

# **WLCA – Method Statement**

**10<sup>th</sup> November 2023  
RIBA 2**

## **Euston Tower**

**RIBA Stage 2 Whole Life Carbon assessment note.**

This is a RIBA 2 Whole Life Carbon Assessment (WLCA) method statement for the Euston Tower development. This statement is constructed to accord with the methodological requirements of the RICS Professional Statement Whole life carbon analysis for the built environment (2017) publication.

## EN 15978 Module Coverage

As per the requirements of the RICS PS 1<sup>st</sup> Edition Table 2, a WLCA must cover core modules of EN 15978:2011, typically representing where the majority of WLC impacts fall. As an absolute minimum, a Sweco WLCA assessment will cover these modules in full. Sweco look to include all possible EN 15978:2011 modules, subject to the limitations of the One Click LCA tool, the RIBA stage/timing of the assessment and the availability of data/scenario information from the industry at the time of writing. The below demonstrates which modules have been included in this study.

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

## Reference Study Period

The RICS Professional Statement has set requirements for the reference study period (RSP) which must be used for the WLC assessment process. For domestic and non-domestic projects, the RSP is **60 years**. The RSPs are fixed to provide a level of comparability between WLC results for different projects, and to enable better future interrogation and interpretation of results.

## Building Elements Coverage

The table presented below shows the percentage of costs covered by the G&T cost plan for each elemental category. In cases where the coverage is less than 100%, an adjustment factor was applied to provide an allowance for the carbon impacts of the missing elements or components as per the RICS WLCA PS 1<sup>st</sup> Edition recommendation. For instance, if the coverage is 95%, then the adjustment factor for carbon of those elements quantified in that category would be 1.05.

For certain building element categories, based on the current stage in design and availability of information, benchmarked carbon values were used on a per m<sup>2</sup> basis. These categories are indicated below.

It is worth noting that in the latest version of the Cost Plan issued to Sweco, costs were redacted, therefore the same cost plan coverage factors were used as per the interim Stage 2 WCLA, which was itself based on an earlier version of the cost plan with costs presented. However, Sweco have determined that the same overall coverage of elements in this iteration is equivalent to the interim Stage 2 assessment so maintaining these coverage factors is deemed appropriate.

**Table 1.0:** Building elements coverage for ET at RIBA 2.

|   | Building parts/<br>Element groups           | Building Elements   | Coverage (%)   |
|---|---|---|--|
| 0 | Facilitating works                          | 0.1 Temporary/Enabling works/ Preliminaries                                       | Benchmarked Value  |
|   |   | 0.2 Specialist groundworks  | N/A  |
| 1 | Substructure                                | 1.1 Substructure  | 95%  |
| 2 | Superstructure                              | 2.1 Frame<br>2.2 Upper floors incl. balconies<br>2.3 Roof<br>2.4 Stairs and ramps | 99%  |
|   | Superstructure                              | 2.5 External Walls<br>2.6 Windows and External Doors                              | 100%<br>(Contingency factors added separately as part of CWCT process) |
|   | Superstructure                              | 2.7 Internal Walls and Partitions<br>2.8 Internal Doors                           | 100%   |
| 3 | Finishes                                    | 3.1 Wall finishes<br>3.2 Floor finishes<br>3.3 Ceiling finishes                   | 97%  |
| 4 | Fittings, furnishings, and equipment (FF&E) | Building-related<br>Non-building-related  | 59%  |
| 5 | Building services / MEP                     | 5.1 - 5.14 Building-related services  | 44%  |
|   |   | Non-building-related  | N/A  |
| 6 | Prefabricated Buildings and Building Units  | 6.1 Prefabricated Buildings and Building Units                                    | N/A  |
| 7 | Work to Existing Building                   | 7.1 Minor Demolition and Alteration Works   | Benchmarked Value  |

|   | Building parts/<br>Element groups | Building Elements  | Coverage (%)      |
|---|-----------------------------------|--|-------------------|
| 8 | External works                    | 8.1 Site preparation works<br>8.2 Roads, Paths, Paving and Surfacing<br>8.3 Soft landscaping, Planting, and Irrigation Systems<br>8.4 Fencing, Railings and Walls<br>8.5 External fixtures<br>8.6 External drainage<br>8.7 External Services<br>8.8 Minor Building Works and Ancillary Buildings | Benchmarked Value |

