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# Whole Life Carbon Assessment

## Saffron Hill – Office building

**For**

**Saffron Hill Investment holdings**

**September 2023**

**Rev F: June 2024**

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| 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<br>❑ corrections to quantities of rebar<br>❑ rationalised steel structure<br>❑ 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 |
| G | 26th June 2024 | Updated with the GLA planning commentary – changes highlighted |
| H | 30th July 2024 | Further updates following commentary from design team. |
| H2 | 21st October 2024 | Section 2.4 added to discuss modules B to C |

**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.*

# Contents

# 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 **16,087,509 $kgCO_2$** including **2,389,018 $kgCO_2$** for Carbon Sequestration with the Upfront Carbon impacts (A1-A5) calculated as **5,812,984 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 – Annual WLCA Results**

| EMBODIED CARBON: | tonnes $CO_2e$ | $kg/CO_2/m^2$ |
|---|---|---|
| 'Upfront' / 'Cradle to Practical Completion' Emissions (A1 – A5) | 6,381.93 | 538.47 |
| Carbon Sequestration | -2,389.02 | -201.57 |
| Anticipated Life Cycle 'in use' Embodied Carbon Emissions (B1 – B5) | 3,355.23 | 283.09 |
| Anticipated 'End of Life' Emissions (C1-C4) | 2,634.05 | 222.25 |
| | | |
| **OPERATIONAL CARBON:** | | |
| Anticipated Life Cycle Operational Energy and Water Emissions (B6-B7) | 6105.32 | 515.13 |

**Figure 1 - WLCA result**

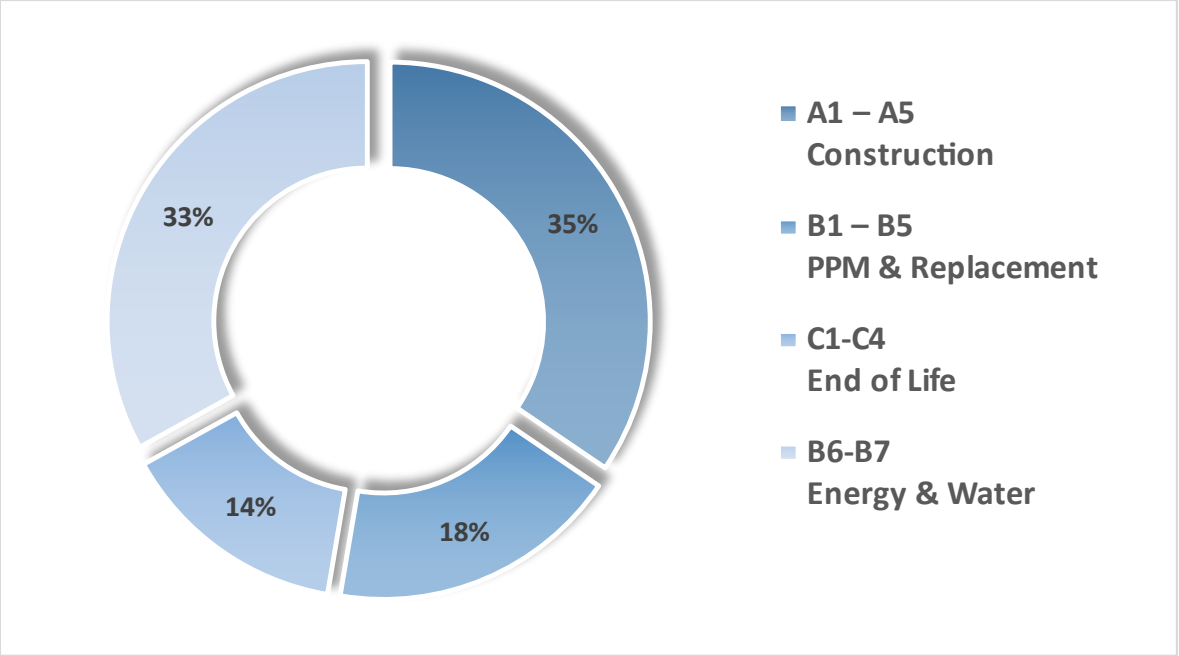
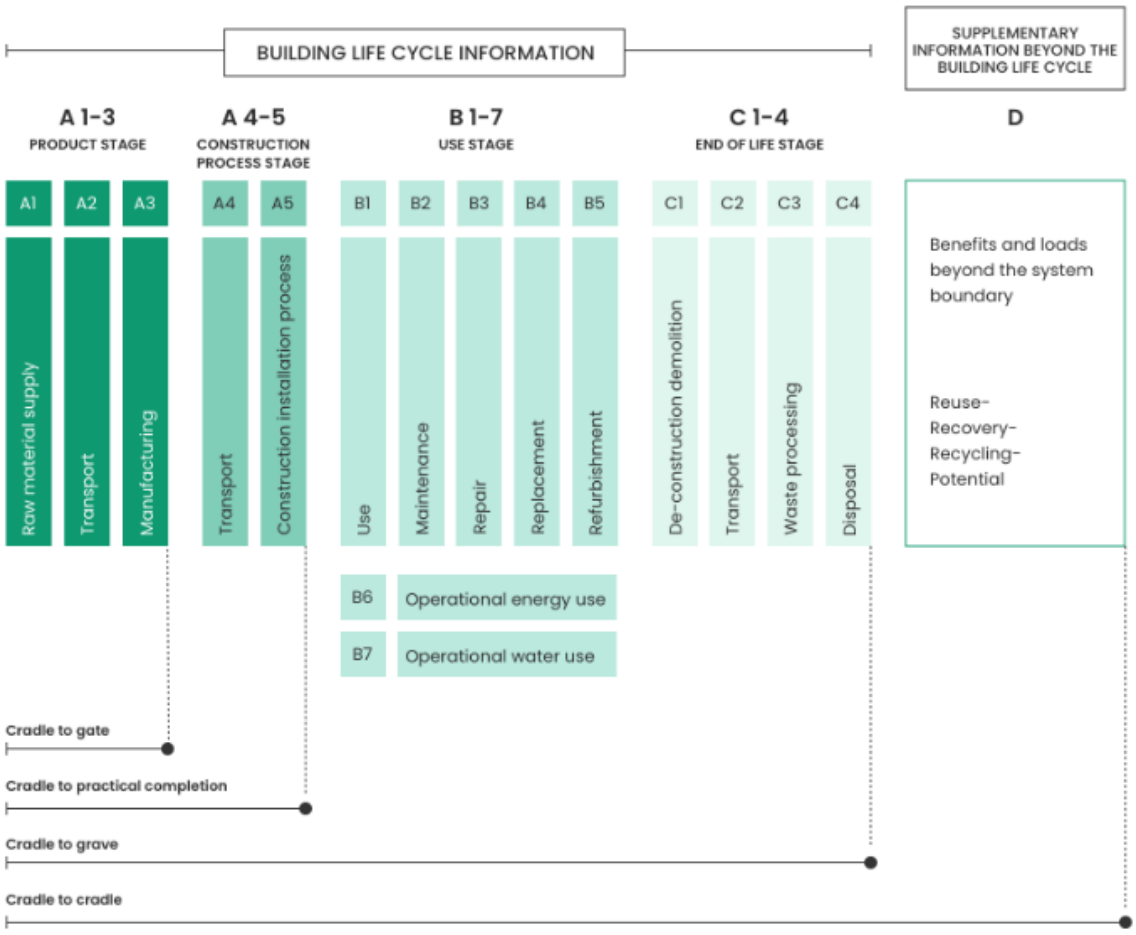
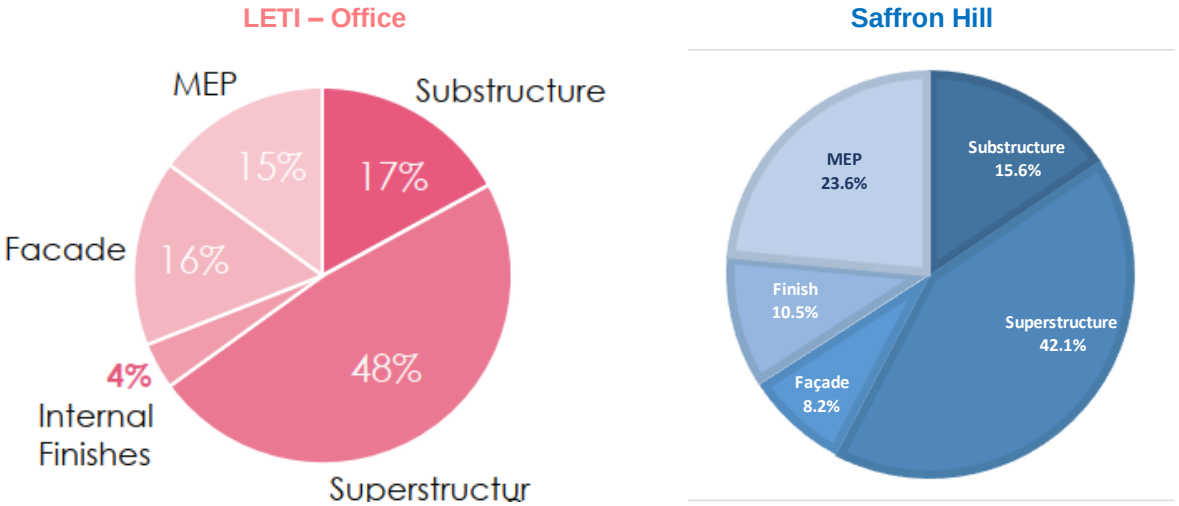


Figure 2 - Building life-cycle module according to the EN-15978




A1 to A3 Up front impacts total **5,812,984 kgCO₂** and are broken down and compared with the LETI figures as shown in figure 3.

Figure 3 – Up Front (A1 – A3) impacts – compared by type




We have noted that internal finishes are high in comparison to the LETI benchmark however these impacts are primarily made up primarily from the raised floor which RICS classifies as finishes. Ways to reduce this impact are

discussed in section 2.3.3 however the raised floor forms part of the MEP systems (acting as a plenum) and so technical issues prevent us from selecting a lower impact raised floor.

Further we note that the overall façade proportion is lower when compared to the LETI figure. This appears to be due to the significant extent of party walls vs. the glazed / aluminium façade. It also provides evidence of the benefit of the work the design team did at an early stage in optimising the façade and selecting lower impact materials.

The main element of the party walls of made from concrete blocks and the selection of the Aggregate Industries Enviroblock has meant that the impact of this is minimised.

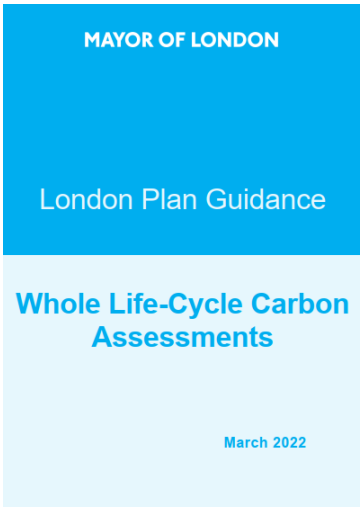
# 2 Detailed Analysis

Below we set out the policy context and 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 which are 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 setting out how to prepare the WLCA to accompany strategic planning applications in London.

