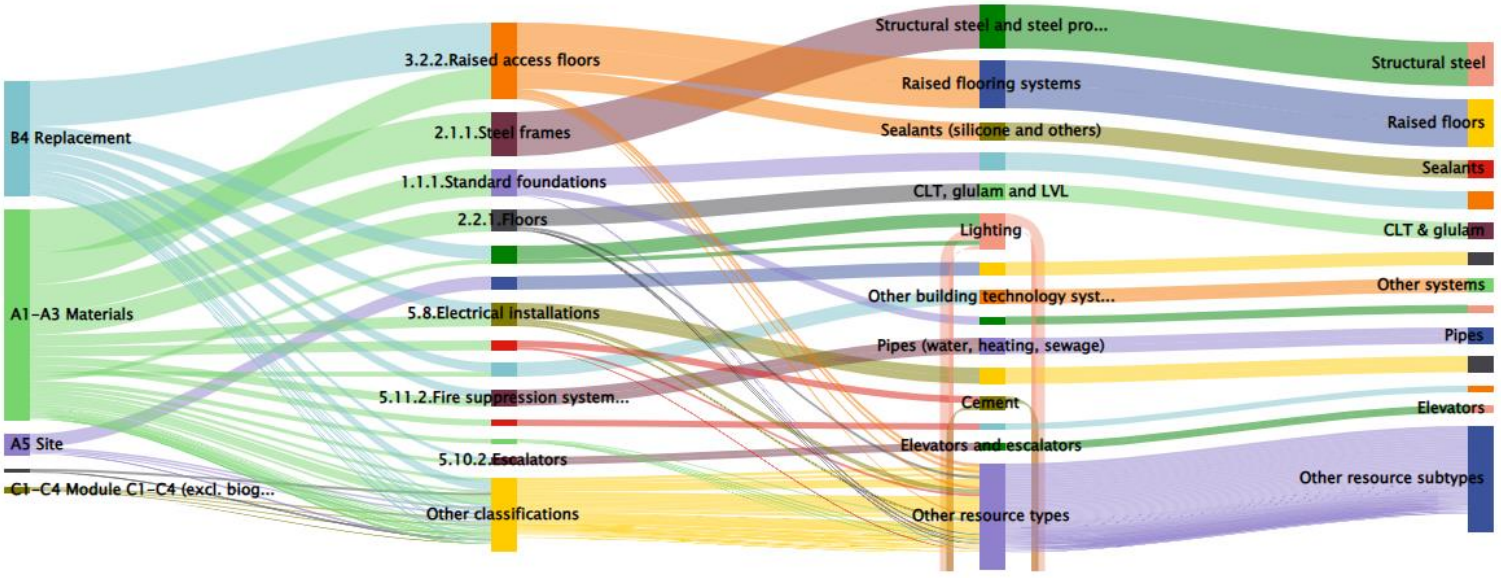
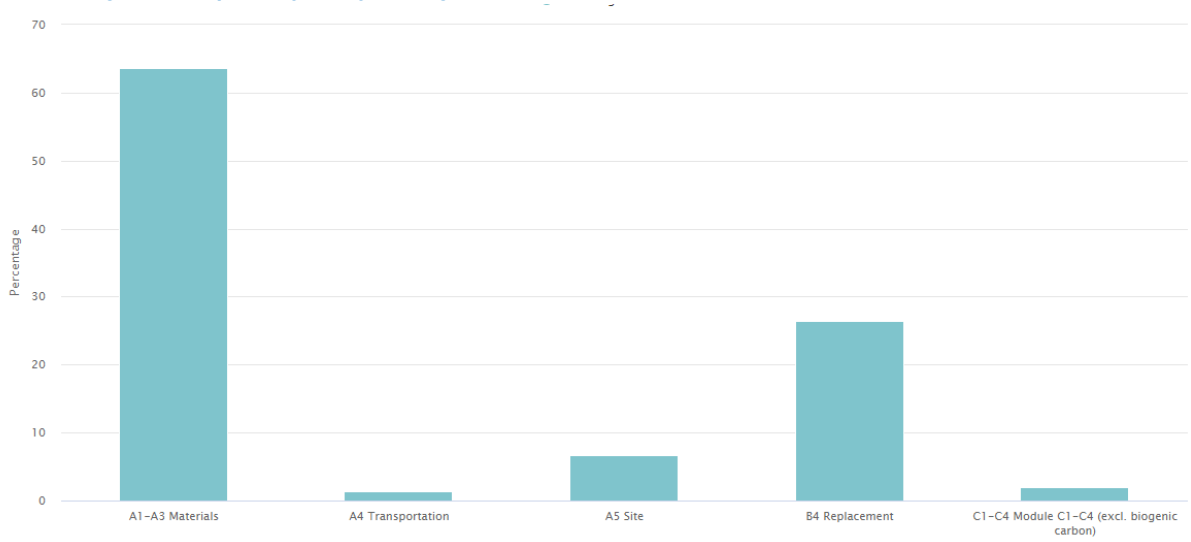
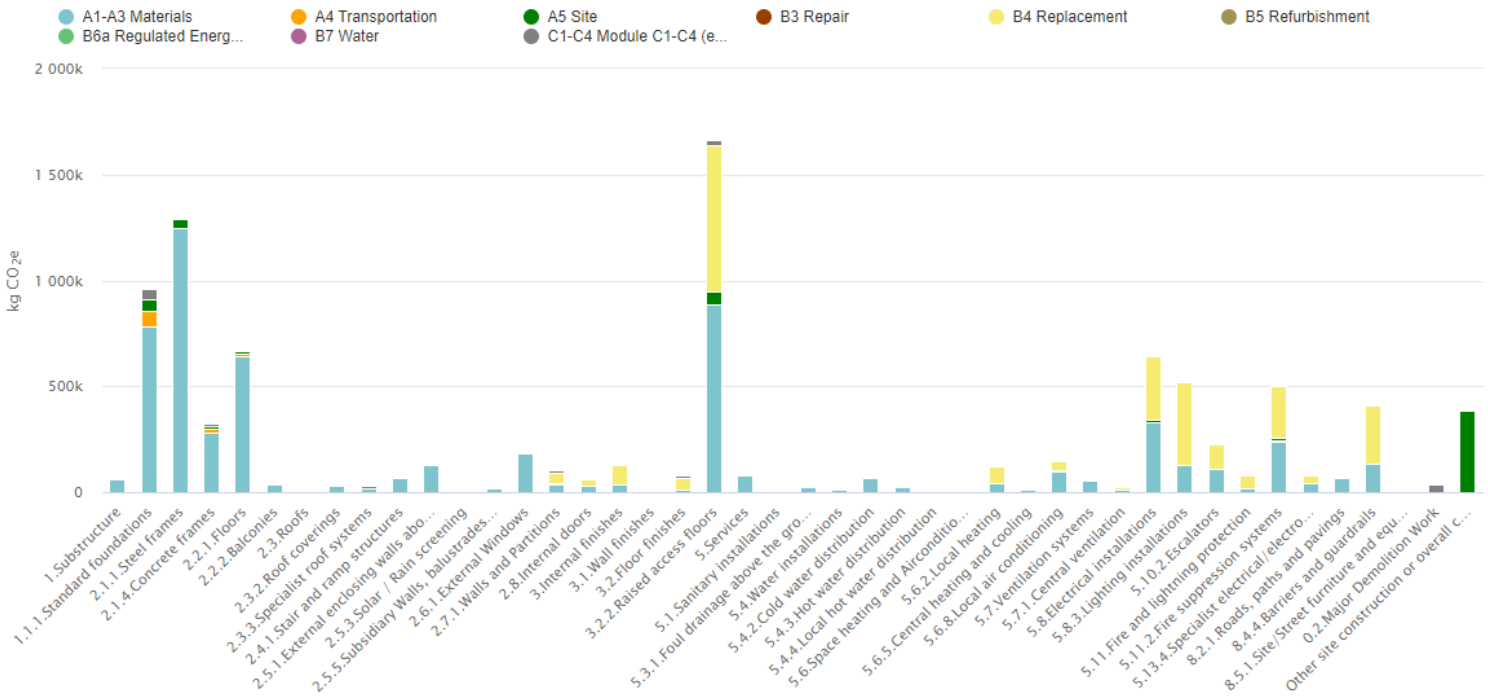


Figure 6 – Impacts by Lifecycle stage



As the graph above shows that the two major impacts are from A1-A3 – the Up Front Materials – and from module B4 which represents Replacement of materials over the building lifecycle.