## Measurement Source References

**Table 2.0:** Key material quantities data sources (non-exhaustive).

| Data Source   | Data Source Type           | Comments  |
|---|----------------------------|---|
| Euston Tower - Cost Plan (17.10.23)   | Cost Plan                  | Source for majority of quantities.  |
| ET - WLCA Structural Quantities Review – Rev F (GT AMENDS REVA) – Received 09.11.23 | Material Quantity Schedule | Further refinement of structural material quantities provided by G&T and Arup.  |
| 1312_Sustainability_Mtg_230531_RevA   | PDF Presentation           | Provided the baseline carbon factors (A1-A3) for concrete.  |
| Euston Tower Interim Stage 2 Area Schedule (20.10.23)                               | Area Schedule              | Latest area schedule provided by G&T.   |
| ARUP Structures correspondence  | Emails                     | A number of further clarifications and quantity provision on a more granular level than in cost plan – see below.   |
| CWCT Façade Calculations  | Excel data sheet           | CWCT compliance calculations for façades provided by 3XN.   |
| Initial MEP Equipment Schedule  | Excel data sheet.          | Arup MEP provided a provisional/high level equipment schedule that formed the basis of their initial Stage 2 Design. (Sanitaryware, lifts, trench heaters and floor diffusers updated as per latest cost plan). |
| ARUP Energy Statement - EST-ARP-XX-XX-RP-M-00002                                    | Energy Report              | TM54 calculation used for B6 module.  |
| Refrigerant Schedule  | Excel data sheet.          | Arup MEP filled in refrigerant schedule based on initial Stage 2 Design.  |

## Product and Construction Process Stage

At Stage 2, there was insufficient design information in certain categories to derive reliable quantities from the cost plan of material specifications from other reference material. In these cases, an overall carbon rate per m<sup>2</sup> GIA, that was established earlier in the design, was applied as a placeholder allowance. This is relevant to the following elemental categories:

- Demolition impacts of existing building: **20 kgCO<sub>2</sub>e/m<sup>2</sup> GIA.**
- Temporary works (which included Works to Existing Building): **15 kgCO<sub>2</sub>e/m<sup>2</sup>GIA.**
- External works: **20 kgCO<sub>2</sub>e/m<sup>2</sup> GIA.**
- Site activities: **26 kgCO<sub>2</sub>e/m<sup>2</sup> GIA.**

## Carbon factors used (A1-A3)

### Structural Components

The baseline carbon factors for structural materials were confirmed to Sweco as follows:

- **Structural steel:** Bracing, façade, columns and floors – **0.33 kgCO<sub>2</sub>e/kg** – as per Acellor Mittal's XCarb Steel.
- **Structural steel:** Connections only – **2.45 kgCO<sub>2</sub>e/kg** – Basic Oxygen Furnace UK typical.
- **Structural steel:** Basement truss and bolt on podium structure – **1.74 kgCO<sub>2</sub>e/kg** – blended rate of EAF to BOF.
- **Structural steel:** 10% of 7,818 tonnes assumed reused steel (782 tonnes) with CF of **0.0466 kgCO<sub>2</sub>e/kg**, based on EMR EPD.
- **Steel reinforcement:** 0.3 kgCO<sub>2</sub>e/kg – Acellor Mittal's XCarb Rebar product.
- **Piles, continuous piled wall concrete carbon factor:** RC 32/40 50% GGBS - 0.0888 kgCO<sub>2</sub>e/kg.
- **Raft slab, Liner wall, satellite retaining wall, basement slabs concrete carbon factor:** RC 32/40 25% GGBS – 0.12 kgCO<sub>2</sub>e/kg.
- **Precast slabs concrete carbon factor:** RC 32/40 25% GGBS – 0.12 kgCO<sub>2</sub>e/kg.
- Arup structures provided structural steel intumescent paint rate of **80,000 m<sup>2</sup> at 1mm** thick in mid stage 2, updated proportionally with new steel tonnage (**84,310 m<sup>2</sup> at 1mm** thick).
- Arup structures confirmed **grouting** between slabs at **8 kg/m<sup>2</sup>.**
- **Basement slab waterproofing:** Sweco material library default input polyethene membrane.
- **Basement slab:** Sweco material library default input **300mm EPS.**
- **Precast stair reinforcement** rate assumed at **130 kg/m<sup>3</sup>.**