Whole Life-Cycle Carbon (WLC) assessments should be carried out in line with Policy SI 2 F of the London Plan 2021 and are to be submitted using the WLC assessment Excel template. Policy SI 2 F applies to planning applications which are referred to the mayor; however they are also supported and encouraged on major applications that are not referable.

The overarching GLA 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 – including policy context.

The WLC assessment Excel template must include all the information listed in **GLA WLCA Guidance Section 3.2.2 Box 4**. These are summarised below and signposted to the various sections within this document. Screenshots of the Excel template are included in Appendix A.

- Project and assessment details: 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% of the capital cost allocated to each building element category. (Section 2.1.1)
- The third-party QA and Audit 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.
- 60% of the existing foundations will be retained from the existing structure.
- Summary of key actions to achieve the WLC emissions reported and alongside these the emission reductions that are expected to be achieve.
- Proposed key materials and levels of recycled content.
- Opportunities to reduce the development's WLC emissions further – Section 2.3.3 considers 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 these will be fitted by the future tenant, However the raised floor is classed by RICS as finishes and this has been identified as a significant impact and the specification of this is integral to the MEP strategy.***

### 2.2.2 EN 15978 Module Coverage and life span

BS EN15978:3011 has been used as 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
- Most finishes and fitting outside of core areas with the exclusion of the raised floor.
- 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 B2 Maintenance Assumptions

The assessment is currently at a relatively early stage of design and therefore the Module B2 is difficult to estimate. We have therefore provided figures in line with the GLA WLCA Guidance section 2.5.12 state that …." *for module B2 emissions, a total figure of 10 kg$CO_{2e}$/$m^2$ gross internal area (GIA) may be used to cover all building element categories, or 1 per cent of modules A1-A5, whichever is greater."*

The 10 kg$CO_{2e}$/$m^2$ gross internal area figure is the higher figure and so this is used. These have been apportioned across those items most likely to require maintenance such as Lower floor glazing, sanitaryware, finishes, etc.

### Module B3 Repair Assumptions

The assessment utilises Repair scenario which are compliant with the GLA Guidance which states that these may be estimated as 25 per cent of module B2, as per the RICS Professional Statement (item 3.5.3.3).

- All MEP materials repair rate will be updated at As-Build stage.

### 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."*

CPE have updated the lifespan according to the RICS Professional Statement Table 9.

## 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:

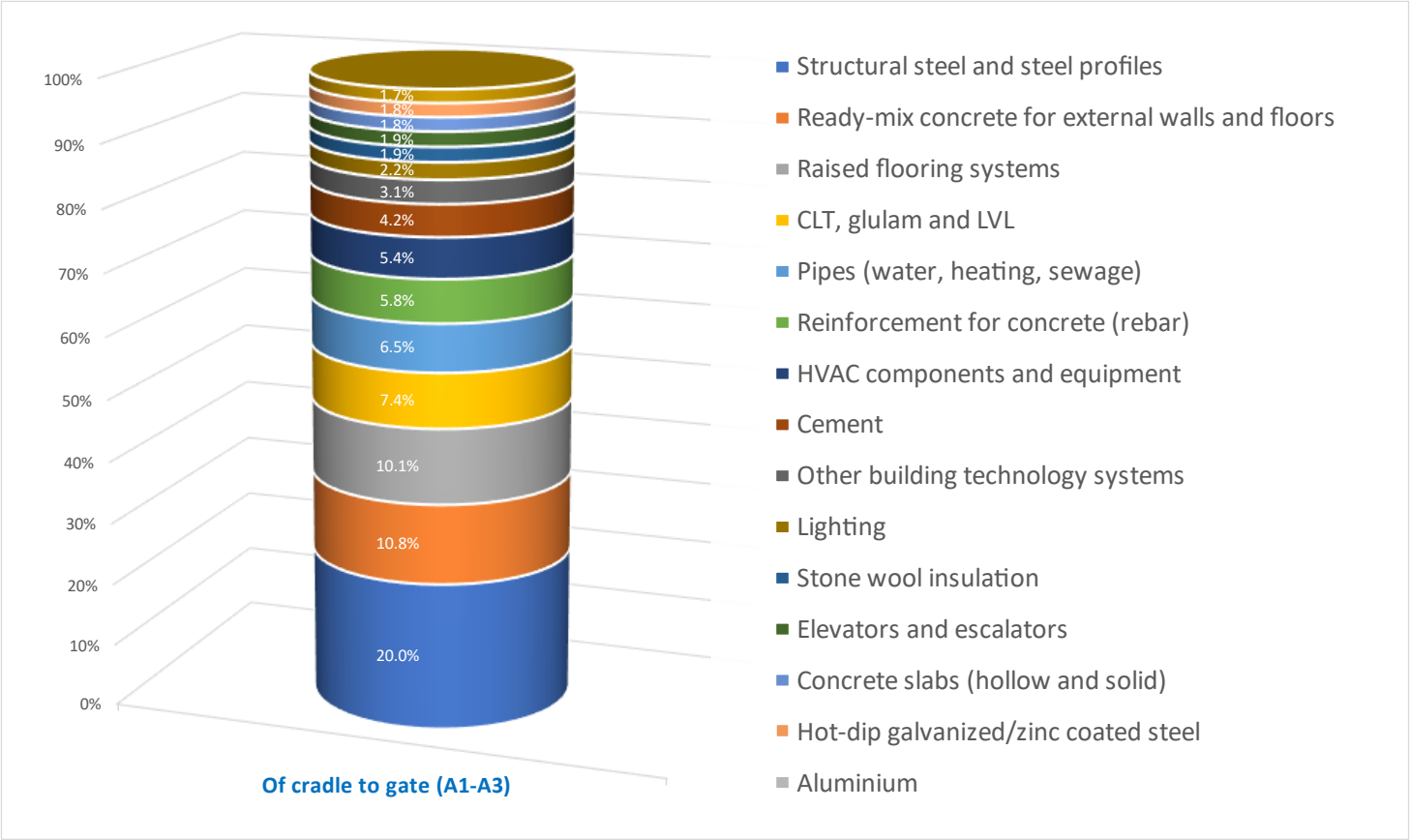
- Steel Frame = **~25% of total materials impact**.
- Raised Access flooring = **9.8% of total materials impact**.
- MEP services materials have **22.8% of total materials impact**.

**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 | 20.0% |
| 2 | Ready-mix concrete for external walls and floors | 627.34 | 10.8% |
| 3 | Raised flooring systems | 589.85 | 10.1% |
| 4 | CLT, glulam and LVL | 429.25 | 7.4% |
| 5 | Pipes (water, heating, sewage) | 375.00 | 6.5% |
| 6 | Reinforcement for concrete (rebar) | 335.35 | 5.8% |
| 7 | HVAC components and equipment | 312.72 | 5.4% |
| 8 | Cement | 245.87 | 4.2% |
| 9 | Other building technology systems | 180.43 | 3.1% |
| 10 | Lighting | 128.74 | 2.2% |
| 11 | Stone wool insulation | 112.80 | 1.9% |
| 12 | Elevators and escalators | 112.65 | 1.9% |
| 13 | Concrete slabs (hollow and solid) | 104.60 | 1.8% |
| 14 | Hot-dip galvanized/zinc coated steel | 102.81 | 1.8% |
| 15 | Aluminium | 100.94 | 1.7% |
| 16 | Ventilation ducts and channels | 97.42 | 1.7% |
| 17 | Sealants (silicone and others) | 95.69 | 1.6% |
| 18 | HVAC equipment with refrigerant | 75.10 | 1.3% |
| 19 | Specialty gypsum board | 62.38 | 1.1% |
| 20 | Other precast concrete products | 61.52 | 1.1% |
| 21 | EPS (expanded polystyrene) insulation | 45.97 | 0.8% |
| 22 | Acoustic insulation panels | 41.08 | 0.7% |
| 23 | Safety glass panes | 31.79 | 0.5% |
| 24 | Aluminium frame windows | 30.77 | 0.5% |
| 25 | Wood and wood board doors | 30.54 | 0.5% |