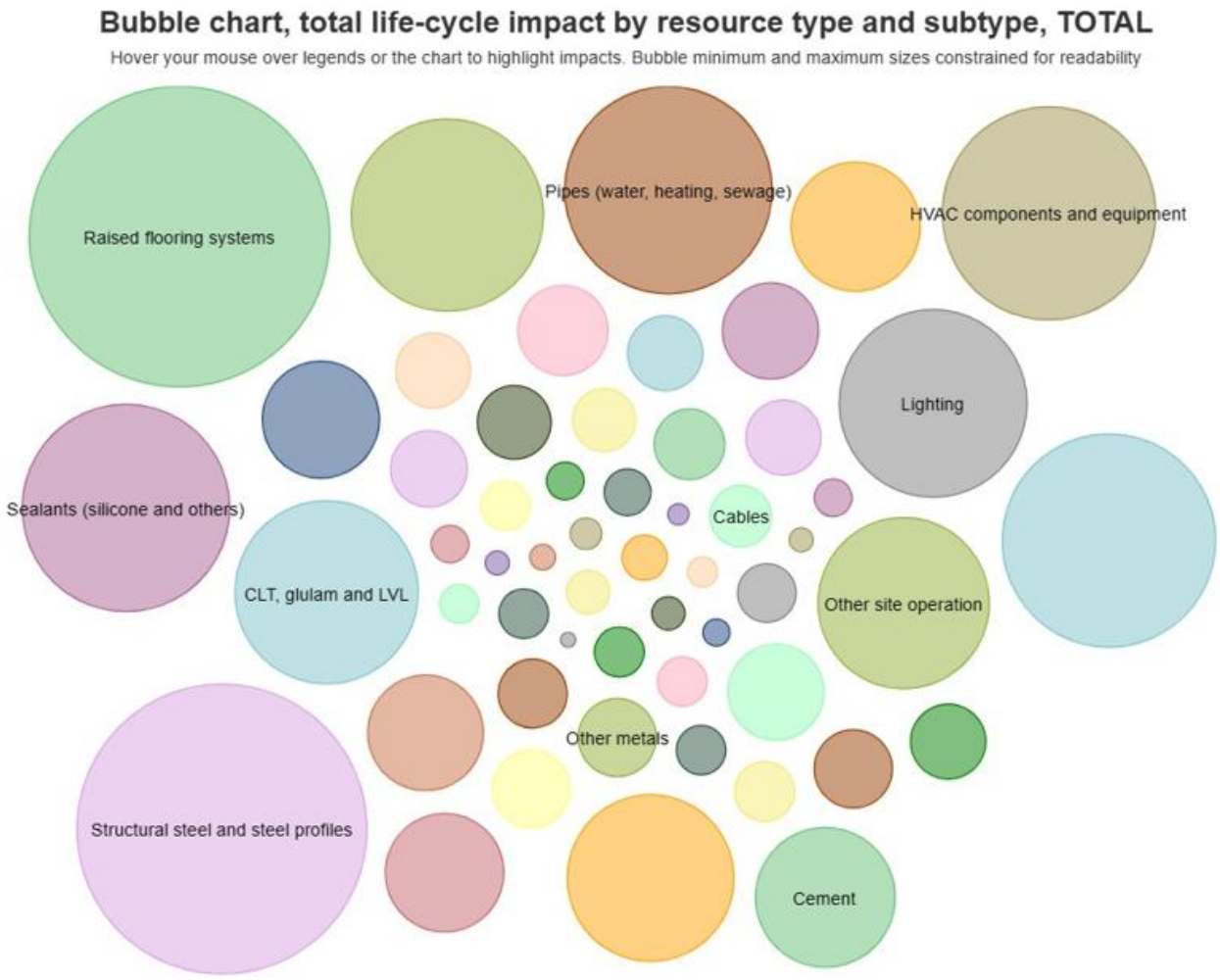
Figure 7 – Impacts by RICS Category



The two graphs above have shown that the embodied carbon with in raised access floor is especially high in both module A and module B. Therefore, to procure a lower impact raised access floor would be one of the measures to lower the impact.

Figure 8 below provides a more simplistic ‘Bubble Chart’ with impacts broken down by RICS Category. This is used to identify key impacts which can be considered for further reductions.

Figure 8 – Impacts by RICS Category



- Ready-mix concrete for external walls and floors
- EPS (expanded polystyrene) insulation
- Cement
- Rock wool insulation
- Other metals
- Concrete masonry units (CMU)
- Natural stone
- CLT, glulam and LVL
- Acoustic insulation panels
- Raised flooring systems
- Aluminium
- Other building technology systems
- Paints, coatings and lacquers
- Coated glass panes
- Other precast concrete products
- Pipes (water, heating, sewage)
- Ventilation ducts and channels
- Cables
- Other site operation
- Reinforcement for concrete (rebar)
- Plastic membranes
- Alternative concrete binders
- Regular gypsum board
- Fibre cement products
- Mortar (masonry/bricklaying)
- Laminate flooring
- Concrete slabs (hollow and solid)
- Bitumen and other roofing
- Sealants (silicone and others)
- Stainless steel
- Glass facades and glazing
- Carpet flooring
- Resilient flooring
- Elevators and escalators
- HVAC equipment with refrigerant
- Electrification components and systems
- Water heating and handling equipment
- Machine operation
- Explosives and other chemicals
- Sand, soil and gravel
- Structural steel and steel profiles
- Copper
- Hot-dip galvanized/zinc coated steel
- Specialty gypsum board
- Leveling screeds (for floors)
- Glass wool insulation
- Plain wood/timber (softwood and hardwood)
- Safety glass panes
- Wood and wood board doors
- Wall and floor tiles
- Tile adhesive
- Sanitary ware
- HVAC components and equipment
- Lighting
- Energy production systems from renewable energy

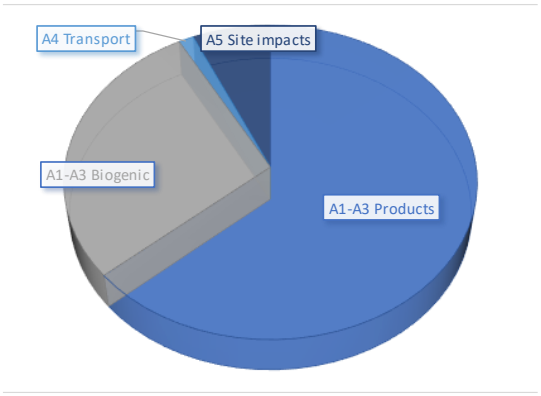
2.3.2 LCA impact breakdown

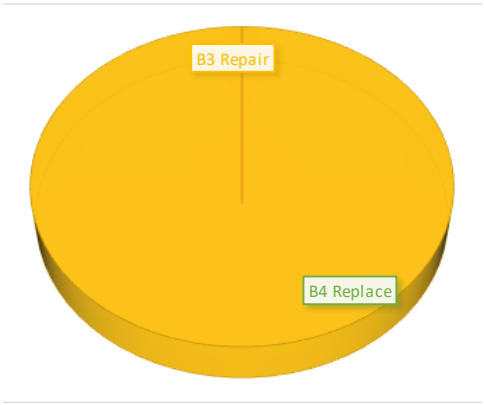
The detailed results of the WLCA are compared to the GLA benchmark shown in the section 2.5 and the total saving of the embodied carbon is around 70% compared to these WLCA benchmarks.

Figure 9 - Emissions charts by stage

A1-A5 Embodied Carbon Emission			
A1-A3	Product Stage	5,999.10	tCO2e
A1-A3	Biogenic	-2,389.00	tCO2e
A4	Transport to site	125.70	tCO2e
A5	Construction and installation	445.60	tCO2e
	Total A1-A5	4,181.40	tCO2e

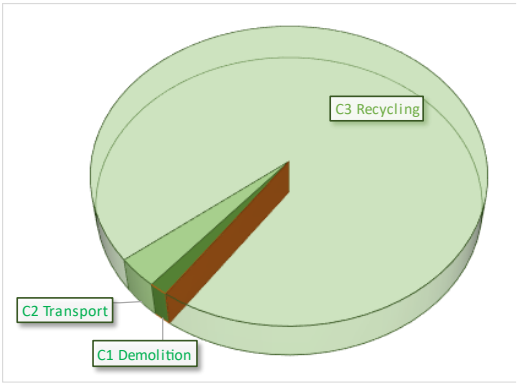
B1-B5 Embodied Carbon Emission			
B1-B2	Use and Maintenance	0.00	tCO2e
B3	Repair	0.00	tCO2e
B4	Replacement	2,245.00	tCO2e
B5	Refurbishment	0.00	tCO2e
	Total B1-B5	2,245.00	tCO2e

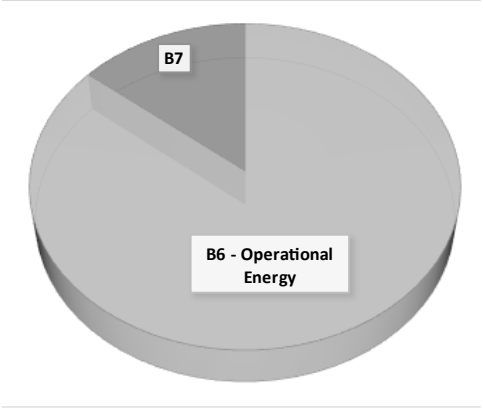




C1-C4 Embodied Carbon Emission			
C1	Demolition	39.40	tCO2e
C2	Transport to disposal	95.80	tCO2e
C3	Waste processing for reuse, recovery or recycle	2,441.50	tCO2e
C4	Refurbishment	0.90	tCO2e
	Total C1-C4	2,577.60	tCO2e

B6-B7 Operational Carbon Emission			
B6	Operational Energy Use	5,243.58	tCO2e
B7	Operational Water Use	861.73	tCO2e
	Total B6-B7	6,105.32	tCO2e