## Facades

- **BMU** – only ‘number of’ highlighted in Cost Plan – generic Sweco input used for this with material weights.
- **Internal lining of external wall** assumed as 2 x 15mm plasterboard with steel studwork at 1.3kg/m<sup>2</sup>.

**CWCT calculations** provided by 3XN. Some key notes and assumptions from these calculations:

- The carbon performance of the **Podium Façade** was based on the averaged performance of the other façade types.
- A **5% material scale up** factor was applied to all material components, then a separate **façade scale up factor of 5%** was also applied.
- The facades were assumed to be assembled **offsite in European factory**.
- **The aluminium extrusions** were based on the **Hydro Reduxa EPD** value for billet only at **4 kgCO<sub>2</sub>e/kg** plus a placeholder allowance for extruding (**0.5 kgCO<sub>2</sub>e/kg**), pre anodization (**2.24 kgCO<sub>2</sub>e/kg**) and PPC coating (**0.13 kgCO<sub>2</sub>e/kg**).
- An allowance of **263 kgCO<sub>2</sub>e/m<sup>2</sup> FSA (A1-A5)** was assumed for the **soffits** with the area for this element being taken from the Cost Plan.

The performance of the other façade types, including all contingencies (i.e., material and overall façade scale up) for modules A1-A5:

- **Typical Bay:** 461 kgCO<sub>2</sub>e/m<sup>2</sup> FSA
- **Amenity Façade:** 527 kgCO<sub>2</sub>e/m<sup>2</sup> FSA
- **Wedges:** 530 kgCO<sub>2</sub>e/m<sup>2</sup> FSA
- **Podium Façade:** 506 kgCO<sub>2</sub>e/m<sup>2</sup> FSA (averaged value from other types)

## Internal Walls, Finishes & Fittings

- Sweco material library defaults for **drylining build-ups** in model i.e., **plasterboard, acoustic insulation and metal studwork**.
- Sweco material library defaults for **bike racks and lockers**. Number of units taken from Cost Plan.
- **Internal doors:** allowance in cost plan on a cost per m<sup>2</sup> GIA basis rather than the number of doors itemised. Therefore, Sweco looked at the number of internal doors per m<sup>2</sup> GIA on other office developments and used this as a means to estimate the number of doors in Euston Tower.
- **Reused RAF for S&C areas** (excluding the WC's) – input based on RMF e-coated (0.71 kgCO<sub>2</sub>e/m<sup>2</sup>) with pedestals assumed 4kg/m<sup>2</sup> of material.
- **RAF for WC's and office CAT A** - input based on Kingspan RMG 600 (40.56 kgCO<sub>2</sub>e/m<sup>2</sup>) in first instance (worst case) with pedestals assumed 4kg/m<sup>2</sup> of material.
- **Screed** – 50mm thick assumed to all basement area (provided by G&T in a call with Sweco on 02/11).

Where not directly provided in architectural responses following assumptions made to finishes:

- **Void formers** at 100mm.
- **Ceramic floor tiles** at 10mm thick and associated adhesive at 10mm thick.
- **0.4mm epoxy resin** finish to **plant and bike store areas**.
- **Natural stone** 10mm thick and associated adhesive at 10mm thick for enhanced finishes to lifts.

## Building Services

Main plant items as per the basis of design in ARUP indicative MEP schedule.

- **Distribution MEP materials** in base build areas based on per m<sup>2</sup> inputs i.e. pipework, ductwork and containment.
- **280 m<sup>2</sup> of PV** assumed based on Arup MEP response (noted as still to be formally confirmed).