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

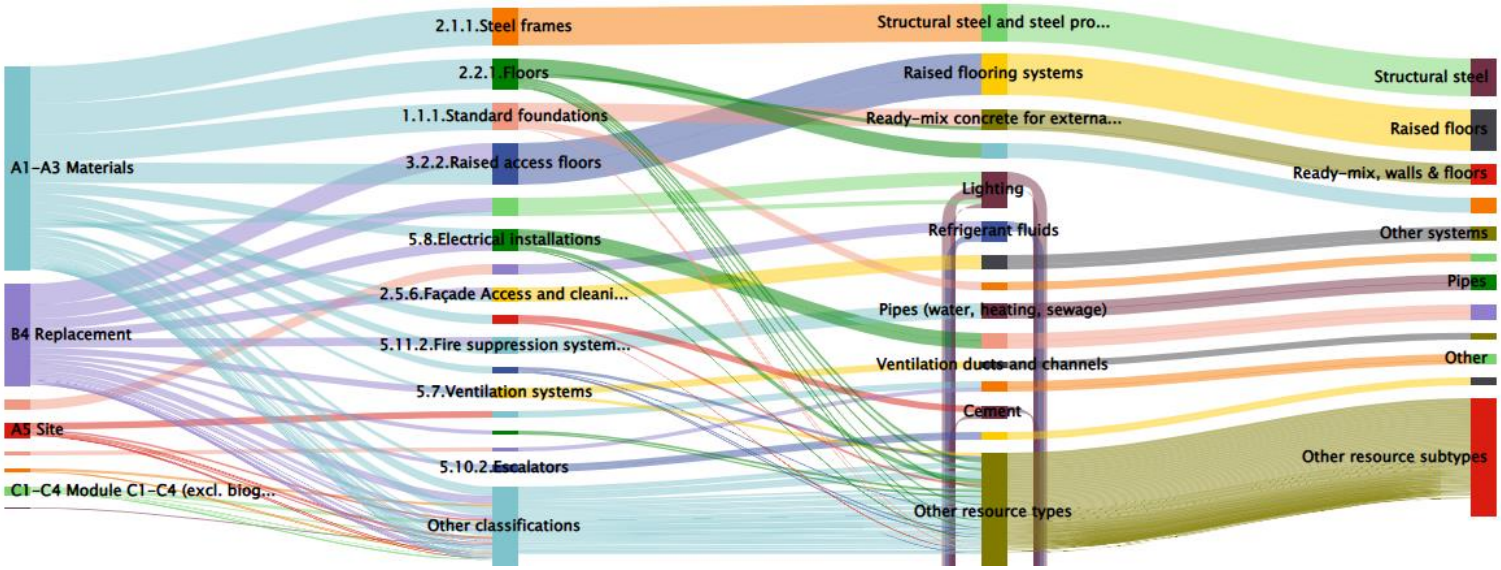
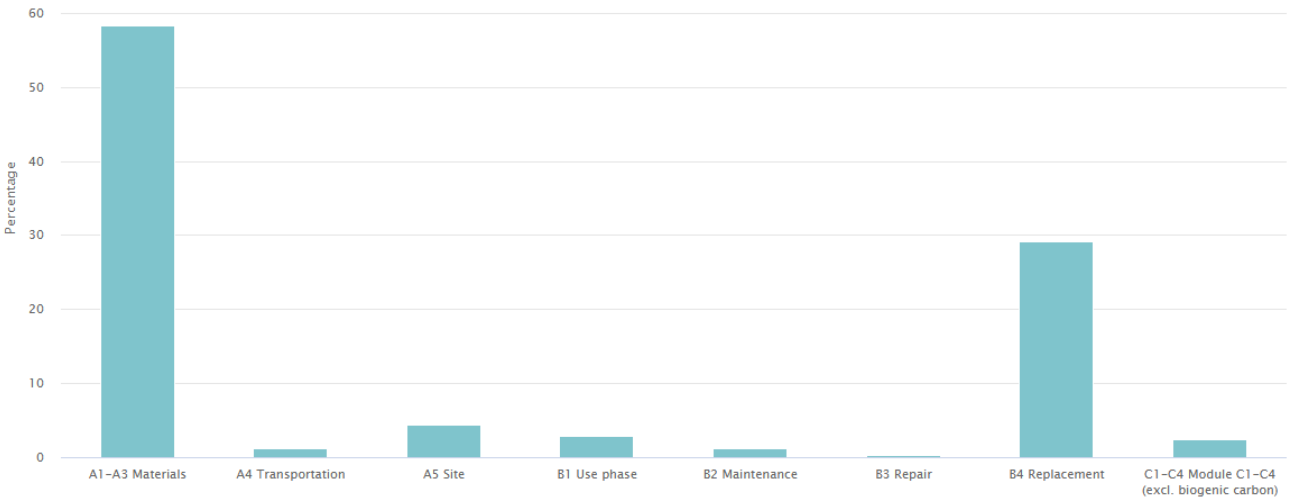
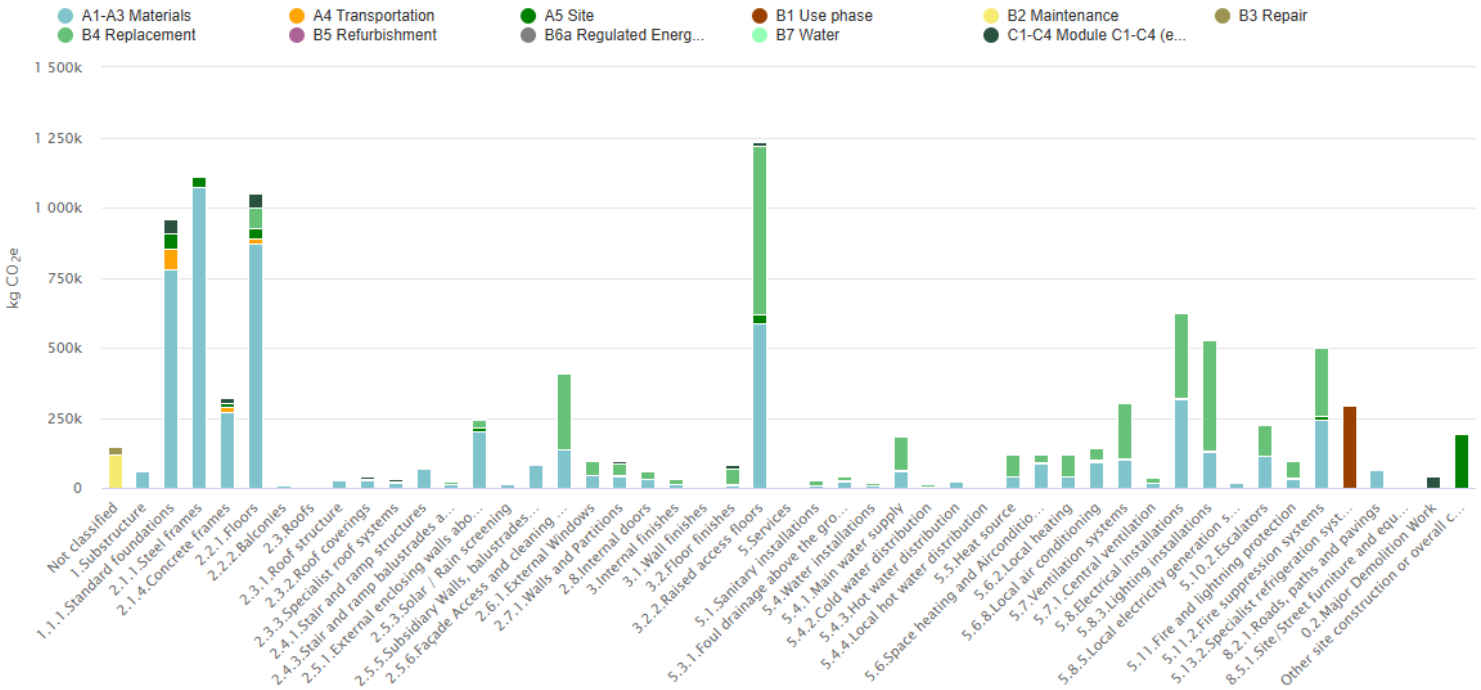


Figure 6 – Impacts by Lifecycle stage




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.

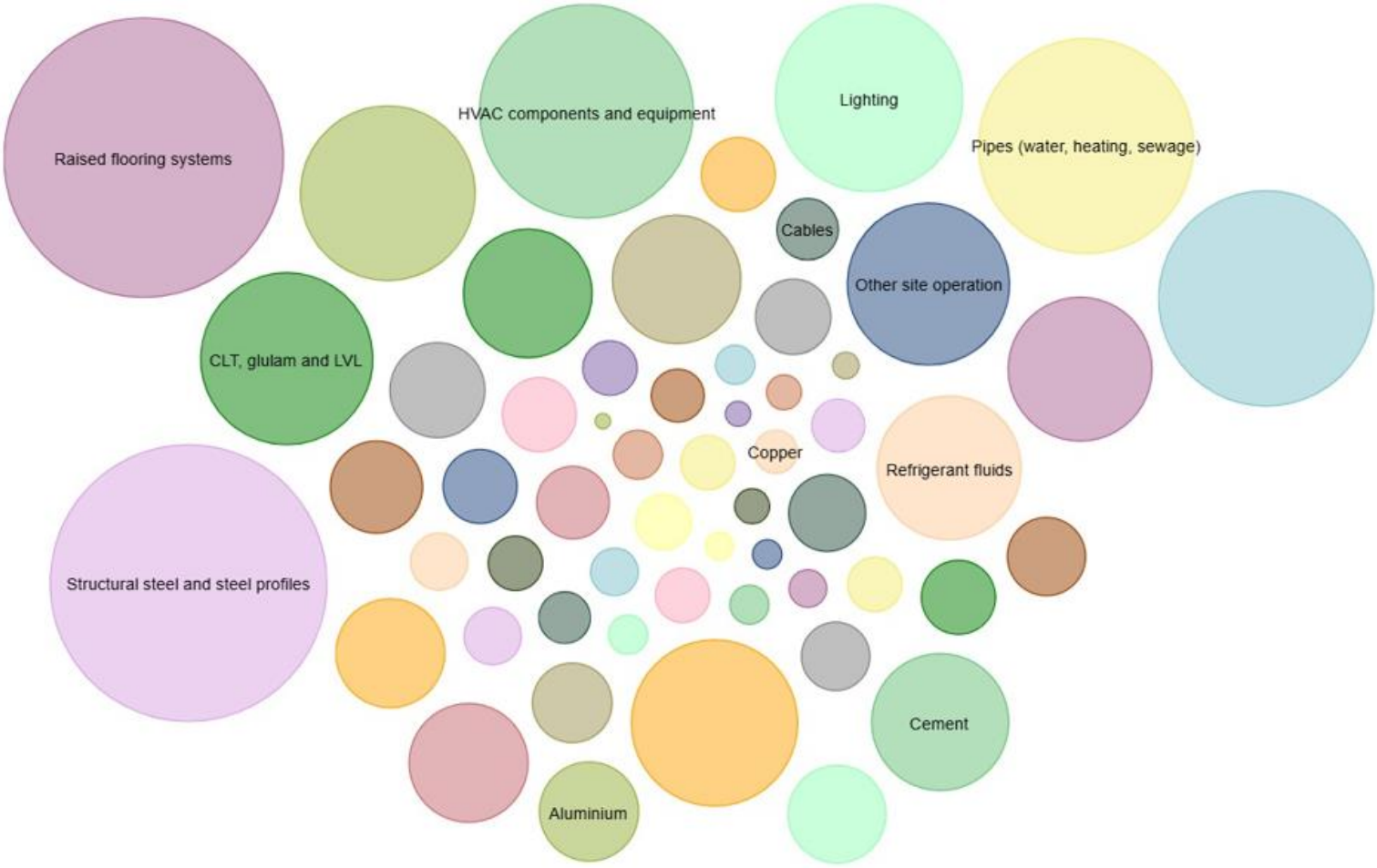
Figure 7 – Impacts by RICS Category




The two graphs above show that the embodied carbon within the 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 interrogate to lower the impact of the building.

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



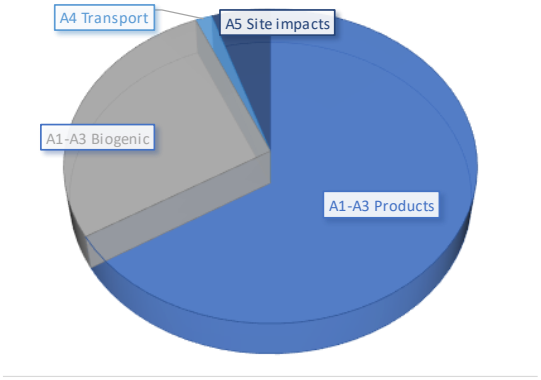

- Ready-mix concrete for external walls and floors
- EPS (expanded polystyrene) insulation
- Cement
- Stone wool insulation
- Aluminium
- Concrete masonry units (CMU)
- Natural stone
- Other metals
- Concrete slabs (hollow and solid)
- Bitumen and other roofing
- Plain wood/timber (softwood and hardwood)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

### 2.3.2 LCA impact breakdown

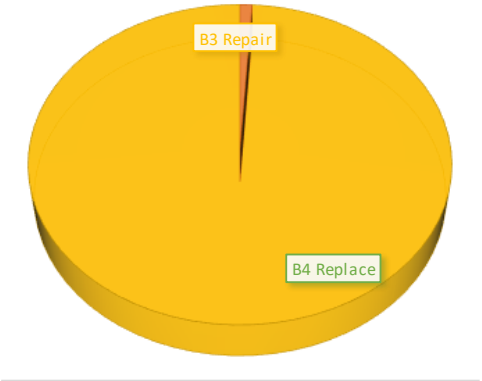
The detailed results of the WLCA are compared to the GLA benchmark shown in the section 2.5 and the total saving of the embodied carbon is around 70% compared to these WLCA benchmarks.