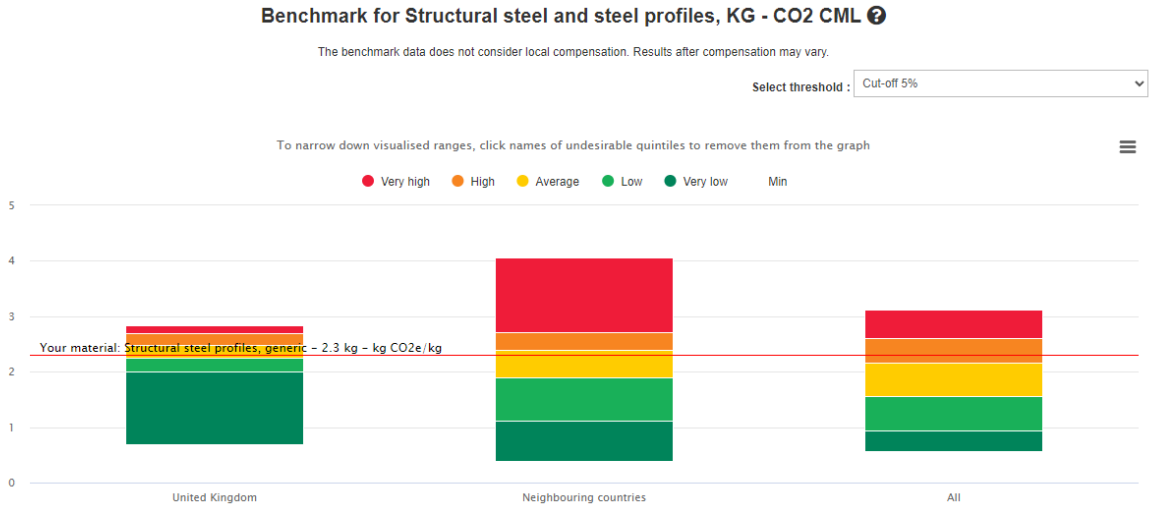


2.3.3 Further Reductions

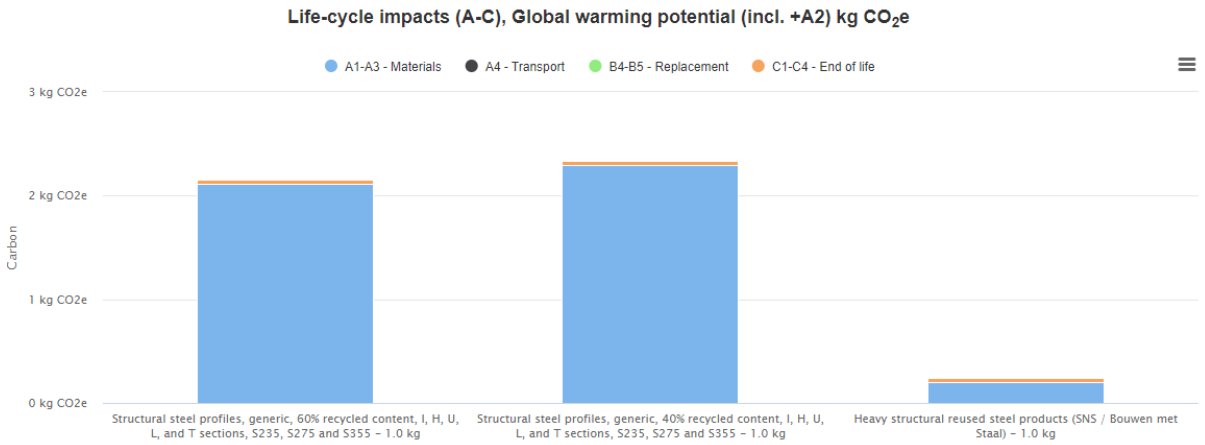
The following areas of potential further reduction have been identified which will be considered during the detailed design stages:

Reclaimed steel

The use of 100% reclaimed steel members is increasing in frequency but is limited to the availability of the correct steel members at the time of construction. If 10% of the steel structure within the building was procured from reclaimed sources would result in a 5-10% reduction in A1-A3.



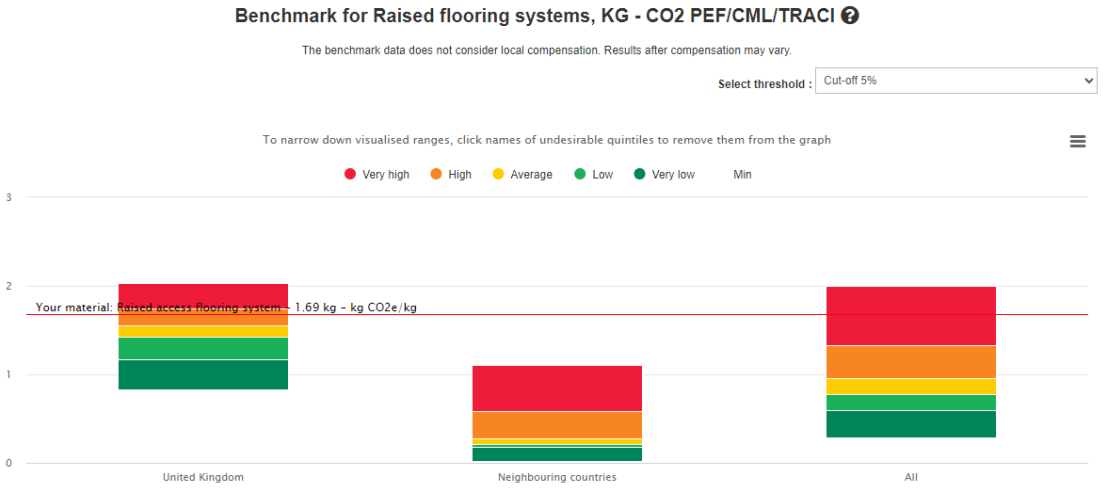
The following graph compared the carbon emissions / kg among 40%, 60% recycled content and reclaimed steel frame.



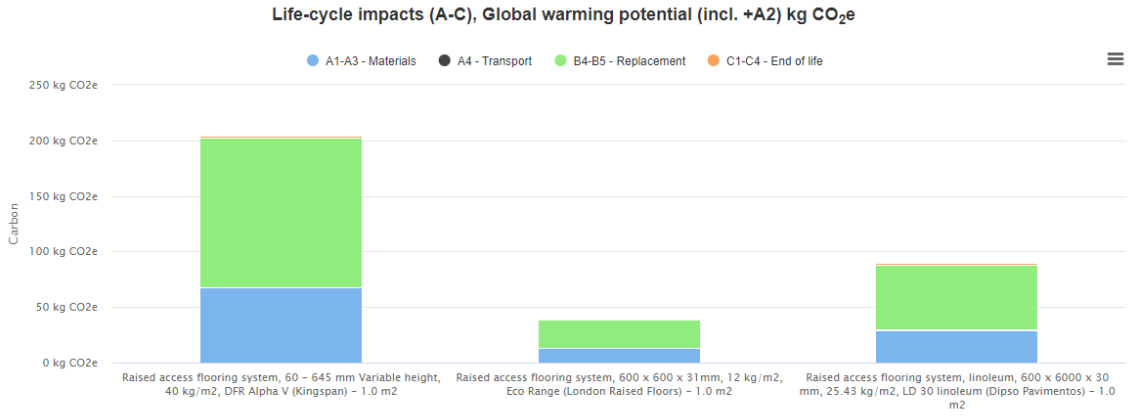
Resource name	Quantity	A1-A3 - Materials (kg CO_2e)	A4 - Transport (kg CO_2e)	B4-B5 - Replacement (kg CO_2e)	C1-C4 - End of life (kg CO_2e)	Financial cost (€)	Financial and carbon cost (€)
Structural steel profiles, generic, 60% recycled content, I, H, U, L, and T sections, S235, S275 and S355 - 1.0 kg	1.0 kg	2.11	0	0	0.04	1	1.2
Structural steel profiles, generic, 40% recycled content, I, H, U, L, and T sections, S235, S275 and S355 - 1.0 kg	1.0 kg	2.29	0	0	0.04	1	1.21
Heavy structural reused steel products (SNS / Bouwen met Staal) - 1.0 kg	1.0 kg	0.2	0	0	0.04	1	1.03

Raised Access Floor

We have been investigating alternative raised access floors which have lower impacts as well as reclaimed raised access floor tiles. These would provide the following reductions:



The following graph compared the carbon emissions/m^2 among three different raised access flooring system. Using the lower impact product would result in a total of 3-8% emission reduction for WLCA,



Resource name	Quantity	A1-A3 - Materials (kg CO_2e)	A4 - Transport (kg CO_2e)	B4-B5 - Replacement (kg CO_2e)	C1-C4 - End of life (kg CO_2e)	Financial cost (€)	Financial and carbon cost (€)
Raised access flooring system, 60 - 645 mm Variable height, 40 kg/m2, DFR Alpha V (Kingspan) - 1.0 m2	1.0 m2	67.4	0.17	134.8	1.62	48	0.0
Raised access flooring system, 600 x 600 x 31mm, 12 kg/m2, Eco Range (London Raised Floors) - 1.0 m2	1.0 m2	12.89	0.05	25.78	0.49	48	51.57
Raised access flooring system, linoleum, 600 x 6000 x 30 mm, 25.43 kg/m2, LD 30 linoleum (Dipso Pavimentos) - 1.0 m2	1.0 m2	29.41	0.11	58.82	1.03	48	56.14

2.4 Module B6 Operational Energy - Results

Annual energy consumptions and carbon emissions for the building are calculated using a full TM54 Operational Energy Assessment with the resulting energy demands from the building being 642,956 kWh of electricity use per year. This equates to **54.22 kWh/m²/year** which is lower than the 55 kWh/m²/year which is the Paris proof benchmark for all energy use.

While we apply SAP10 carbon factor 0.136, the carbon emissions would be =

642,596 kWh/year x 0.136 = 87,393 kg CO_2e / year

Building life span 60 years= 87,393 kg CO_2e /year x 60 years = 5,243,583 kg CO_2e (60years)

2.5 Module B7 Operational Water - Results

According to Table 22 of the BSRIA Rules of Thumb – guidelines for the building services (fifth edition), the occupancy assumption and water demand assumption are calculated as the following table.

Table 4 - Water Consumption sources

Description	Rule of thumb
General offices	10 m² per workspace
	6 m² per person
	12 m² per person
	8 –13 m² per workspace

Table 22: Maximum daily hot water demand and total water demand for

Description	Rule of thumb	
	Maximum daily hot water consumption (l/person)	Maximum daily total water consumption (l/person)
Offices		
Offices with canteen	15	45
Offices without canteen	10	45

*Total Occupancy = (GIA of office ÷ 10m²) = Assumed occupancy; 8317*0.8 ÷10= 681 people*

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

Water use = ((55 x 681) x 365 x 60) ÷ 1000 = 820.698 m³ of water consumed over development life.

The 2020 version of the GHG Factors for Company Reporting confirms that the emissions factor for water supply is 0.34 kgCO_2e/m³, and 0.71 kgCO_2e/m³ for water treatment.

Supply = 820,698 x 0.34 = 279,037 kgCO_2e

Treatment = 820,698 x 0.71 = 582,696 kgCO_2e

Total water emissions = 861,733 kgCO_2e (60years)

2.6 Comparison – Embodied Carbon Benchmarks

2.6.1 GLA – WLCA Benchmarks

The following table presents the results from the GLA WLCA spreadsheet template which accompanies this report.