**CAT A fit out** assumptions:

- **Lab enabled:** Cost Plan confirmed that floors 3-11 are being designed as lab enabled, and two of these floors will be fitted out. Area from cost plan.
- CAT A office areas: **floor area** from latest cost plan (**4 floors**).
- CAT A for office and Lab **specific equipment** based on **per m<sup>2</sup> inputs** for areas above e.g., **ductwork, cabling, lighting, sprinklers, containment**.
- **No localised building services** materials assumed in Office or lab enabled tenant areas that are to be fitted to **shell and core** specification.

## Assumptions for Transportation Distances (A4)

For the vast majority of modelling inputs, the transport distances have been based on the RICS WLCA PS defaults. A summary of these assumptions are provided in the table below.

**Table 3.0:** RICS WLCA PS (2017) Default transport distances.

| Assumed Transport Distance (km) | Product group/material in project WLC analysis   |
|---------------------------------|--|
| <b>50 (local)</b>               | Concrete, screed, aggregates   |
| <b>300 (UK)</b>                 | Formwork, steel deck, timber terrace decking, pavers, balustrades & handrails, stone pavers, resin-bonded gravel, internal timber doors, blockwork, cement mortar, plasterboard, acrylic paint, carpet, vinyl flooring, RAF, suspended metal ceiling, baffle ceiling, ceramic tiles, concrete sealant, terrazzo.   |
| <b>1500 (EU)</b>                | Insulation, bitumen membranes, pedestals, sanitaryware, steel studwork, pipe/duct insulation, lighting, waterproofing membranes for structure, rebar, riser doors, revolving door sets, aluminium/glass internal doors, stair core doors, glazed internal screens, cycle racks & lockers, ductwork & pipework, all other building services items not assumed in UK (300km) list above. |

An exception to this is the precast concrete elements, where two transport distances have been applied (300 km x2 concrete and 1500 km + 300 km for rebar). These additional distances provide an allowance for to account for upstream transportation movements prior to leaving the factory to site i.e., it avoids the underestimation of transport impacts where A2 impacts are lacking from the EPD used.

In a similar vein, any building services product or system that has been built up by Sweco from individual materials, and not taken directly from a product EPD, two transport distances have again been provided to make an allowance for movements of raw materials/products to the factory, and then from factory to site (1500 km x 2).

As noted in previous sections, some elemental categories at this stage have been based on benchmarked A1-A5 carbon intensity values. Therefore, the transport impacts are included within this benchmarked figure. However, as the majority of the data that underpins the intensity allocations came from internal portfolios (particularly from Sweco), based on design information from other projects, it is reasonable to state that all values for transport are in accordance with the design values set out within the RICS PS WLCA (2017) methodology.

## Predicted Construction Site Energy Use and Waste (A5)

This section can be separated into two parts: construction site emissions (A5s) and construction site waste (A5w). The methodology for each is set out below.

The emission rate of 26 kgCO<sub>2</sub>e/m<sup>2</sup> GIA for A5s it was suggested by Sweco based on a target rate for a 100% new build and the modification was made based on the difference in construction program length between the Hybrid C option being proposed for planning and a hypothetical new build. It's important to note that this emission rate only takes into account site emissions and doesn't include waste.

The A5w data uses default WRAP waste values as applied within software such as One Click and is included within reported A1-A5 values. Again, for those elements based on benchmarked values the same default rates are included in the A1-A5 value in the sense that the same methodology was used in the projects that provided these benchmarked values.

## Use Stage

### Assumption for Refrigerants (B1)

The refrigerant information was provided by ARUP, while the annual and end-of-life leakage rates have been taken from the CIBSE TM65 Table 4.13 values for the relevant systems, as set out below.

**Table 4.0:** Systems & refrigerants used in WLCA Stage 2 baseline.

| System   | Refrigerant Type | GWP (kgCO <sub>2</sub> e/kg) | Service Life (yrs.) | Total Charge (kg) | Annual Leakage Rate (%) | EoL Leakage Rate (%) |
|----------|------------------|------------------------------|---------------------|-------------------|-------------------------|----------------------|
| ASHP     | R513A            | 656.45                       | 15                  | 1955              | 2                       | 1                    |
| Chillers | R513A            | 656.45                       | 15                  | 2250              | 2                       | 1                    |
| DX Units | R-32             | 675                          | 15                  | 315               | 6                       | 3                    |