**Figure 9 - Emissions charts by stage**

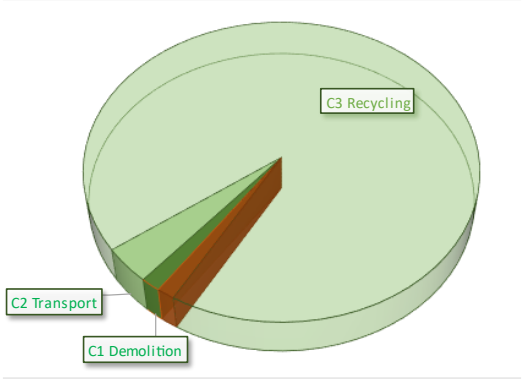
| A1-A5 Embodied Carbon Emission | | | |
|---|---|---|---|
| A1-A3 | Product Stage | 5,813.00 | tCO2e |
| A1-A3 | Biogenic | -2,389.00 | tCO2e |
| A4 | Transport to site | 125.20 | tCO2e |
| A5 | Construction and installation | 443.80 | tCO2e |
| | | | |
| | Total A1-A5 | 3,993.00 | tCO2e |



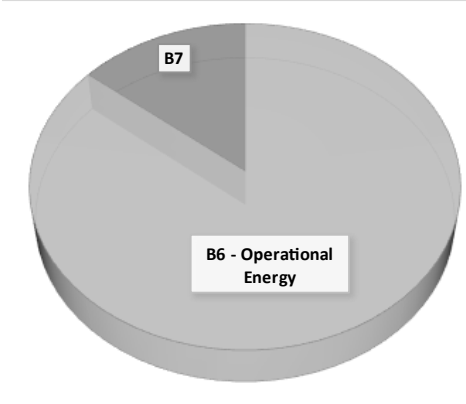

| B1-B5 Embodied Carbon Emission | | | |
|---|---|---|---|
| B1-B2 | Use and Maintenance | 410.20 | tCO2e |
| B3 | Repair | 29.60 | tCO2e |
| B4 | Replacement | 2,915.40 | tCO2e |
| B5 | Refurbishment | 0.00 | tCO2e |
| | | | |
| | Total B1-B5 | 3,355.20 | tCO2e |




| C1-C4 Embodied Carbon Emission | | | |
|---|---|---|---|
| C1 | Demolition | 39.40 | tCO2e |
| C2 | Transport to disposal | 100.90 | tCO2e |
| C3 | Waste processing for reuse, recovery or recycle | 2,457.80 | tCO2e |
| C4 | Refurbishment | 35.90 | tCO2e |
| | | | |
| | Total C1-C4 | 2,634.00 | 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 |

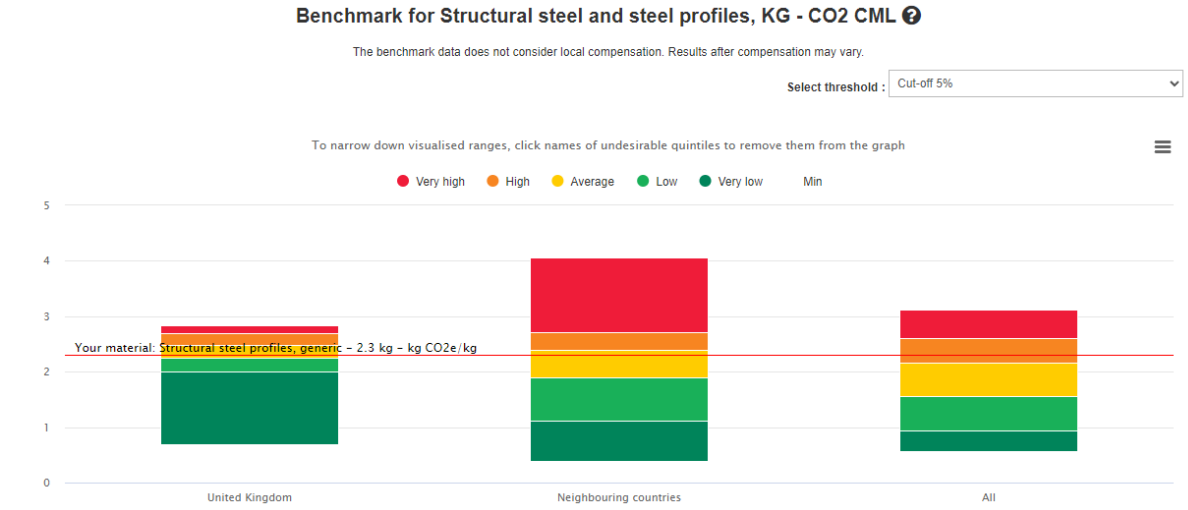


### 2.3.3 Further Reductions

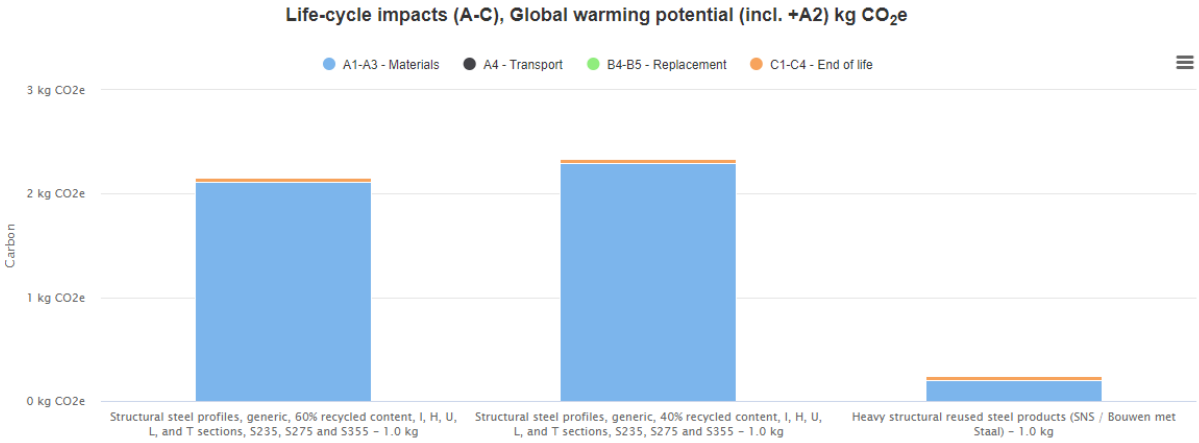
The following areas and elements where the potential for reduction have been identified will be investigated further during the detailed design stages:

#### 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.



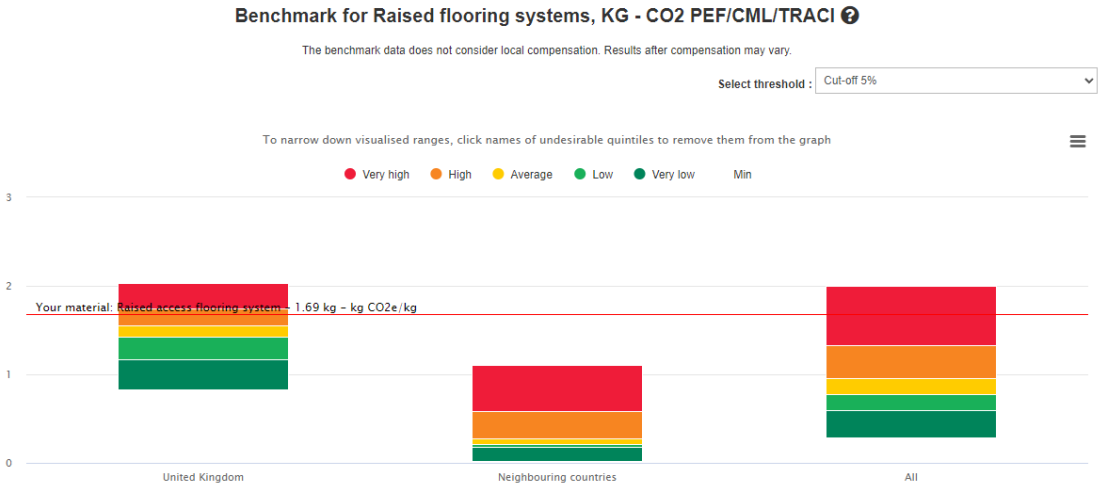

The following graph compares the carbon emissions / kg among 40%, 60% recycled content and reclaimed steel frame.



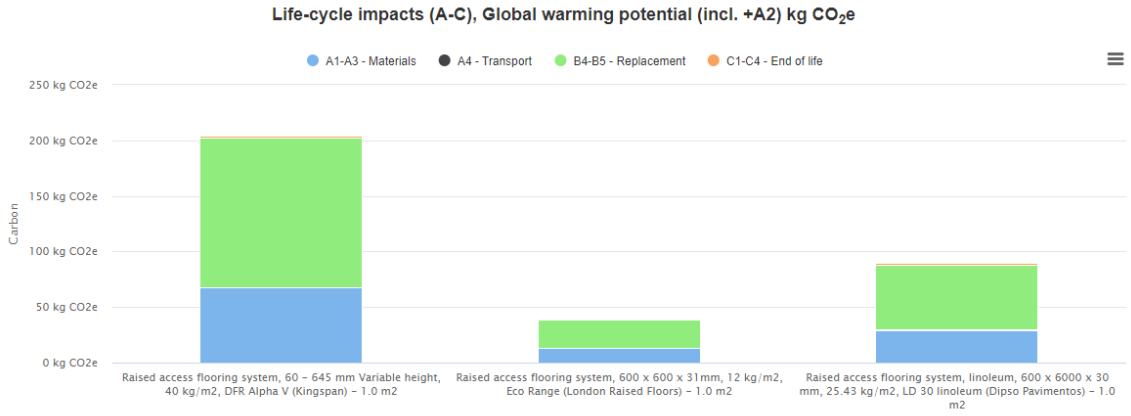

| Resource name | Quantity | A1-A3 - Materials (kg $CO_2e$) | A4 - Transport (kg $CO_2e$) | B4-B5 - Replacement (kg $CO_2e$) | C1-C4 - End of life (kg $CO_2e$) | Financial cost (€) | Financial and carbon cost (€) |
|---|---|---|---|---|---|---|---|
| Structural steel profiles, generic, 60% recycled content, 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,



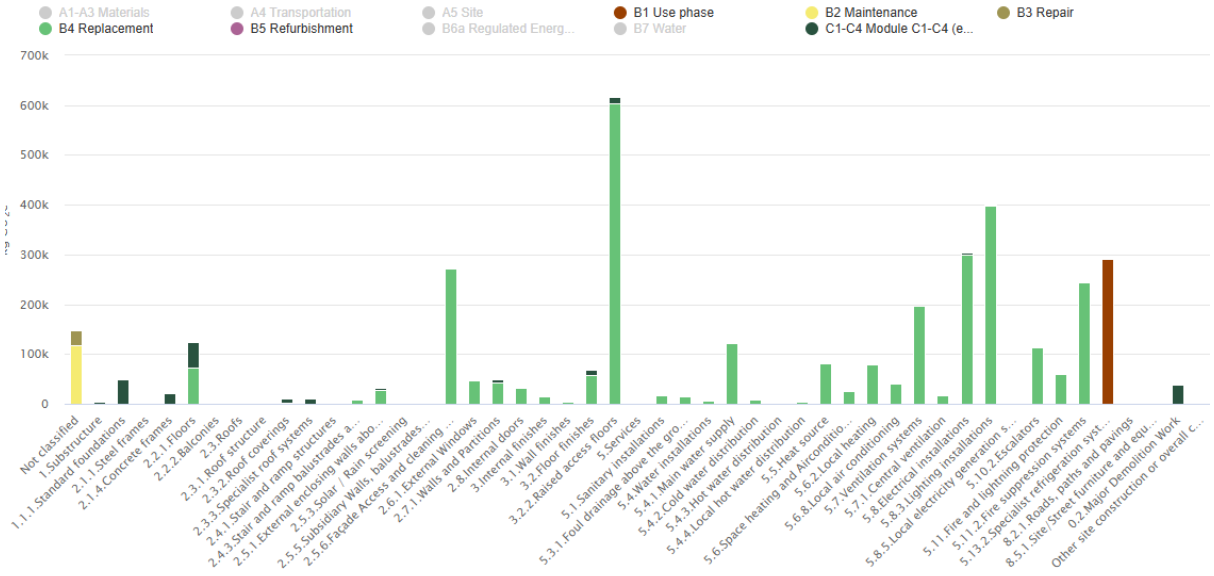

| Resource name | Quantity | A1-A3 - Materials (kg $CO_2e$) | A4 - Transport (kg $CO_2e$) | B4-B5 - Replacement (kg $CO_2e$) | C1-C4 - End of life (kg $CO_2e$) | Financial cost (€) | Financial and carbon cost (€) |
|---|---|---|---|---|---|---|---|
| Raised access flooring system, 60 - 645 mm Variable 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 |

At this time the opportunity to reduce these impacts from both modules A and B must await more detailed investigations as the raised floor acts as a plenum for the ventilation systems and therefore has to meet strict technical criteria.