Table 5 - GLA WLCA Results table

	Module A1-A5 (excluding sequestered carbon)	Modules B-C (excl B6 & B7)	Modules A-C (excl B6 & B7; including sequestered carbon)
TOTAL kg CO_2e	6,570,424 kg CO2e	4,822,556 kg CO2e	9,003,962 kg CO2e
TOTAL kg CO_2e/m^2 GIA	**554.37**	**406.9**	**759.7**
Benchmark Type	Office		
GLA WLC Benchmark kg CO_2e/m^2 GIA	*<950*	*<450*	*<1400*
GLA Aspirational WLC Benchmark kg CO_2e/m^2 GIA	*<600*	*<370*	*<970*

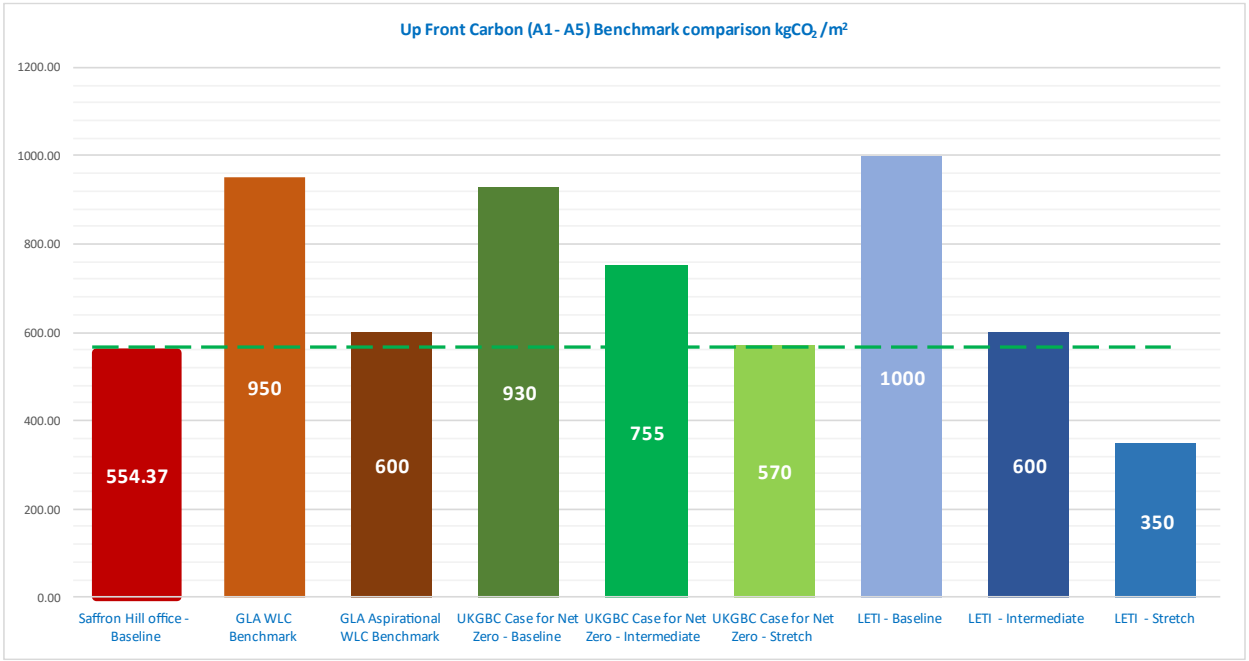
The RIBA Stage 2 Whole Life Carbon assessment confirmed the proposals have a current carbon intensity in construction (A1-A5) of **554.37 kgCO_2/m^2 GIA** which is:

- **42% lower** for the A1-A5 compared to the GLA WLC Benchmark (950 kgCO_2/m^2),
- **7.6% lower** than the Aspirational GLA WLC Benchmark (600 kgCO_2/m^2).

The following is the comparison table showing the result of this assessment compared to various benchmarks.

Module A1-A5 (excluding sequestered carbon)

Figure 10 - (A1 to A5) Benchmark Comparison



3 Overall WLC Results

The overall WLC result (including all modules of WLC) are shown in the table and chart below.

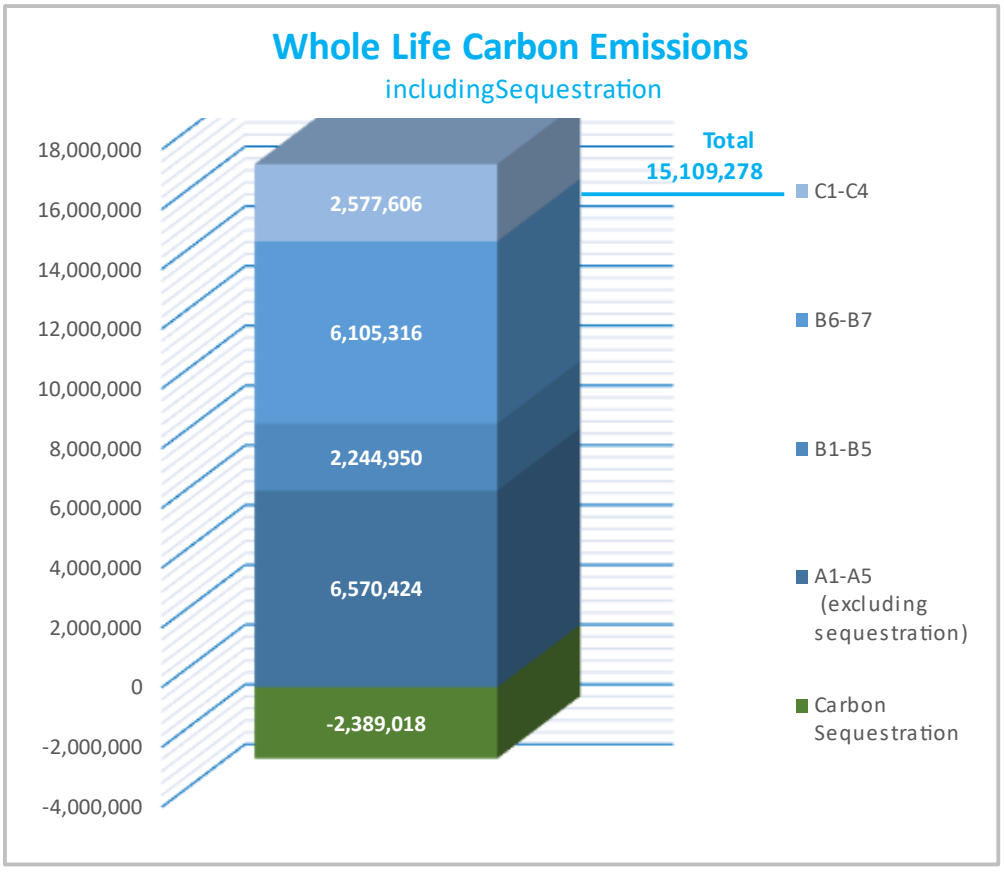
In the tables, all carbon emissions are listed by WLC modules, to demonstrate the specific elements that can be improved or for the future reference.

Table 6 - Summary WLCA results

WLC Result						
Modules	**A1-A5** (excluding sequestration)	**B1-B5**	**B6-B7**	**C1-C4**	**Carbon Sequestration**	**Total** (including sequestration)
kgCO₂e	6,570,424	2,244,950	6,105,316	2,577,606	-2,389,018	15,109,278

The chart below gives a visualisation of the WLC breakdown for the building, with module A1-A5, B1-B5, B6 & B7, and C1-C4.

Figure 11 - WLCA Breakdown by Stages (including Sequestration)



3.1 Indictive Embodied Carbon Offset Cost

To be verified as a Net Zero Carbon Building, the carbon emissions can be offset via recognised existing offsetting frameworks which are align with UKGBC Net Zero Carbon Framework.

- Gold Standard
- Verified Carbon Standard
- Clean Development Mechanism
- UK Woodland Carbon Code
- UK Peatland Code

The total embodied impact from A1-A5 emissions is estimated to be **6,570.40 tCO_2** which at various offset costs range from £136k to £644k for the scope of the development project. However, the Camden council use £95 per tonnes as their carbon offset cost (below in **RED**), which would be **£624,190**.

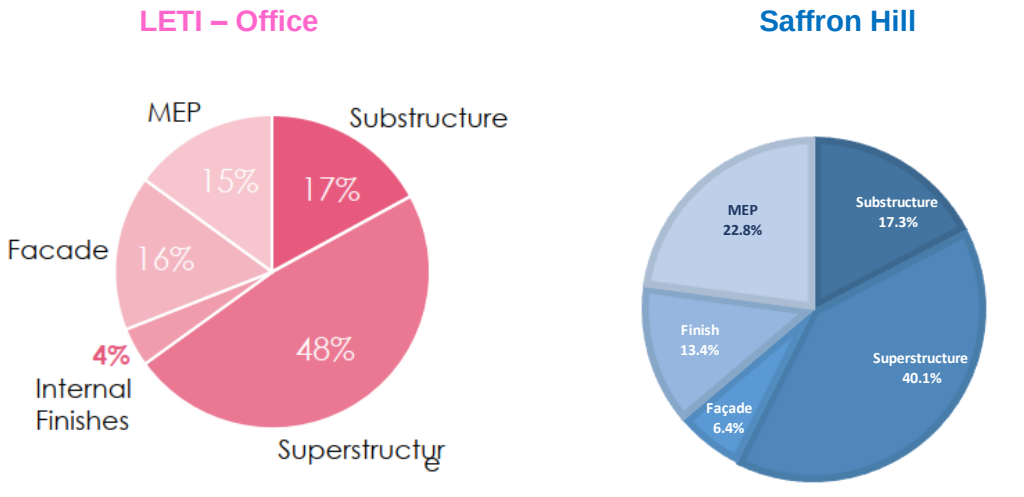
Table 7 - offset values

Offset Option	Cost per tCO_{2e}	tCO_{2e} A1-A5	Indicative Cost (£)
UK Woodland Trust	£30	6,570.40	£197,120
International Schemes	£20		£131,410
UKGBC (Recommended for net zero carbon leaders)	£73		£479,640
GLA Carbon Offset Fund	**£95**		**£624,190**

3.2 Proportions of embodied carbon by building element

A1 to A3 Up front impacts total **5,999,060 $kgCO_2$** and are broken down and compared with the LETI figures as shown in figure 12.