## Assumptions for Maintenance and Repair (B2 & B3)

Modules B2 and B3 includes the embodied carbon associated with maintenance and repairs over the duration of the building's RSP. Greater London Authority (GLA) updated "London Plan Guidance – Whole Life-Carbon Assessments" publication, released in March 2022 provides some guidance on assumptions for Modules B2 and B3 when they are unknown at an early stage within section 2.5.15, and to encourage some assessment of the impact of these modules provides the following guidance:

*"...for module B2 emissions, a total figure of 10 kgCO<sub>2</sub>e/m<sup>2</sup> gross internal area (GIA) may be used to cover all building element categories, or 1 per cent of modules A1-A5, whichever is greater. For module B3 emissions, these may be estimated as 25 per cent of module B2, as per the RICS PS (item 3.5.3.3)."*

These additions are not added between all buildings parts as some will require either minor maintenance and repairs only during its life span, or no maintenance/repairs at all. The following categories are used for the additions as stated in RICS PS section 3.5.3.2; roof, façade and external doors, finishes, and services.

## Assumptions for Lifecycles of materials (B4)

The assumptions for life cycle replacement of materials have been made in accordance with RICS PS, except for building services, which adheres to CIBSE Guide M, and for the facade, which follows the CWCT methodology.

## Assumption for Operational Energy and Water (B6 & B7)

The predicted energy consumption for Euston Tower was provided by ARUP, as part of their energy statement draft issued on the 20<sup>th</sup> of October 2023.

**Table 5.0:** Predicted Energy Consumption for ET.

| Baseline Office/Lab | Predicted Energy Consumption (MWh/year) |         |          |
|---------------------|---|---------|----------|
|                     | Base Build                              | Tenant  | Total    |
|                     | 7139.67                                 | 8313.96 | 15453.63 |

For the baseline water consumption calculation, Sweco have used the Better Building Partnership's 2020 Real Estate Energy Benchmarking (REEB) publication, released in August 2021. The 'Typical Practice' water use intensity (WUI) for offices of 636 (litres/m<sup>2</sup> NLA/year) was used, in the absence of more specific data. The emissions factors associated with water use and treatment are derived from Thames Water, and the consequent emissions factors, published in 2022/2023, are 0.0402 kgCO<sub>2</sub>e/m<sup>3</sup> for water supply, and 0.1822 kgCO<sub>2</sub>e/m<sup>3</sup> for water treatment (assuming 90% of potable water ends up going to sewer).

## End of Life Stage

### Assumption for End of Life (C1-C4)

The end-of-life waste streams, and their associated C1-C4 impact, is based on the pre-set typical practice UK scenarios for each material type.

## Results

The A1-A3 section summarises the key assumptions made within each building element category. However, prior to presenting the results it is worth reiterating the specific carbon reducing intervention measures that are included in these results. These were outlined as reduction measures in the interim Stage 2 WLCA, and subsequently they have been committed to by the client for inclusion in the Baseline position. These specific intervention measures are listed as follows:

- 10% of the rolled sections (782 tonnes) are targeted as being used by reused steel. Sweco have applied a placeholder input for the small carbon allowance for these reused steel as per the EMR EPD with a carbon factor of **0.0466 kgCO<sub>2</sub>e/kg**.
- Then the remaining rolled steel sections (7,037 tonnes) comprising: bracing, façade support, columns, and floors – have been modelled as per Acellor Mittal's (AM) XCarb steel product (0.33 kgCO<sub>2</sub>e/kg).
- AM XCarb rebar has also been included for steel reinforcement within the associate concrete elements within the substructure and superstructure.
- The base build raised access flooring (RAF) (24,526 m<sup>2</sup>), which excludes WC areas, is based on the RMF Eco range tiles.
- Concrete elements are based on the GGBS proportions, and associated carbon factors, as confirmed to Sweco and set out in the A1-A3 inputs section earlier in this note.

Table 6.0 below shows the performance, provided at three levels – whole life carbon (A-C including B6 & B7), life cycle embodied carbon (A-C excluding B6 & B7) and upfront embodied carbon (A1-A5).