## 2.4 Module B1 to B4 - Results discussion

The GLA Benchmark for B and C is exceeded with this impact totalling 505.34 kg/$CO_2$/$m^2$ and the benchmark being 450 kg/$CO_2$/$m^2$. To achieve the Benchmark a reduction of 55.34 kg/$CO_2$/$m^2$ which is equivalent to 656 Tonnes / $CO_2$ overall.

The chart below shows the breakdown of Module B and C into individual RICS category elements and as discussed above in Section 2.3.1 and 2.3.3 the Raised floor is the single biggest impact with lighting installations following closely behind.



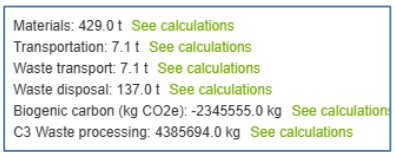

### CLT End of Life

The chart also shows the limited impact for End of life (Module C) overall within the assessment and this takes account of the proposed re-use of the CLT slabs at End of life. The OneClick software makes the following assumptions:

> *It is a common conception that timber is a more climate-friendly material because it stores carbon, and this results in **negative embodied carbon.** Unfortunately, as is often the case, the full picture is not quite so simple. The vast majority of the buildings built today are not designed or delivered in a manner to allow for the reuse of the timber structures after the end of the building's life. This results, in most cases, in the timber being incinerated after deconstruction or demolition, which **releases the carbon back into the atmosphere**. While this does delay the emission of the biogenic carbon emissions stored in the buildings by several decades, it clearly cannot be considered as negative embodied carbon.*

The GLA spreadsheet shows an impact for C3 for the upper floors of 2,346,537 kg/$CO_2$ (equivalent to 197.98 kg/$CO_2$/$m^2$) even though we have set the End of Life scenario as being ***Reuse as Material*** i.e. there is no waste processing.

The majority of the upper floors are constructed from CLT slabs and the C3 waste processing element of their impact is 4,385,694 kg/$CO_2$ from which the biogenic storage of 2,345,555 kg/$CO_2$ removed leaving 2,040,139 kg/$CO_2$.




- **Overall this would reduce the impact for C3 by 172.13 kg/$CO_2$**

## Further work

To achieve the very low operational emissions the building is quite heavily serviced and so the replacement lifecycles of these items also have an impact.

We are determined to work with manufacturers to procure items that have longer lifespans and lower impacts overall, however at this time the Benchmark cannot be achieved without compromising other sustainability aspects. However we note that:

- A change to the medium impact Raised floor would remove 662 Tonnes from this section.
- A reduction of 10% in the lighting impact would remove 40 Tonnes from this section.

## 2.5 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 $CO_2$e / year**

**Building life span 60 years= 87,393 kg $CO_2$e /year x 60 years = 5,243,583 kg $CO_2$e (60years)**

The above overall energy consumption can be subdivided as follows for inclusion in the GLA Spreadsheet.

**Table NT1: New table to show split of Regulated and Unregulated**

| | Total kWh/year | Total $CO_2$ / year | 60 year $CO_2$ |
|---|---|---|---|
| Total Energy | 642,596 | 87,393 | 5,243,583 |
| Unregulated total | 351,058 | 47,744 | 2,864,630 |
| Regulated total | 291,538 | 39,649 | 2,378,953 |

## 2.6 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 $m^2$ per workspace |
| | 6 $m^2$ per person |
| | 12 $m^2$ per person |
| | 8 –13 $m^2$ 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 ÷ 10$m^2$) = 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 $m^3$ 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 $kgCO_2e/m^3$, and 0.71 $kgCO_2e/m^3$ 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)***

## 2.7 Comparison – Embodied Carbon Benchmarks

### 2.7.1 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 $CO_2e$ | 6,381,928 kg CO2e | 5,989,282 kg CO2e | 9,982,193 kg CO2e |
| TOTAL kg $CO_2e/m^2$ GIA | **538.468** | **505.339** | **842.237** |
| 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 **538.468 $CO_{2e}/m^2$ GIA** which is:

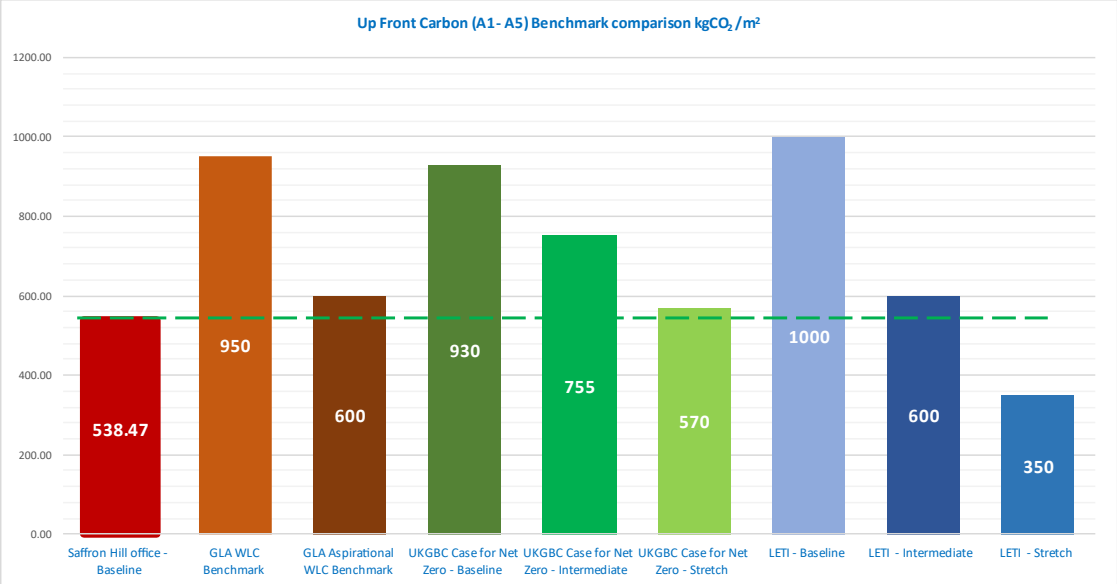
- **43.32% lower** for the A1-A5 compared to the GLA WLC Benchmark (950 $kgCO_2/m^2$),
- **10.26% lower** than the Aspirational GLA WLC Benchmark (600 $kgCO_2/m^2$).

**The Module A1-A5 is lower than the Aspirational GLA WLC Benchmark (600 $kgCO_2/m^2$) by specifying high recycled content materials (30%GGBS in concrete and 60% in steel frame, 70% in aluminium cladding and window frames), CLT floor slab for about 80% of the floor, and materials optimised steel frame. Moreover, to maintain the flexibility for future tenant there is no partition or finishes been specified or included in tenant area.**

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.

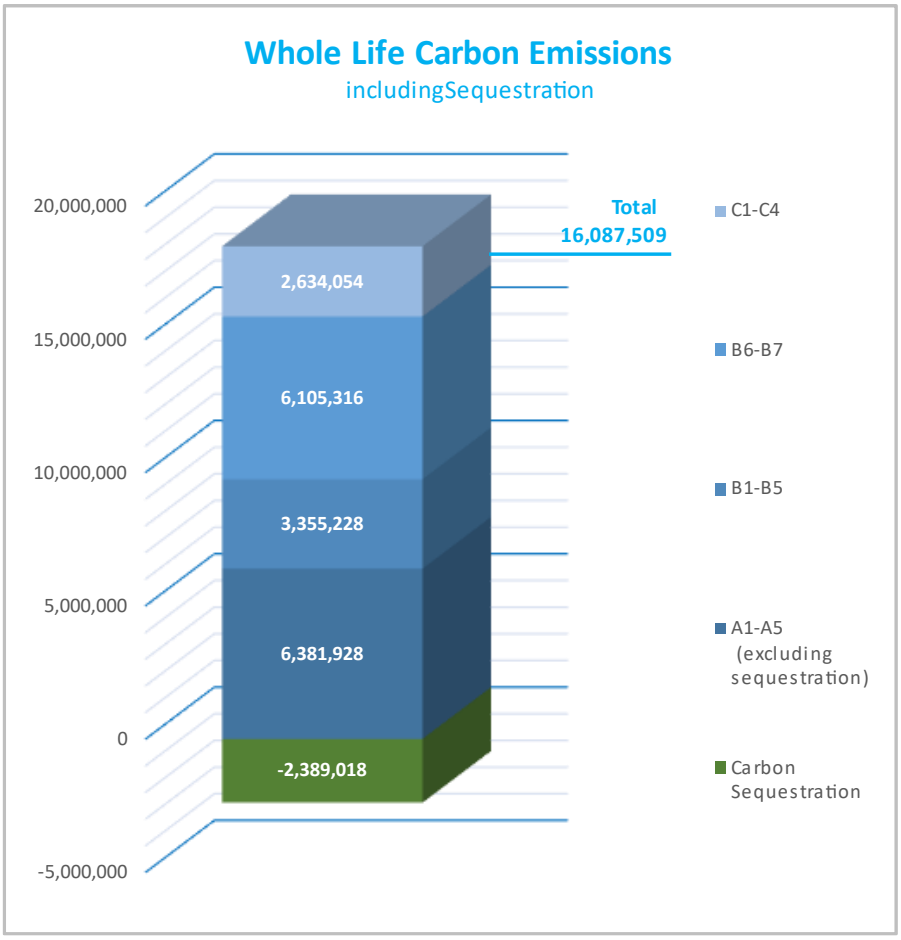
In the tables, all carbon emissions are listed by WLC modules, to demonstrate the specific elements that can be improved or for the future reference.

**Table 6 - Summary WLCA results**

| WLC Result | | | | | | |
|---|---|---|---|---|---|---|
| **Modules** | **A1-A5 (excluding sequestration)** | **B1-B5** | **B6-B7** | **C1-C4** | **Carbon Sequestration** | **Total (including sequestration)** |
| **$kgCO_2e$** | 6,381,928 | 3,355,228 | 6,105,316 | 2,634,054 | -2,389,018 | 16,087,509 |

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 **6,381.90tCO$_2$** 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 **£606,290**.