Figure 12 – Up Front impacts – compared by type



Appendix A – WLCA Template

GWP POTENTIAL FOR ALL LIFE-CYCLE MODULES ($kgCO_2e$) (See Note 1 below if you entered a reference study period in cell C12)		Sequestered (or biogenic) carbon (negative value) ($kgCO_2e$)	Product stage ($kgCO_2e$)	Construction process stage ($kgCO_2e$)			
			Module A				
Building element category			[A1] to [A3]	[A4]	[A5]	[B1]	[B2]
0.1	Demolition: Toxic/Hazardous/Contaminated Material Treatment						
0.2	Major Demolition Works						
0.3	Temporary Support to Adjacent Structures						
0.4	Specialist Ground Works						
0.5	Temporary Diversion Works						
1	Substructure	0 kg CO2e	840,794 kg CO2e	77,446 kg CO2e	58,707 kg CO2e		
2.1	Superstructure: Frame	0 kg CO2e	1,408,805 kg CO2e	20,061 kg CO2e	51,211 kg CO2e		
2.2	Superstructure: Upper Floors	-2,345,555 kg CO2e	758,070 kg CO2e	18,114 kg CO2e	13,136 kg CO2e		
2.3	Superstructure: Roof	-10,288 kg CO2e	52,598 kg CO2e	134 kg CO2e	4,193 kg CO2e		
2.4	Superstructure: Stairs and Ramps	0 kg CO2e	67,307 kg CO2e	1,399 kg CO2e	1,034 kg CO2e		
2.5	Superstructure: External Walls	0 kg CO2e	202,221 kg CO2e	1,625 kg CO2e	14,628 kg CO2e		
2.6	Superstructure: Windows and External Doors	0 kg CO2e	182,116 kg CO2e	131 kg CO2e	81 kg CO2e		
2.7	Superstructure: Internal Walls and Partitions	0 kg CO2e	86,007 kg CO2e	753 kg CO2e	9,769 kg CO2e		
2.8	Superstructure: Internal Doors	-33,175 kg CO2e	30,542 kg CO2e	131 kg CO2e	0 kg CO2e		
3	Finishes	0 kg CO2e	801,425 kg CO2e	2,823 kg CO2e	54,540 kg CO2e		
4	Fittings, furnishings & equipment						
5	Services (MEP)	0 kg CO2e	1,370,449 kg CO2e	2,189 kg CO2e	43,666 kg CO2e		
6	Prefabricated Buildings and Building Units						
7	Work to Existing Building						
8	External works	0 kg CO2e	198,728 kg CO2e	916 kg CO2e	65 kg CO2e		
Other site construction impacts or overall construction stage [A5] carbon emissions not specific to an individual building element category					194,610 kg CO2e		
TOTAL kg CO_2e		-2,389,018 kg CO2e	5,999,060 kg CO2e	125,723 kg CO2e	445,640 kg CO2e	0 kg CO2e	0 kg CO2e
TOTAL - kg CO_2e/m^2 GIA		-202 kg CO2e/m2 GIA	506 kg CO2e/m2 GIA	11 kg CO2e/m2 GIA	38 kg CO2e/m2 GIA	0 kg CO2e/m2 GIA	0 kg CO2e/m2 GIA

Use stage ($kgCO_2e$)					End of Life (EoL) stage ($kgCO_2e$)				TOTAL Modules A-C $kgCO_2e$	Benefits and loads beyond the system boundary ($kgCO_2e$)
Module B					Module C					Module D
[B3]	[B4]	[B5]	[B6]	[B7]	[C1]	[C2]	[C3]	[C4]		
					[Where only a single C1-C4 is known, please include it here]				0 kg CO2e	
					39,423 kg CO2e				39,423 kg CO2e	
									0 kg CO2e	
									0 kg CO2e	
									0 kg CO2e	
0 kg CO2e						34,941 kg CO2e	15,207 kg CO2e	101 kg CO2e	1,027,196 kg CO2e	-136,914 kg CO2e
0 kg CO2e						6,721 kg CO2e	426 kg CO2e	346 kg CO2e	1,487,570 kg CO2e	-543,735 kg CO2e
0 kg CO2e	2,239 kg CO2e	0 kg CO2e				7,515 kg CO2e	2,346,245 kg CO2e	29 kg CO2e	799,793 kg CO2e	-1,359,835 kg CO2e
0 kg CO2e	123 kg CO2e	0 kg CO2e				195 kg CO2e	27,251 kg CO2e	53 kg CO2e	74,259 kg CO2e	-2,195 kg CO2e
0 kg CO2e						1,100 kg CO2e	100 kg CO2e	1 kg CO2e	70,942 kg CO2e	-4,575 kg CO2e
0 kg CO2e						3,983 kg CO2e	1,759 kg CO2e	61 kg CO2e	224,278 kg CO2e	-43,047 kg CO2e
0 kg CO2e	808 kg CO2e	0 kg CO2e				2,172 kg CO2e	335 kg CO2e		185,642 kg CO2e	-535 kg CO2e
0 kg CO2e	22,245 kg CO2e	0 kg CO2e				7,084 kg CO2e	3,587 kg CO2e		129,444 kg CO2e	-6,993 kg CO2e
0 kg CO2e	31,059 kg CO2e	0 kg CO2e				101 kg CO2e	33,446 kg CO2e	14 kg CO2e	62,118 kg CO2e	
0 kg CO2e	681,537 kg CO2e	0 kg CO2e				22,842 kg CO2e	12,409 kg CO2e	148 kg CO2e	1,575,722 kg CO2e	-1,692,210 kg CO2e
									0 kg CO2e	
0 kg CO2e	1,235,348 kg CO2e	0 kg CO2e	5,243,583 kg CO2e		861,733 kg CO2e	8,584 kg CO2e	698 kg CO2e	115 kg CO2e	8,766,366 kg CO2e	-646,398 kg CO2e
									0 kg CO2e	
									0 kg CO2e	
0 kg CO2e	271,593 kg CO2e	0 kg CO2e				553 kg CO2e	59 kg CO2e	2 kg CO2e	471,916 kg CO2e	-25,496 kg CO2e
									194,610 kg CO2e	
0 kg CO2e	**2,244,950 kg CO2e**	**0 kg CO2e**	**5,243,583 kg CO2e**	**861,733 kg CO2e**	**39,423 kg CO2e**	**95,791 kg CO2e**	**2,441,523 kg CO2e**	**868 kg CO2e**	**15,109,278 kg CO2e**	**-4,461,933 kg CO2e**
0 kg CO2e/m2 GIA	**189 kg CO2e/m2 GIA**	**0 kg CO2e/m2 GIA**	**442 kg CO2e/m2 GIA**	**73 kg CO2e/m2 GIA**	**3 kg CO2e/m2 GIA**	**8 kg CO2e/m2 GIA**	**206 kg CO2e/m2 GIA**	**0 kg CO2e/m2 GIA**	**1,275 kg CO2e/m2 GIA**	**-376 kg CO2e/m2 GIA**

Appendix B – GLA WLCA template Module D Table

MATERIAL QUANTITY AND END OF LIFE SCENARIOS		Product and Construction Stage (Module A)		Assumptions made with respect to maintenance, repair and replacement cycles (Module B)	Material 'end of life' scenarios (Module C)	Benefits and loads beyond the system boundary (Module D)	
Building element category		Material type	Material quantity (kg)			Estimated reusable materials (kg)	Estimated recyclable materials (kg)
0.1	Demolition: Toxic/Hazardous/Contaminated Material Treatment						
0.2	Major Demolition Works						
0.3	Temporary Support to Adjacent Structures						
0.4	Specialist Ground Works						
1	Substructure	Reinforcement steel	490400	Assumed permanent service life.	Steel recycling	0 kg	490,400 kg
		Ready-mix concrete, C32/40 30% GGBS content in cement	5420256	Assumed permanent service life.	Concrete crushed to aggregate	5,420,256 kg	0 kg
		Concrete - C40/50	238585.2	Assumed permanent service life.	Concrete crushed to aggregate	238,585 kg	0 kg
		EPS insulation	3630	Assumed permanent service life.	plastic recycling	0 kg	3,630 kg
		Waterproofing membrane	712.8	Assumed permanent service life.	Landfilling (for inert materials)	0 kg	0 kg
2.1	Superstructure: Frame	Structural steel profiles, 60% recycled content	388176.5	Assumed permanent service life.	Steel reclaimed	388,177 kg	0 kg
		Reinforcement steel (rebar), generic	148380.6	Assumed permanent service life.	Steel recycling	0 kg	148,381 kg

MATERIAL QUANTITY AND END OF LIFE SCENARIOS		Product and Construction Stage (Module A)		Assumptions made with respect to maintenance, repair and replacement cycles (Module B)	Material 'end of life' scenarios (Module C)	Benefits and loads beyond the system boundary (Module D)	
Building element category		Material type	Material quantity (kg)			Estimated reusable materials (kg)	Estimated recyclable materials (kg)
		Concrete - C40/50	2950090.1	Assumed permanent service life.	Concrete crushed to aggregate	2,950,090 kg	0 kg
2.2	Superstructure: Upper Floors	CLT wood panels, biogenic CO2 not subtracted (for CML)	1064550	Assumed permanent service life.	90% reclaimed 10% recycled	958,095 kg	106,455 kg
		Ready-mix concrete, C32/40 30% GGBS content in cement	839928	Assumed permanent service life.	Concrete crushed to aggregate	0 kg	839,928 kg
		Reinforcement steel (rebar), generic	47250	Assumed permanent service life.	Steel recycling	0 kg	47,250 kg
		Hollow core concrete slabs, generic	102998	Assumed permanent service life.	90% reclaimed 10% recycled	92,698 kg	10,300 kg
		Floor screed mortar, cement screed	119550	Assumed permanent service life.	Landfilling (for inert materials)	0 kg	0 kg
		Acoustic partition roll insulation, unfaced	8367	Assumed permanent service life.	100% recycle by certified contractor	0 kg	8,367 kg
		Metal facade cladding from Nordic bronze	6264.3	Assumed permanent service life.	Steel recycling	0 kg	6,264 kg
		Rock wool insulation for ETICS and flat roofs	2625.04	Assumed permanent service life.	100% recycle by certified contractor	0 kg	2,625 kg
		Gypsum board, water resistant	11216.08	40 years	Assumed 20 % recyclable	0 kg	2,243 kg
		Steel framing system for dry lining	1789.8	Assumed permanent service life.	Steel reclaimed	1,790 kg	0 kg
		2.2.2 Balconies - Stainless steel handrail	429	Assumed permanent service life.	Steel recycling	0 kg	429 kg

MATERIAL QUANTITY AND END OF LIFE SCENARIOS		Product and Construction Stage (Module A)		Assumptions made with respect to maintenance, repair and replacement cycles (Module B)	Material 'end of life' scenarios (Module C)	Benefits and loads beyond the system boundary (Module D)	
Building element category		Material type	Material quantity (kg)			Estimated reusable materials (kg)	Estimated recyclable materials (kg)
		2.2.2 Balconies - Toughened safety glass	21261	Assumed permanent service life.	glass recycled	0 kg	21,261 kg
2.3	Superstructure: Roof	EPS Insulation	4500.6	Assumed permanent service life.	Landfilling (for inert materials)	0 kg	0 kg
		Multi layer waterproofing system with flexible sheets for roofing	12486.36	Assumed 20 year service life - replaced 2 times.	Landfilling (for inert materials)	0 kg	0 kg
		Glass wool insulation, unfaced	1054.02	Assumed permanent service life.	recycled	0 kg	1,054 kg
		Synthetic roofing membrane from FPO - PP	309.44	Assumed 30 year service life - replaced 1 times.	Landfilling (for inert materials)	0 kg	0 kg
		Raised floor system steel pedestal, per m2	1275618.498	Assumed 25 year service life - replaced 2 times.	Steel recycling	0 kg	1,275,618 kg
		Planned redwood decking	5223.86	Assumed permanent service life.		0 kg	5,224 kg
		Extensive green roof system	3734.4	Assumed 20 year service life - replaced 2 times.	assumed 60% recyclable	0 kg	2,241 kg
		Coping system (for rood edging) from coated aluminium sheets	316.47	Assumed permanent service life.	Steel recycling	0 kg	316 kg
2.4	Superstructure: Stairs and Ramps	Ready-mix concrete, normal strength, generic	167208	Assumed permanent service life.	Concrete crushed to aggregate	167,208 kg	0 kg
		Reinforcement steel (rebar), generic	10450.6	Assumed permanent service life.	Steel recycling	0 kg	10,451 kg
		Steel/aluminum helical staircase, with railing and landing	5505.5	Assumed permanent service life.	Reclaimed	5,506 kg	0 kg

MATERIAL QUANTITY AND END OF LIFE SCENARIOS		Product and Construction Stage (Module A)		Assumptions made with respect to maintenance, repair and replacement cycles (Module B)	Material 'end of life' scenarios (Module C)	Benefits and loads beyond the system boundary (Module D)	
Building element category		Material type	Material quantity (kg)			Estimated reusable materials (kg)	Estimated recyclable materials (kg)
2.5	Superstructure: External Walls	Steel purlins and framing	8940	Assumed permanent service life.	Reclaimed	8,940 kg	0 kg
		Metal facade cladding from Nordic bronze (Royal)	14036	Assumed permanent service life.	Steel recycling	0 kg	14,036 kg
		Rock wool insulation panels	18198	Assumed permanent service life.	Assumed 90% recycable	0 kg	16,378 kg
		Plastic vapour control layer	386.28	Assumed permanent service life.	Landfilling (for inert materials)	0 kg	0 kg
		Fiber reinforced cement board for exterior	12851.25	Assumed permanent service life.	Recycled	0 kg	12,851 kg
		Copper sunshade (Brise-Soleil), French average	1314.78	Assumed permanent service life.	metal recycled	0 kg	1,315 kg
		Precast concrete blocks (CMU)	367575	Assumed permanent service life.	Recycled	0 kg	367,575 kg
		Cementitious mortar for masonry work	38217	Assumed permanent service life.	Landfilling	0 kg	0 kg
		Gypsum plasterboard	39882.5	Assumed permanent service life.	Recycled	0 kg	39,883 kg
		Metal framing components for gypsum plasterboard	3484	Assumed permanent service life.	metal recycled	0 kg	3,484 kg
		HS2 baseline - Structural steel Sections	5024	Assumed permanent service life.	metal recycled	0 kg	5,024 kg
		Polyethylene vapour barrier membrane	259.7	Assumed 30 year service life - replaced 1 times.	Landfilling (for inert materials)	0 kg	0 kg

MATERIAL QUANTITY AND END OF LIFE SCENARIOS		Product and Construction Stage (Module A)		Assumptions made with respect to maintenance, repair and replacement cycles (Module B)	Material 'end of life' scenarios (Module C)	Benefits and loads beyond the system boundary (Module D)	
Building element category		Material type	Material quantity (kg)			Estimated reusable materials (kg)	Estimated recyclable materials (kg)
		Natural stone wall cladding	27559.82	Assumed permanent service life.	reclaimed	27,560 kg	0 kg
		Metal facade cladding from Nordic brass	8487.675	Assumed permanent service life.	metal recycled	0 kg	8,488 kg
2.6	Superstructure: Windows and External Doors	Window system for glass façade, with aluminum composite profile framing, double glazed	56697.875	Assumed permanent service life.	metal recycled	0 kg	56,698 kg
		EPDM rubber membrane for weather-sealing around window frames and facades	155.23	Assumed permanent service life.	Landfilling (for inert materials)	0 kg	0 kg
2.7	Superstructure: Internal Walls and Partitions	Gypsum plasterboard	292202.2	Assumed permanent service life.	100% recycle by certified contractor	0 kg	292,202 kg
		Metal framing components for gypsum plasterboard	17369.6	Assumed permanent service life.	metal recycled	0 kg	56,698 kg
		High pressure and solid grade laminate sheets (HPL and SGL)	1642.9	Assumed 15 year service life - replaced 3 times.	Recycled	0 kg	0kg
2.8	Superstructure: Internal Doors	Fire proof door with wood frame, automatic closing, biogenic CO2 not subtracted (for CML)	11630.08	Assumed 40 year service life - replaced 1 times.	Recycled	0 kg	11,630 kg
		Wooden door with wooden frame, fire resistant, biogenic CO2 not subtracted (for CML)	14743.29	Assumed 40 year service life - replaced 1 times.	Recycled	0 kg	14,743 kg
3	Finishes	Emulsion matt paint for allround interior use	1366.4	Assumed 10 year service life - replaced 5 times.	Landfilling (for inert materials)	0 kg	0 kg
		3.2.2.Raised access floors - Polyurethane waterproofing membrane	18794.454	Assumed 10 year service life - replaced 5 times.	Landfilling (for inert materials)	0 kg	0 kg
		3.2.2.Raised access floors - Gypsum fibre tiles for raised flooring systems	613152.4	Assumed 50 year service life - replaced 1 times.	Assumed 100% recycable	0 kg	613,152 kg

MATERIAL QUANTITY AND END OF LIFE SCENARIOS		Product and Construction Stage (Module A)		Assumptions made with respect to maintenance, repair and replacement cycles (Module B)	Material 'end of life' scenarios (Module C)	Benefits and loads beyond the system boundary (Module D)	
Building element category		Material type	Material quantity (kg)			Estimated reusable materials (kg)	Estimated recyclable materials (kg)
		3.2.2.Raised access floors - Acoustic insulation sheets from calcium carbonate	40302.393	Assumed 50 year service life - replaced 1 times.	Assumed 60% recycable	0 kg	24,181 kg
		3.2.2.Raised access floors - Raised access flooring system	380840	Assumed 30 year service life - replaced 1 times.	Recycled	0 kg	380,840 kg
		Fibre bonded carpet tiles and sheets	3859.2	Assumed 15 year service life - replaced 3 times.	Landfilling (for inert materials)	0 kg	0 kg
		Luxury vinyl tile flooring, for commercial use	1633.8	Assumed 25 year service life - replaced 2 times.	Landfilling (for inert materials)	0 kg	0 kg
		Ceramic tiles	7507.5	Assumed 30 year service life - replaced 1 times.	recycled	0 kg	7,508 kg
		Mirror	1000	Assumed 35 year service life - replaced 1 times.	Landfilling (for inert materials)	0 kg	0 kg
		Stainless steel handrail	343.85	Assumed 35 year service life - replaced 1 times.	metal recycled	0 kg	344 kg
		Waterborne acrylic intumescent coating for steel surfaces	4745	Assumed 10 year service life - replaced 5 times.	Landfilling (for inert materials)	0 kg	0 kg
		Dispersion-based tile adhesive	375	Assumed 30 year service life - replaced 1 times.	Landfilling (for inert materials)	0 kg	0 kg
4	Fittings, furnishings & equipment (FFE)						
5	Services (MEP)	5.1.Sanitary installations - Ceramic toilet with flush tank (cistern)	2749.2	Assumed permanent service life.	Landfilling (for inert materials)	0 kg	0 kg
		5.1.Sanitary installations - Ceramic wall-mounted bathroom sink	1450.68	Assumed permanent service life.	Landfilling (for inert materials)	0 kg	0 kg

MATERIAL QUANTITY AND END OF LIFE SCENARIOS		Product and Construction Stage (Module A)		Assumptions made with respect to maintenance, repair and replacement cycles (Module B)	Material 'end of life' scenarios (Module C)	Benefits and loads beyond the system boundary (Module D)	
Building element category		Material type	Material quantity (kg)			Estimated reusable materials (kg)	Estimated recyclable materials (kg)
		5.1.Sanitary installations - Shower head	3	Assumed permanent service life.	Landfilling (for inert materials)	0 kg	0 kg
		5.10.2.Escalators - Electric elevator elements (cabin and others), complete system	20136	Assumed 40 year service life - replaced 1 times.	Assumed 90% recycable	0 kg	18,122 kg
		Steel pipes for heating and cooling system	43341.61	Assumed 30 year service life - replaced 1 times.	metal recycled	0 kg	43,342 kg
		5.11.2.Fire suppression systems - Fire sprinkler	189.36	Assumed 30 year service life - replaced 1 times.	Landfilling (for inert materials)	0 kg	0 kg
		5.11.2.Fire suppression systems - Hot dip galvanized steel	994.7	Assumed 30 year service life - replaced 1 times.	steel recycling	0 kg	995 kg
		5.11.2.Fire suppression systems - Stainless steel sheet	1646.52	Assumed 30 year service life - replaced 1 times.	Stainless steel recycling	0 kg	1,647 kg
		5.11.2.Fire suppression systems - Cast iron globe valves	244.5	Assumed 30 year service life - replaced 1 times.	Landfilling (for inert materials)	0 kg	0 kg
		5.11.2.Fire suppression systems - Brass quarter-turn valve	115.9	Assumed 30 year service life - replaced 1 times.	Landfilling (for inert materials)	0 kg	0 kg
		5.11.2.Fire suppression systems - Waterborne alkyd modified acrylic paint for industrial painting of metals, anti-corrosive	358.43	Assumed 30 year service life - replaced 1 times.	Landfilling (for inert materials)	0 kg	0 kg
		5.11 Fire and lightning protection - Smoke detector	1052	Assumed 15 year service life - replaced 3 times.	Metal-containing product recycling (90 % metal)	0 kg	947 kg
		5.11 Fire and lightning protection - Communication cable	2249.94	Assumed 15 year service life - replaced 3 times.	Landfilling (for inert materials)	0 kg	0 kg
		5.13.4 Roof integrated mono-crystalline photovoltaic module, per Wp	1900	Assumed 20 year service life - replaced 2 times.	Metal-containing product recycling (90 % metal)	0 kg	1,710 kg