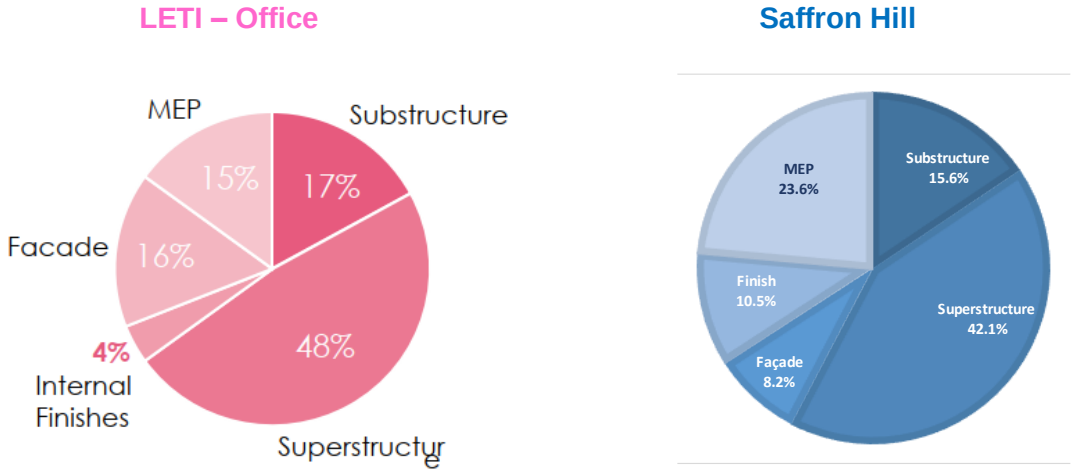
**Table 7 - offset values**

| Offset Option | Cost per tCO$_{2e}$ | tCO$_{2e}$ A1-A5 | Indicative Cost (£) |
|---|---|---|---|
| UK Woodland Trust | £30 | 6,381.90 | £191,460 |
| International Schemes | £20 | | £127,640 |
| UKGBC (Recommended for net zero carbon leaders) | £73 | | £465,880 |
| **GLA Carbon Offset Fund** | **£95** | | £606,290 |

## 3.2 Proportions of embodied carbon by building element

A1 to A3 Up front impacts total **5,812,984 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 | | 0 kg CO2e |
| 2.1 | Superstructure: Frame | 0 kg CO2e | 1,342,590 kg CO2e | 19,794 kg CO2e | 49,010 kg CO2e | | 0 kg CO2e |
| 2.2 | Superstructure: Upper Floors | -2,345,555 kg CO2e | 879,511 kg CO2e | 18,927 kg CO2e | 36,078 kg CO2e | | 0 kg CO2e |
| 2.3 | Superstructure: Roof | -10,288 kg CO2e | 74,996 kg CO2e | 529 kg CO2e | 4,215 kg CO2e | | 4,021 kg CO2e |
| 2.4 | Superstructure: Stairs and Ramps | 0 kg CO2e | 79,652 kg CO2e | 1,406 kg CO2e | 2,261 kg CO2e | | 4,201 kg CO2e |
| 2.5 | Superstructure: External Walls | 0 kg CO2e | 431,293 kg CO2e | 1,966 kg CO2e | 16,607 kg CO2e | | 0 kg CO2e |
| 2.6 | Superstructure: Windows and External Doors | 0 kg CO2e | 47,272 kg CO2e | 62 kg CO2e | 81 kg CO2e | | 2,391 kg CO2e |
| 2.7 | Superstructure: Internal Walls and Partitions | 0 kg CO2e | 40,088 kg CO2e | 311 kg CO2e | 4,374 kg CO2e | | 2,258 kg CO2e |
| 2.8 | Superstructure: Internal Doors | -33,175 kg CO2e | 30,542 kg CO2e | 131 kg CO2e | 0 kg CO2e | | 1,547 kg CO2e |
| 3 | **Finishes** | 0 kg CO2e | 612,478 kg CO2e | 1,561 kg CO2e | 33,692 kg CO2e | | 32,662 kg CO2e |
| 4 | **Fittings, furnishings & equipment** | | | | | | 0 kg CO2e |
| 5 | **Services (MEP)** | 0 kg CO2e | 1,370,528 kg CO2e | 2,189 kg CO2e | 44,061 kg CO2e | 291,692 kg CO2e | 71,441 kg CO2e |
| 6 | **Prefabricated Buildings and Building Units** | | | | | | 0 kg CO2e |
| 7 | **Work to Existing Building** | | | | | | 0 kg CO2e |
| 8 | **External works** | 0 kg CO2e | 63,240 kg CO2e | 860 kg CO2e | 65 kg CO2e | | 0 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** | **5,812,984 kg CO2e** | **125,184 kg CO2e** | **443,760 kg CO2e** | **291,692 kg CO2e** | **118,520 kg CO2e** |
| **TOTAL** - kg $CO_2e/m^2$ GIA | | **-202 kg CO2e/m2 GIA** | **490 kg CO2e/m2 GIA** | **11 kg CO2e/m2 GIA** | **37 kg CO2e/m2 GIA** | **25 kg CO2e/m2 GIA** | **10 kg CO2e/m2 GIA** |

| Use stage (kgCO$_2$e) | | | | | End of Life (EoL) stage (kgCO$_2$e) | | | | TOTAL Modules A-C kgCO$_2$e | Benefits and loads beyond the system boundary (kgCO$_2$e) |
|---|---|---|---|---|---|---|---|---|---|---|
| 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 | | | | | | 37,038 kg CO2e | 16,390 kg CO2e | 361 kg CO2e | 1,031,336 kg CO2e | -171,636 kg CO2e |
| 0 kg CO2e | | | | | | 13,694 kg CO2e | 6,509 kg CO2e | 1,232 kg CO2e | 1,432,830 kg CO2e | -1,197,726 kg CO2e |
| 0 kg CO2e | 73,154 kg CO2e | 0 kg CO2e | | | | 17,214 kg CO2e | 2,346,537 kg CO2e | 32,475 kg CO2e | 1,058,341 kg CO2e | -458,427 kg CO2e |
| 1,005 kg CO2e | 1,521 kg CO2e | 0 kg CO2e | | | | 240 kg CO2e | 29,521 kg CO2e | 736 kg CO2e | 106,495 kg CO2e | -48,527 kg CO2e |
| 1,050 kg CO2e | 8,734 kg CO2e | | | | | 1,120 kg CO2e | 101 kg CO2e | 1 kg CO2e | 98,527 kg CO2e | -15,499 kg CO2e |
| 0 kg CO2e | 299,033 kg CO2e | 0 kg CO2e | | | | 5,241 kg CO2e | 1,797 kg CO2e | 194 kg CO2e | 756,131 kg CO2e | -85,137 kg CO2e |
| 598 kg CO2e | 47,849 kg CO2e | 0 kg CO2e | | | | 192 kg CO2e | 322 kg CO2e | | 98,767 kg CO2e | -619 kg CO2e |
| 564 kg CO2e | 43,305 kg CO2e | 0 kg CO2e | | | | 2,877 kg CO2e | 3,443 kg CO2e | 1 kg CO2e | 97,220 kg CO2e | -23,303 kg CO2e |
| 387 kg CO2e | 31,059 kg CO2e | 0 kg CO2e | | | | 101 kg CO2e | 33,446 kg CO2e | 14 kg CO2e | 64,051 kg CO2e | 0 kg CO2e |
| 8,165 kg CO2e | 680,107 kg CO2e | 0 kg CO2e | | | | 13,434 kg CO2e | 12,128 kg CO2e | 19 kg CO2e | 1,394,247 kg CO2e | -1,598,078 kg CO2e |
| 0 kg CO2e | | | | | | | | | 0 kg CO2e | |
| 17,860 kg CO2e | 1,730,623 kg CO2e | 0 kg CO2e | 2,378,953 kg CO2e | 2,864,630 kg CO2e | 861,733 kg CO2e | 8,585 kg CO2e | 6,446 kg CO2e | 827 kg CO2e | 9,649,569 kg CO2e | -1,057,712 kg CO2e |
| 0 kg CO2e | | | | | | | | | 0 kg CO2e | |
| 0 kg CO2e | | | | | | | | | 0 kg CO2e | |
| 0 kg CO2e | | 0 kg CO2e | | | | 1,214 kg CO2e | 579 kg CO2e | 2 kg CO2e | 65,961 kg CO2e | -63,068 kg CO2e |
| | | | | | | | | | 194,610 kg CO2e | |
| **29,630 kg CO2e** | **2,915,386 kg CO2e** | **0 kg CO2e** | **5,243,583 kg CO2e** | **861,733 kg CO2e** | **39,423 kg CO2e** | **100,951 kg CO2e** | **2,457,820 kg CO2e** | **35,861 kg CO2e** | **16,087,509 kg CO2e** | **-4,719,731 kg CO2e** |
| **3 kg CO2e/m2 GIA** | **246 kg CO2e/m2 GIA** | **0 kg CO2e/m2 GIA** | **442 kg CO2e/m2 GIA** | **73 kg CO2e/m2 GIA** | **3 kg CO2e/m2 GIA** | **9 kg CO2e/m2 GIA** | **207 kg CO2e/m2 GIA** | **3 kg CO2e/m2 GIA** | **1,357 kg CO2e/m2 GIA** | **-398 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 | 490,400.0 kg |
| | | Ready-mix concrete, C32/40 30% GGBS content in cement | 5420256 | Assumed permanent service life. | Concrete crushed to aggregate | 5,420,256 kg | 0.0 kg |
| | | Concrete - C40/50 | 238585.2 | Assumed permanent service life. | Concrete crushed to aggregate | 238,585 kg | 0.0 kg |
| | | EPS insulation | 3630 | Assumed permanent service life. | Landfilling (for inert materials) | 0 kg | 3,630.0 kg |
| | | Waterproofing membrane | 712.8 | Assumed permanent service life. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| 2.1 | Superstructure: Frame | Structural steel profiles, 60% recycled content | 388176.5 | Assumed permanent service life. | Steel reclaimed | 388,177 kg | 0.0 kg |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | Reinforcement steel (rebar), generic | 148380.6 | Assumed permanent service life. | Steel recycling | 0 kg | 148,380.6 kg |
| | | Concrete - C40/50 | 2950090.1 | Assumed permanent service life. | Concrete crushed to aggregate | 2,950,090 kg | 0.0 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 | 106,455.0 kg |
| | | Ready-mix concrete, C32/40 30% GGBS content in cement | 839928 | Assumed permanent service life. | Concrete crushed to aggregate | 0 kg | 839,928.0 kg |
| | | Reinforcement steel (rebar), generic | 47250 | Assumed permanent service life. | Steel recycling | 0 kg | 47,250.0 kg |
| | | Hollow core concrete slabs, generic | 517342 | Assumed permanent service life. | 90% reclaimed 10% recycled | 465,608 kg | 51,734.2 kg |
| | | Floor screed mortar, cement screed | 119550 | Assumed permanent service life. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | Acoustic partition roll insulation, unfaced | 8367 | Assumed permanent service life. | 100% recycle by certified contractor | 0 kg | 8,367.0 kg |
| | | Metal facade cladding from Nordic bronze | 6264.3 | Assumed permanent service life. | Steel recycling | 0 kg | 6,264.3 kg |
| | | Rock wool insulation for ETICS and flat roofs | 2625.04 | Assumed permanent service life. | 100% recycle by certified contractor | 0 kg | 2,625.0 kg |
| | | Gypsum board, water resistant | 11216.08 | 40 years | Gypsum Recycled | 0 kg | 11216.08 kg |
| | | Steel framing system for dry lining | 1789.8 | Assumed permanent service life. | Steel reclaimed | 1,790 kg | 0.0 kg |
| | | 2.2.2 Balconies - Stainless steel handrail | 429 | Assumed permanent service life. | Steel recycling | 0 kg | 429.0 kg |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | 2.2.2 Balconies - Toughened safety glass | 21261 | Assumed permanent service life. | glass recycled | 0 kg | 21,261.0 kg |
| 2.3 | Superstructure: Roof | EPS Insulation | 4500.6 | Assumed permanent service life. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | Hollow core concrete slabs | 172158 | Assumed permanent service life. | 90% reclaimed 10% recycled | 154,942 kg | 17,215.8 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 | 0.0 kg |
| | | Glass wool insulation, unfaced | 1054.02 | Assumed permanent service life. | recycled | 0 kg | 1,054.0 kg |
| | | Synthetic roofing membrane from FPO - PP | 309.44 | Assumed 30 year service life - replaced 1 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | Raised floor system steel pedestal, per m2 | 1275618.498 | Assumed 25 year service life - replaced 2 times. | Steel recycling | 0 kg | 1,275,618.5 kg |
| | | Planned redwood decking | 5223.86 | Assumed permanent service life. | Recycled | 0 kg | 5,223.9 kg |
| | | Extensive green roof system | 3734.4 | Assumed 20 year service life - replaced 2 times. | assumed 60% recycable | 0 kg | 2,240.6 kg |
| | | Coping system (for rood edging) from coated aluminium sheets | 316.47 | Assumed permanent service life. | Steel recycling | 0 kg | 316.5 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 | 0.0 kg |
| | | Reinforcement steel (rebar), generic | 10450.6 | Assumed permanent service life. | Steel recycling | 0 kg | 10,450.6 kg |
| | | Steel/aluminum helical staircase, with railing and landing | 5505.5 | Assumed permanent service life. | Reclaimed | 5,506 kg | 0.0 kg |
| 2.5 | Superstructure: External Walls | Steel purlins and framing | 8940 | Assumed permanent service life. | Reclaimed | 8,940 kg | 0.0 kg |