MATERIAL QUANTITY AND END OF LIFE SCENARIOS		Product and Construction Stage (Module A)		Assumptions made with respect to maintenance, repair and replacement cycles (Module B)	Material 'end of life' scenarios (Module C)	Benefits and loads beyond the system boundary (Module D)	
Building element category		Material type	Material quantity (kg)			Estimated reusable materials (kg)	Estimated recyclable materials (kg)
		5.13.4 Aluminium section PV mounting system	1958.61	Assumed permanent service life.	steel recycling	0 kg	1,959 kg
		5.3.1 Cast iron drainage pipes and fittings for wastewater and rainwater	10929.96	Assumed 30 year service life - replaced 1 times.	Metal-containing product recycling (90 % metal)	0 kg	9,837 kg
		5.3.1 HDPE sewage pipe	1950.07	Assumed 30 year service life - replaced 1 times.	Metal-containing product recycling (90 % metal)	0 kg	1,755 kg
		5.3.1 Hot dip galvanized steel sheet	778.473	Assumed 30 year service life - replaced 1 times.	steel recycling	0 kg	778 kg
		5.4.2 Cold water storage tank	654.16	Assumed 25 year service life - replaced 2 times.	Landfilling (for inert materials)	0 kg	0 kg
		5.4.2 Booster pump	72.4	Assumed 35 year service life - replaced 1 times.	Landfilling (for inert materials)	0 kg	0 kg
		5.4.2 Thermodynamic water heater (water cylinder)	3420	Assumed permanent service life.	Metal-containing product recycling (90 % metal)	0 kg	3,078 kg
		5.4.2 Thermostatic water mixer, for collective use	398	Assumed permanent service life.	Landfilling (for inert materials)	0 kg	0 kg
		5.4.2 Composite water meter	20	Assumed permanent service life.	Metal-containing product recycling (90 % metal)	0 kg	18 kg
		5.4.3 Galvanized steel pipes	4347	Assumed permanent service life.	Metal-containing product recycling (90 % metal)	0 kg	3,912 kg
		Pipe and tubes insulation from rock wool DN 100 mm.	6599.64	Assumed permanent service life.	Landfilling (for inert materials)	0 kg	0 kg
		5.4.4 Heated water storage tank, for collective use	652.12	Assumed permanent service life.	Landfilling (for inert materials)	0 kg	0 kg

MATERIAL QUANTITY AND END OF LIFE SCENARIOS		Product and Construction Stage (Module A)		Assumptions made with respect to maintenance, repair and replacement cycles (Module B)	Material 'end of life' scenarios (Module C)	Benefits and loads beyond the system boundary (Module D)	
Building element category		Material type	Material quantity (kg)			Estimated reusable materials (kg)	Estimated recyclable materials (kg)
		5.4 Brass fixtures, taps	280.3	Assumed permanent service life.	Metal-containing product recycling (90 % metal)	0 kg	252 kg
		5.4 Valve, 2 or 3-way	518.4	Assumed permanent service life.	Metal-containing product recycling (90 % metal)	0 kg	467 kg
		5.4 Copper pipes	526.864	Assumed permanent service life.	Metal-containing product recycling (90 % metal)	0 kg	474 kg
		5.6 Reversible air/water heat pump for collective housing	1291.2	Assumed 22 year service life - replaced 2 times.	Metal-containing product recycling (90 % metal)	0 kg	1,162 kg
		5.6 Fan coil unit	3205.8	Assumed 25 year service life - replaced 2 times.	Metal-containing product recycling (90 % metal)	0 kg	2,885 kg
		5.6 Steel pipes for heating and cooling system	13923	Assumed permanent service life.	steel recycling	0 kg	13,923 kg
		5.6 Rectangular fire damper, per unit	574	Assumed 25 year service life - replaced 2 times.	Metal-containing product recycling (90 % metal)	0 kg	517 kg
		5.7 Reversible air/water heat pump for collective housing	645.6	Assumed 22 year service life - replaced 2 times.	Metal-containing product recycling (90 % metal)	0 kg	581 kg
		5.7 Ventilation centralized with heat recovery (Air handling unit (AHU))	1408	Assumed 25 year service life - replaced 2 times.	Metal-containing product recycling (90 % metal)	0 kg	1,267 kg
		5.7 Galvanized steel ventilation ducts	19718.4	Assumed permanent service life.	steel recycling	0 kg	19,718 kg
		5.7 Glass wool insulataion for air ducts, black glass, PE and aluminium facing	2979.1944	Assumed permanent service life.	Assumed 80% recycable	0 kg	2,383 kg
		5.8 LED overhead lighting system	4195.584	Assumed 17 year service life - replaced 3 times.	Landfilling (for inert materials)	0 kg	0 kg

MATERIAL QUANTITY AND END OF LIFE SCENARIOS		Product and Construction Stage (Module A)		Assumptions made with respect to maintenance, repair and replacement cycles (Module B)	Material 'end of life' scenarios (Module C)		Benefits and loads beyond the system boundary (Module D)	
Building element category		Material type	Material quantity (kg)				Estimated reusable materials (kg)	Estimated recyclable materials (kg)
		5.8 LED Downlight	231.14	Assumed 45 year service life - replaced 1 times.	Metal-containing product recycling (90 % metal)		0 kg	208 kg
		5.8 Oil immersed ground mounted transformer	6538	Assumed 45 year service life - replaced 1 times.	Metal-containing product recycling (90 % metal)		0 kg	5,884 kg
		5.8 Steel sheet hot dip galvanized - Cable tray	25927.5	Assumed 30 year service life - replaced 1 times.	steel recycling		0 kg	25,928 kg
6	Prefabricated Buildings and Building Units							
7	Work to Existing Building							
8	External works	Aluminum louver shutter	6025	Assumed 25 year service life - replaced 2 times.	steel recycling		0 kg	6,025 kg
		Natural stone slab for exterior paving	31231.3	Assumed permanent service life.	Brick/stone crushed to aggregate		31,231 kg	0 kg
		Galvanised steel profiles - Cycle rack	26	Assumed permanent service life.	steel recycling		0 kg	26 kg
		Structural steel bollard (Truck Stopper)	62370	Assumed permanent service life.	steel recycling		0 kg	62,370 kg
		Concrete kerbs	10651.5	Assumed permanent service life.	Rebar separated (2 %), concrete to aggregate		0 kg	10,652 kg
		Precast drainage channels	5700	Assumed permanent service life.	Rebar separated (2 %), concrete to aggregate		0 kg	5,700 kg
Refrigerants		**Refrigerant name**	**Initial Charge(kg)**	**Annual leakage rate %**	**Refrigerant GWP ($kgCO_2e/kg$)**	**End of Life recovery rate %**		
a	Refrigerants Type 1 (if applicable) - please see CIBSE TM65 for methodology	ASHP - R32	426	1	677	100		

MATERIAL QUANTITY AND END OF LIFE SCENARIOS		Product and Construction Stage (Module A)		Assumptions made with respect to maintenance, repair and replacement cycles (Module B)	Material 'end of life' scenarios (Module C)		Benefits and loads beyond the system boundary (Module D)	
Building element category		Material type	Material quantity (kg)				Estimated reusable materials (kg)	Estimated recyclable materials (kg)
b	Refrigerants Type 2 (if applicable) - please see CIBSE TM65 for methodology	WSHP - R134A	6	1	1300	100		
c	Refrigerants Type 3 (if applicable) - please see CIBSE TM65 for methodology	Air Cooled Chillers - R32	42.5	1	677	*100*		
		TOTAL	15,674,098 kg				10,290,135 kg	5,120,303 kg
		Material intensity (kg/m2 GIA)	1,322 kg/m2 GIA				868 kg/m2 GIA	432 kg/m2 GIA

Appendix C – Quality Assurance

Data quality and transparency is critical in ensuring that the outcomes of the RIBA Stage 2 LCA are translated into the final specifications. To ensure this Carbon Plan Engineering has developed the following process to help manage the detailed design, construction and handover process.