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|---|---|---|---|---|---|---|---|
| | | Aluminium façade cladding panel, powder coated, 70% recycled content | 11178 | Assumed permanent service life. | Steel recycling | 0 kg | 11,178.0 kg |
| | | Rock wool insulation panels | 18198 | Assumed permanent service life. | Assumed 90% recycable | 0 kg | 16,378.2 kg |
| | | Plastic vapour control layer | 386.28 | Assumed permanent service life. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | Fiber reinforced cement board for exterior | 12851.25 | Assumed permanent service life. | Recycled | 0 kg | 12,851.3 kg |
| | | Copper sunshade (Brise-Soleil), French average | 3385.25 | Assumed permanent service life. | metal recycled | 0 kg | 3385.25 kg |
| | | Precast concrete blocks (CMU) | 367575 | Assumed permanent service life. | Recycled | 0 kg | 367,575.0 kg |
| | | Cementitious mortar for masonry work | 38217 | Assumed permanent service life. | Landfilling | 0 kg | 0.0 kg |
| | | Gypsum plasterboard | 39882.5 | Assumed 30 year service life - replaced 1 times. | Gypsum Recycled | 0 kg | 39,882.5 kg |
| | | Metal framing components for gypsum plasterboard | 3484 | Assumed permanent service life. | metal recycled | 0 kg | 3,484.0 kg |
| | | HS2 baseline - Structural steel Sections | 5024 | Assumed permanent service life. | metal recycled | 0 kg | 5,024.0 kg |
| | | Polyethylene vapour barrier membrane | 259.7 | Assumed 30 year service life - replaced 1 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | Natural stone wall cladding | 27559.82 | Assumed permanent service life. | reclaimed | 27,560 kg | 0.0 kg |
| | | Aluminium framework system for fixing the facade cladding | 1590 | Assumed permanent service life. | metal recycled | 0 kg | 1,590.0 kg |
| 2.6 | Superstructure: Windows and External Doors | Window system for glass façade, with aluminum composite profile framing, double glazed | 56697.875 | Assumed 30 year service life - replaced 1 times. | metal recycled | 0 kg | 56,697.9 kg |

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|---|---|---|---|---|---|---|---|
| | | EPDM rubber membrane for weather-sealing around window frames and facades | 155.23 | Assumed 30 year service life - replaced 1 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| 2.7 | Superstructure: Internal Walls and Partitions | Gypsum plasterboard | 18614.7 | Assumed 30 year service life - replaced 1 times. | 100% recycle by certified contractor, Gypsum recycling | 0 kg | 18,614.7 kg |
| | | Metal framing components for gypsum plasterboard | 1515 | Assumed permanent service life. | metal recycled | 0 kg | 1,515.0 kg |
| | | High pressure and solid grade laminate sheets (HPL and SGL) | 1642.90 | Assumed 15 year service life - replaced 3 times. | Recycled | 0 kg | 1,642.9 kg |
| | | Glass wool /mineral insualtion | 389.61 | Assumed permanent service life. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| 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 | 11,630.1 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 | 14,743.3 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 | 0.0 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 | 0.0 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 | 613,152.4 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 | 24,181.4 kg |
| | | 3.2.2.Raised access floors - Raised access flooring system | 380840 | Assumed 30 year service life - replaced 1 times. | Assumed 80% re-used and 20% Recycled | 304,672 kg | 76,168.0 kg |
| | | Fibre bonded carpet tiles and sheets | 3859.2 | Assumed 15 year service life - replaced 3 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | Luxury vinyl tile flooring, for commercial use | 1633.8 | Assumed 25 year service life - replaced 2 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |

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|---|---|---|---|---|---|---|---|
| | | Ceramic tiles | 7507.5 | Assumed 30 year service life - replaced 1 times. | recycled | 0 kg | 7,507.5 kg |
| | | Mirror | 1000 | Assumed 35 year service life - replaced 1 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | Stainless steel handrail | 343.85 | Assumed 35 year service life - replaced 1 times. | metal recycled | 0 kg | 343.9 kg |
| | | Waterborne acrylic intumescent coating for steel surfaces | 4745 | Assumed 10 year service life - replaced 5 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | Dispersion-based tile adhesive for all tile and vinyl floor | 2244 | Assumed 30 year service life - replaced 1 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| 4 | Fittings, furnishings & equipment (FFE) | | | | | | |
| 5 | Services (MEP) | 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 | 18,122.4 kg |
| | | 5.1.Sanitary installations - Ceramic toilet with flush tank (cistern) | 2679.6 | Assumed 20 year service life - replaced 2 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | 5.1.Sanitary installations - Ceramic wall-mounted bathroom sink | 1450.68 | Assumed 20 year service life - replaced 2 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | 5.1.Sanitary installations - Brass fixtures, taps | 140.14 | Assumed 20 year service life - replaced 2 times. | Metal-containing product recycling | | |
| | | 5.1.Sanitary installations - Shower head | 3 | Assumed 20 year service life - replaced 2 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | 5.6.Space heating and cooling - Modular chiller | 1642 | Assumed 22 year service life - replaced 2 times. | Metal-containing product recycling (90 % metal) | | |
| | | 5.5 Heat source - Air/air reversible heat pump, rooftop mounted, heating/cooling | 2500 | Assumed 22 year service life - replaced 2 times. | Metal-containing product recycling (90 % metal) | 0 kg | 2,250.0 kg |

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|---|---|---|---|---|---|---|---|
| | | 5.6 Space heating and cooling - Steel pipes for heating and cooling system | 13923 | Assumed permanent service life. | steel recycling | 0 kg | 13,923.0 kg |
| | | 5.6.Space heating and cooling - Pipe and tubes insulation from rock wool DN 100 mm. | 5624.4 | Assumed permanent service life. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | 5.11 Fire and lighting protection - waterborne acrylic intumescent coat | 4744.96 | Assumed permanent service life. | Landfilling (for inert materials) | | |
| | | 5.6.8 Local air conditioning - Fan coil unit AET System | 3229.2 | Assumed 25 year service life - replaced 2 times. | Metal-containing product recycling (90 % metal) | | |
| | | 5.7 Ventilation system - Air handling units, modular, collective or tertiary | 2644 | Assumed 30 year service life - replaced 1 times. | Metal-containing product recycling (90 % metal) | 0 kg | 2,379.6 kg |
| | | 5.7 Ventilation system - Galvanized steel ducting | 19718.4 | Assumed permanent service life. | steel recycling | 0 kg | 19,718.4 kg |
| | | 5.7 Ventilation system - Glass wool insulataion for air ducts | 2979.19 | Assumed permanent service life. | Assumed 80% recycable | 0 kg | 2,383.4 kg |
| | | 5.4.3 Hot water distribution - Galvanized steel pipes | 4347 | Assumed permanent service life. | Metal-containing product recycling (90 % metal) | 0 kg | 3,912.3 kg |
| | | 5.4.3 Hot water distribution - Pipe and tubes insulation from rock wool DN 100 mm. | 975.24 | Assumed permanent service life. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | 5.8 Electrical installtion - Electricity distribution system, cabling and central | 44870.76 | Assumed 25 year service life - replaced 2 times. | Metal-containing product recycling (90 % metal) | 0 kg | 40,383.7 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 | 946.8 kg |

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|---|---|---|---|---|---|---|---|
| | | 5.11 Fire and lightning protection - Communication cable | 2249.94 | Assumed 15 year service life - replaced 3 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | 5.11 Fire and lightning protection - Fire Alarm | 2.528 | Assumed 45 year service life - replaced 1 times. | Metal-containing product recycling (90 % metal) | 0 kg | 2.3 kg |
| | | 5.11 Fire and lightning protection - Output device | 14.898 | Assumed 15 year service life - replaced 3 times. | Metal-containing product recycling (90 % metal) | 0 kg | 13.4 kg |
| | | 5.11 Fire and lightning protection - indicator lights | 0.728 | Assumed 15 year service life - replaced 3 times. | Metal-containing product recycling (90 % metal) | 0 kg | 0.7 kg |
| | | 5.11 Fire and lightning protection - Electrical junction box | 2.38 | Assumed 15 year service life - replaced 3 times. | Metal-containing product recycling (90 % metal) | 0 kg | 2.1 kg |
| | | 5.11 Fire and lightning protection - Steel pipes for heating and cooling system | 43341.49 | Assumed 30 year service life - replaced 1 times. | steel recycling | 0 kg | 43,341.5 kg |
| | | 5.11 Fire and lightning protection - Fire sprinkler | 189.36 | Assumed 30 year service life - replaced 1 times. | steel recycling | 0 kg | 189.4 kg |
| | | 5.11 Fire and lightning protection - Hot dip galvanized steel | 944.72 | Assumed 30 year service life - replaced 1 times. | steel recycling | 0 kg | 944.7 kg |
| | | 5.11 Fire and lightning protection - Flexible shower hose | 195.18 | Assumed 30 year service life - replaced 1 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | 5.11 Fire and lightning protection - Stainless steel sheet | 1646.5 | Assumed 30 year service life - replaced 1 times. | Stainless steel recycling | 0 kg | 1,646.5 kg |
| | | 5.11 Fire and lightning protection - Manometers | 17.55 | Assumed 30 year service life - replaced 1 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | 5.11 Fire and lightning protection - Cast iron globe valves | 243.45 | Assumed 30 year service life - replaced 1 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |

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|---|---|---|---|---|---|---|---|
| | | 5.11 Fire and lightning protection - Brass quarter-turn valve | 116.10 | Assumed 30 year service life - replaced 1 times. | Metal-containing product recycling (90 % metal) | 0 kg | 104.5 kg |
| | | 5.11 Fire and lightning protection - Waterborne acrylic paint for painting of metals | 358.40 | Assumed 30 year service life - replaced 1 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | 5.4.1 Main water supply - Water distribution system - Galvanized steel water supply plumbing | 70.27 | Assumed 25 year service life - replaced 2 times. | Steel recycling | 0 kg | 70.3 kg |
| | | 5.4.1 Main water supply - Water distribution system - Pre-insulated pipes | 3820.23 | Assumed 25 year service life - replaced 2 times. | Metal-containing product recycling (90 % metal) | 0 kg | 3,438.2 kg |
| | | 5.4.1 Main water supply - Water distribution system - Brass quarter-turn valve | 1143.60 | Assumed 25 year service life - replaced 2 times. | Metal-containing product recycling (90 % metal) | 0 kg | 1,029.2 kg |
| | | 5.4.1 Main water supply - Water distribution system - Composite water meter | 0.87 | Assumed 25 year service life - replaced 2 times. | Metal-containing product recycling (90 % metal) | 0 kg | 0.8 kg |
| | | 5.4.1 Main water supply - Water distribution system - Valve, 2 or 3-way | 73.44 | Assumed 25 year service life - replaced 2 times. | Metal-containing product recycling (90 % metal) | 0 kg | 66.1 kg |
| | | 5.4.1 Main water supply - Water distribution system - Manometers | 3.51 | Assumed 25 year service life - replaced 2 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | 5.4.1 Main water supply - Water distribution system - Thermodynamic water heater | 3441.60 | Assumed 25 year service life - replaced 2 times. | Metal-containing product recycling (90 % metal) | 0 kg | 3,097.4 kg |
| | | 5.4.1 Main water supply - Water distribution system - Thermostatic water mixer | 392.04 | Assumed 25 year service life - replaced 2 times. | Landfilling (for inert materials) | 0 kg | 0.0 kg |
| | | 5.4.1 Main water supply - Water distribution system - Water pressure regulator | 44.30 | Assumed 25 year service life - replaced 2 times. | Metal-containing product recycling (90 % metal) | 0 kg | 39.9 kg |
| | | 5.4.1 Main water supply - Water distribution system - Stainless steel sheet | 486.14 | Assumed 25 year service life - replaced 2 times. | Stainless steel recycling | 0 kg | 486.1 kg |
| | | 5.4.1 Main water supply - Water distribution system - Expansion tank/vessel | 76.20 | Assumed 25 year service life - replaced 2 times. | Stainless steel recycling | 0 kg | 76.2 kg |
| | | 5.4.1 Main water supply - Water distribution system - PVC rainwater drainage piping network | 0.34 | Assumed 25 year service life - replaced 2 times. | plastic recycling | 0 kg | 0.3 kg |

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|---|---|---|---|---|---|---|---|
| | | 5.4.1 Main water supply - Water distribution system - Steel pipes for heating and cooling system | 143.92 | Assumed 25 year service life - replaced 2 times. | Metal-containing product recycling (90 % metal) | 0 kg | 129.5 kg |
| | | 5.3.1.Foul drainage above the ground - Rainwater sewage network - HDPE sewage pipe | 7176.26 | Assumed 25 year service life - replaced 2 times. | plastic recycling | 0 kg | 7,176 kg |
| | | 5.3.1.Foul drainage above the ground - Rainwater sewage network - Hot dip galvanized sheet | 778.5 | Assumed 25 year service life - replaced 2 times. | Steel recycling | 0 kg | 779 kg |
| | | 5.4.2 Cold water distribution - Cold water storage tank | 654.16 | Assumed 25 year service life - replaced 2 times. | Metal-containing product recycling (90 % metal) | 0 kg | 589 kg |
| | | 5.4.2 Cold water distribution - booster pump | 72.4 | Assumed 35 year service life - replaced 1 times. | Metal-containing product recycling (90 % metal) | 0 kg | 65 kg |
| | | 5.4.4 Local hot water - Heated water storage tank, for collective use | 652.12 | Assumed permanent service life. | Landfilling (for inert materials) | 0 kg | 0 kg |
| | | 5.8 Electrical insatllation - 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 Electrical insatllation - LED overhead lighting system | 4195.58 | Assumed 17 year service life - replaced 3 times. | Landfilling (for inert materials) | 0 kg | 0 kg |
| | | 5.8 Electrical insatllation - LED Downlight | 231.14 | Assumed 45 year service life - replaced 1 times. | Metal-containing product recycling (90 % metal) | 0 kg | 208 kg |
| | | 5.6.2.Local heating - Fan coil unit - Perimeter heating | 5400 | Assumed 25 year service life - replaced 2 times. | Metal-containing product recycling (90 % metal) | 0 kg | 4,860 kg |
| | | 5.8 Electrical installtion - cable tray system | 25927.5 | Assumed 30 year service life - replaced 1 times. | Steel recycling | 0 kg | 25,928 kg |

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|---|---|---|---|---|---|---|---|
| | | 5.6 Space heating and cooling - Rectangular fire damper | 574 | Assumed 25 year service life - replaced 2 times. | Metal-containing product recycling (90 % metal) | 0 kg | 517 kg |
| | | 5.4. Water installtion - Copper pipes, Type L, DN 32 mm | 528 | Assumed permanent service life. | Metal-containing product recycling (90 % metal) | 0 kg | 475 kg |
| | | 5.4. Water installtion - Pipes and tubes insulation from rock wool | 404 | Assumed permanent service life. | Landfilling (for inert materials) | 0 kg | 0 kg |
| | | 5.4. Water installtion - Valve, 2 or 3-way | 520 | Assumed permanent service life. | Metal-containing product recycling (90 % metal) | 0 kg | 468 kg |
| | | 5.8.5 Local electricity generation system - Roof integrated mono-crystalline photovoltaic module | 1900 | Assumed 35 year service life - replaced 1 times. | Metal-containing product recycling (90 % metal) | 0 kg | 1,710 kg |
| | | 5.8.5 Local electricity generation system - Aluminium section (mounting) | 1958 | Assumed permanent service life. | Steel recycling | 0 kg | 1,958 kg |
| | | 5.3.1.Foul drainage above the ground - Cast iron drainage pipes and fittings | 10929.96 | Assumed permanent service life. | Steel recycling | 0 kg | 10,930 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 |

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|---|---|---|---|---|---|---|---|---|
| | | 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 | | |
| 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** | 16,033,604 kg | | | | 10,817,987 kg | 4,936,110 kg |
| | | **Material intensity (kg/m2 GIA)** | 1,353 kg/m2 GIA | | | | 913 kg/m2 GIA | 416 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.<br>Model is further developed through RIBA Stage 3 up to tender and specific requirements are included within the tender.<br>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.<br>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.<br>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:<br>1) Assumptions have been made on materials to be used i.e. where a material is not yet specified to a particular manufacturer.<br>2) Where materials, items, work packages which have a significant impact on the overall performance of the calculations.<br>3) What further reductions could be made against the baseline specifications<br>4) Areas of risk which are to be considered as the design develops<br>**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.<br>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.<br>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.<br>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.<br>All data from the WLCA will be review by a third party to validate the LCA inputs in line with the UKGBC requirements.<br>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.<br>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.<br>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.<br>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.<br>Quantity: Concrete quantity from HTS Quantity table/drawings |
| EPS insulation for Basement | 1.1 Substructure | Product: not specified yet<br>Quantity: Calculated by the GA drawings |
| Basement Waterproofing | 1.1 Substructure | Product: not specified yet<br>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<br>Quantity: Exigere - CATO spreadsheet (BoQ) row218-224 |
| Façade - Blockwork | 2.5 External Wall - Party Wall | Product: not specified yet - but blockwork<br>Quantity: Exigere - CATO spreadsheet (BoQ) row226 |

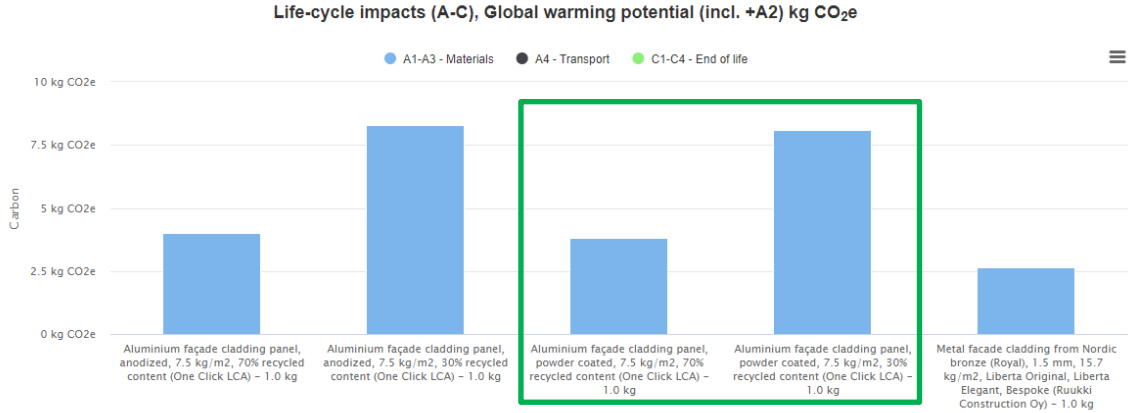
| | | |
|---|---|---|
| Facade - sunshade (side fin) | 2.5 External Wall - side fin and Brise Solei Screens | Product: not specified yet - TBC at the later stage<br>Quantity: measured by architecture drawings |
| Façade - GF Featured cladding | 2.5 External Wall - GF Façade | Product: not specified yet - TBC at the later stage<br>Quantity: measured by architecture drawings |
| Internal wall - Plasterboard | 2.7 Internal Walls | Product: not specified yet - TBC at the later stage<br>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<br>Quantity: measured by architecture drawings |
| Roof covering | 2.3 Roof | Product: not specified yet - TBC at the later stage<br>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<br>Quantity: Exigere - CATO spreadsheet (BoQ) row 914 |
| Green roof system | 2.3 Roof | Product: not specified yet - TBC at the later stage<br>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<br>Quantity: measured by architecture drawings |
| Terrace handrail | 2.2.2 balconies | Product: not specified yet - TBC at the later stage<br>Quantity: Exigere - CATO spreadsheet (BoQ) row 183 |
| Terrace balustrade glazed | 2.2.2 balconies | Product: not specified yet - TBC at the later stage<br>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<br>Quantity: Exigere - CATO spreadsheet (BoQ) row 308+310 |

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