Key	Action	Details of process
A	**Review of Stage 2 / 3 LCA and all available information**	The initial LCA is undertaken to provide a comprehensive review of the impacts of the buildings. The design team review the outcomes and make efforts to reduce the impacts. The detail of the LCA is improved as the design develops; with > 90% accuracy by the time of planning submission. Model is further developed through RIBA Stage 3 up to tender and specific requirements are included within the tender. Data sources:- **Bill of Quantities, Revit / Sketchup model, ER Documents, Measured quantities, Structural calculations**
B	**Build complete Stage 4 LCA model in One Click.**	A full, independent review is undertaken at RIBA Stage 4 to provide a complete and full LCA model using the OneClick software. All data will be reviewed and remeasured to ensure robustness of the Stage 4 model. We will work closely with the Structural Engineering, Façade and CLT supply chain and MEP Designers to ensure that accurate data and quantities are used. This modelling will follow the full RICS WLCA 2nd Edition guidance. Data sources:- **Bill of Quantities, Revit Models, Structural calculations, Architectural & MEP drawings, Material specifications**
C	**GAP analysis and Risk management through Construction.**	Once the initial Stage 4 model has been completed we will provide a comprehensive report which will include a full audit trail of data sources and assumptions. Within this we shall have identified: 1) Assumptions have been made on materials to be used i.e. where a material is not yet specified to a particular manufacturer. 2) Where materials, items, work packages which have a significant impact on the overall performance of the calculations. 3) What further reductions could be made against the baseline specifications 4) Areas of risk which are to be considered as the design develops **This will be a live model and will be kept up to date as information becomes available.**
D	**Integration with data gathering**	For the BREEAM Mat02 and Mat03 credits as well as for determining the actual quantities of installed materials it will be necessary to work with all members of the supply chain to gather data on the exact materials that are being used and the quantities that are installed. We have extensive experience in gathering this data from supply chains and we would use this process to ensure data was used as the As Built model was developed. Should there be any significant detrimental impacts shall provide a commentary on why the impact has changed and we will work with the Contractor and the supply chain to find a remedy and potential mitigation. Data sources:- **Supply chain specific material schedules, EPDs, actual quantities.**

Key	Action	Details of process
E	**As Built model and Validation** 	All of the above data will be used to generate As Built LCA models for the buildings and a full documented audit trail will be provided. A final report will be provided setting out the impacts and the actions taken throughout the design and construction period to minimise the embodied impacts. All data from the WLCA will be review by a third party to validate the LCA inputs in line with the UKGBC requirements. Data sources:- **Supply chain specific material schedules, EPDs, actual quantities.**

Data Sourcing

Product Description	Category	Data Source - product/Quantity
All CLT Floor slab	Superstructure - Core, Floor	Product: N/A - not specified yet, selected closer datapoint to HTS analysis. Quantity: CLT quantity from HTS Quantity table/drawings
All Frame	Superstructure - Frame	Product: HTS has proposed to procured the steel frame with 56% recycled content. Quantity: Steel frame quantity from HTS Quantity table/drawings
All rebar	Substructure & Superstructure - frame, external wall, Floor, Roof	Product: N/A - not specified yet, selected One Click LCA default datapoint with 97% recycled content. Quantity: calculated by concrete volume provided by HTS with the Rebar density.
All concrete (included hollow core slab)	Substructure & Superstructure - Core, Floor, Roof	Product: Concrete Mix design document from main contractor - Galliford Try. Element design mix type from structural Revit model. Quantity: Concrete quantity from HTS Quantity table/drawings
EPS insulation for Basement	1.1 Substructure	Product: not specified yet Quantity: Calculated by the GA drawings
Basement Waterproofing	1.1 Substructure	Product: not specified yet Quantity: Exigere - CATO spreadsheet (BoQ)
Facade - cladding	2.5 External Wall - Façade, Column, and setback(reveal)	Product: not specified yet - powder coated with high recycled content aluminium cladding Quantity: Exigere - CATO spreadsheet (BoQ) row218-224
Façade - Blockwork	2.5 External Wall - Party Wall	Product: not specified yet - but blockwork Quantity: Exigere - CATO spreadsheet (BoQ) row226

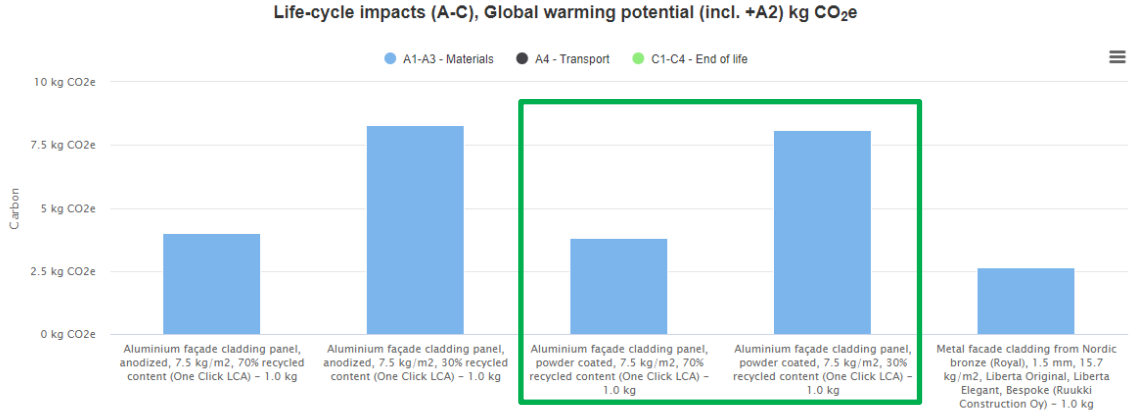
Facade - sunshade (side fin)	2.5 External Wall - side fin and Brise Solei Screens	Product: not specified yet - TBC at the later stage Quantity: measured by architecture drawings
Façade - GF Featured cladding	2.5 External Wall - GF Façade	Product: not specified yet - TBC at the later stage Quantity: measured by architecture drawings
Internal wall - Plasterboard	2.7 Internal Walls	Product: not specified yet - TBC at the later stage Quantity: Exigere - CATO spreadsheet (BoQ) row250
Bathroom partition - solid grade laminate sheet	2.7 Internal Walls	Product: not specified yet - TBC at the later stage Quantity: measured by architecture drawings
Roof covering	2.3 Roof	Product: not specified yet - TBC at the later stage Quantity: measured by architecture drawings and also confirm by CATO spreadsheet (ROOF+TERRACE)
Flooring (Office area) - raised access floor	3.2 Raised access floor	Product: not specified yet - TBC at the later stage Quantity: Exigere - CATO spreadsheet (BoQ) row 914
Green roof system	2.3 Roof	Product: not specified yet - TBC at the later stage Quantity: Exigere - CATO spreadsheet (BoQ) row 192
sun shade on level 6 terrace	2.5 external wall	Product: not specified yet - TBC at the later stage Quantity: measured by architecture drawings
Terrace handrail	2.2.2 balconies	Product: not specified yet - TBC at the later stage Quantity: Exigere - CATO spreadsheet (BoQ) row 183
Terrace balustrade glazed	2.2.2 balconies	Product: not specified yet - TBC at the later stage Quantity: Exigere - CATO spreadsheet (BoQ) row 183 and assumed 1.2m height
Ceramic tiles for floor and wall	3 internal finishes	Product: not specified yet - TBC at the later stage Quantity: Exigere - CATO spreadsheet (BoQ) row 308+310

Paint	3.1 wall finishes	Product: emulsion paint - TBC at the later stage Quantity: Exigere - CATO spreadsheet (BoQ) from row 284 …
Plant enclosure level 8	8.4 Barrier	Product: emulsion paint - TBC at the later stage Quantity: Exigere - CATO spreadsheet (BoQ) row176
All external materials	8.2.1 Road	Product: TBC at the later stage Quantity: all measure by architecture/landscaping drawings
wooden planter on terrace	2.2.2 balconies	Product: TBC at the later stage Quantity: Exigere - CATO spreadsheet (BoQ) row184, assumed thickness 10mm
sanitaryware	5.1 sanitary	Product: TBC at the later stage Quantity: Exigere - CATO spreadsheet (BoQ) row 446-456

Appendix D – Façade material comparison

The following table is the comparison between various material finishing options for a single section of the façade including:

- Aluminium anodised
- Powder coated **– Selected**
- Brass bronze



Resource name	Quantity	A1-A3 - Materials (kg CO_2e)	A4 - Transport (kg CO_2e)	C1-C4 - End of life (kg CO_2e)
Aluminium façade cladding panel, anodized, 7.5 kg/m2, 70% recycled content (One Click LCA) - 1.0 kg	1.0 kg	4.01	0	0.04
Aluminium façade cladding panel, anodized, 7.5 kg/m2, 30% recycled content (One Click LCA) - 1.0 kg	1.0 kg	8.28	0	0.04
Aluminium façade cladding panel, powder coated, 7.5 kg/m2, 70% recycled content (One Click LCA) - 1.0 kg	1.0 kg	3.82	0	0.04
Aluminium façade cladding panel, powder coated, 7.5 kg/m2, 30% recycled content (One Click LCA) - 1.0 kg	1.0 kg	8.1	0	0.04
Metal facade cladding from Nordic bronze (Royal), 1.5 mm, 15.7 kg/m2, Liberta Original, Liberta Elegant, Bespoke (Ruukki Construction Oy) - 1.0 kg	1.0 kg	2.63	0	0.04

Appendix E – Refrigerants - Air Source Heat Pumps

The following presents the proposed refrigerants that are to be used within the project. There are two main systems as described below:

No Daiken EWYT175B-SRA1 Air to water reversible heat pump

Daikin air to water reversible heat pump with hermetic scroll compressors and R32 refrigerant.

Unit information			
Compressor type	Scroll	Refrigerant type	R32
Capacity control	STEP	Air heat exchanger type	HFP
Compressor N°	2	Air heat exchanger fans N°	8
Circuit N°	1	Air heat exchanger fans control	VFD
Refrigerant charge	24.5 kg	Altitude	000 MSL
		Water heat exchanger type	Plated Heat Exchanger

Total Charge = 49kg – R32

5 No Daiken EWAT135B-SRA1 Air cooled chiller

Daikin air-cooled chiller with hermetic scroll compressors and R32 refrigerant.

Unit information			
Compressor type	Scroll	Refrigerant type	R32
Capacity control	Step	Condenser type	Microchannel
Compressor N°	2	Condenser fans N°	6
Circuit N°	1	Condenser fans control	Phase cut
Refrigerant charge	8.5 kg	Altitude	0 MSL
Nominal air flow	7396 l/s	Evaporator type	Brazed plate

Actual refrigerant charge depends on the final unit construction, refer to unit nameplate.

Total Charge = 42.5kg – R32

1 No Mitsubishi Climaventa EW-HT /0152

Water to water heat pumps for high temperature water production which represent the best solution for systems where very high temperature water is needed, for domestic hot water production. The special compressor adopted grants hot water production up to 78°C and allows high evaporation temperature (evaporator leaving water temperature up to 40°C).

REFRIGERANT		
Refrigerant		R134a
Theoretical refrigerant charge	kg	6.00
GWP100 value (from IPCC AR5)		1300
CO2 equivalent	t	7.80

Total Charge = 6kg – R134a