**Table 6.0:** Summary of Baseline RIBA Stage 2 WLC performance of ET at the three levels of detail, with all values as intensity (kgCO<sub>2</sub>e/m<sup>2</sup> GIA) according to GLA.

| EN 15978:2011 Modules   | Whole Building (inc. contingencies)<br>kgCO <sub>2</sub> e/m <sup>2</sup> GIA |
|---|---|
| Whole Life Carbon (A-C inc. B6 & B7)<br><b>Including sequestration</b>  | <b>2,894</b>  |
| Life Cycle Embodied (A-C ex. B6 & B7)<br><b>Including sequestration</b> | <b>1,262</b>  |
| Upfront Carbon (A1-A5)  | <b>711</b>  |

## Contingencies

As this assessment is still at an early design stage, suitable contingencies have been allowed for in the results. However, is more than one type of contingency applied, and some are only applicable to specific elements. For transparency, Table 7.0 below sets out the results across the various building elements, in intensity terms, and segregates the various contingencies applied. All of these contingencies then culminate in the total A1-A5 figures.

The façade scale-up factors are in line with CWCT guidance. The cost coverage factors reflect the coverage of building elements, as stated at the start of this note. Additionally, a 15% contingency is applied to account for early-stage design, in line with RICS WLCA PS 2<sup>nd</sup> edition. This last contingency applies to all elements except for façades, external works, site activities, temporary works and demolition. However, a 10% contingency is applied to demolition as a thorough Pre-Refurbishment/Demolition Audit has been carried out during the initial stages of the feasibility study by Reusefully. However, a reduced contingency of 10% is deemed appropriate for demolition impacts as a thorough Pre-Refurbishment/Demolition Audit has been carried out during the initial design stages.

**Table 7.0:** A1-A5 results intensity (kgCO<sub>2</sub>e/m<sup>2</sup> GIA) segregated out to highlight the various contingencies including in the reporting.


| Building Element                  | Stage 2 - A1-A5 (kgCO <sub>2</sub> e/m <sup>2</sup> ) |                                |          |                            |                   | Total Intensity with Contingencies |
|-----------------------------------|---|--------------------------------|----------|----------------------------|-------------------|------------------------------------|
|                                   | Results Intensity                                     | Façade Scale up Factors (CWCT) |          | Cost Plan Coverage Factors | 15% Contingency * |                                    |
| Demolition                        | 20  |                                |          | 0                          | 2                 | <b>22</b>                          |
| Substructure                      | 46  |                                |          | 2                          | 7                 | <b>56</b>                          |
| Superstructure                    | 178   |                                |          | 2                          | 27                | <b>207</b>                         |
| External walls, windows and doors | 159   | 8                              | 7        | 0                          | 0.7               | <b>174</b>                         |
| Internal Walls & Doors            | 19  |                                |          | 0                          | 3                 | <b>21</b>                          |
| Finishes                          | 24  |                                |          | 1                          | 4                 | <b>29</b>                          |
| Fittings                          | 3   |                                |          | 1                          | 0                 | <b>5</b>                           |
| Building Services                 | 88  |                                |          | 49                         | 21                | <b>158</b>                         |
| External Works                    | 20  |                                |          | 0                          | 0                 | <b>20</b>                          |
| Site Activities                   | 26  |                                |          | 0                          | 0                 | <b>26</b>                          |
| Temporary Works                   | 15  |                                |          | 0                          | 0                 | <b>15</b>                          |
| <b>Total</b>                      | <b>599</b>  | <b>8</b>                       | <b>7</b> | <b>55</b>                  | <b>65</b>         | <b>733</b>                         |

\*excludes: demolition, CWCT façade, external works, site activities and temporary works.

## Reduction Opportunities

Options have been presented in the waterfall below. They cover modules A1-A5 only at this stage, given the current industry focus on upfront embodied carbon. All reductions are in intensity (kgCO<sub>2</sub>e/m<sup>2</sup> GIA) and are measured against the base specification material.

The table below provides an estimated quantification of these further reductions in A1-A5 intensity terms. They are also illustrated in the subsequent waterfall chart. It should be noted that in a number of cases these reductions reported are cumulative i.e., the quantified reduction cannot be taken separately from the other associated reductions before it.

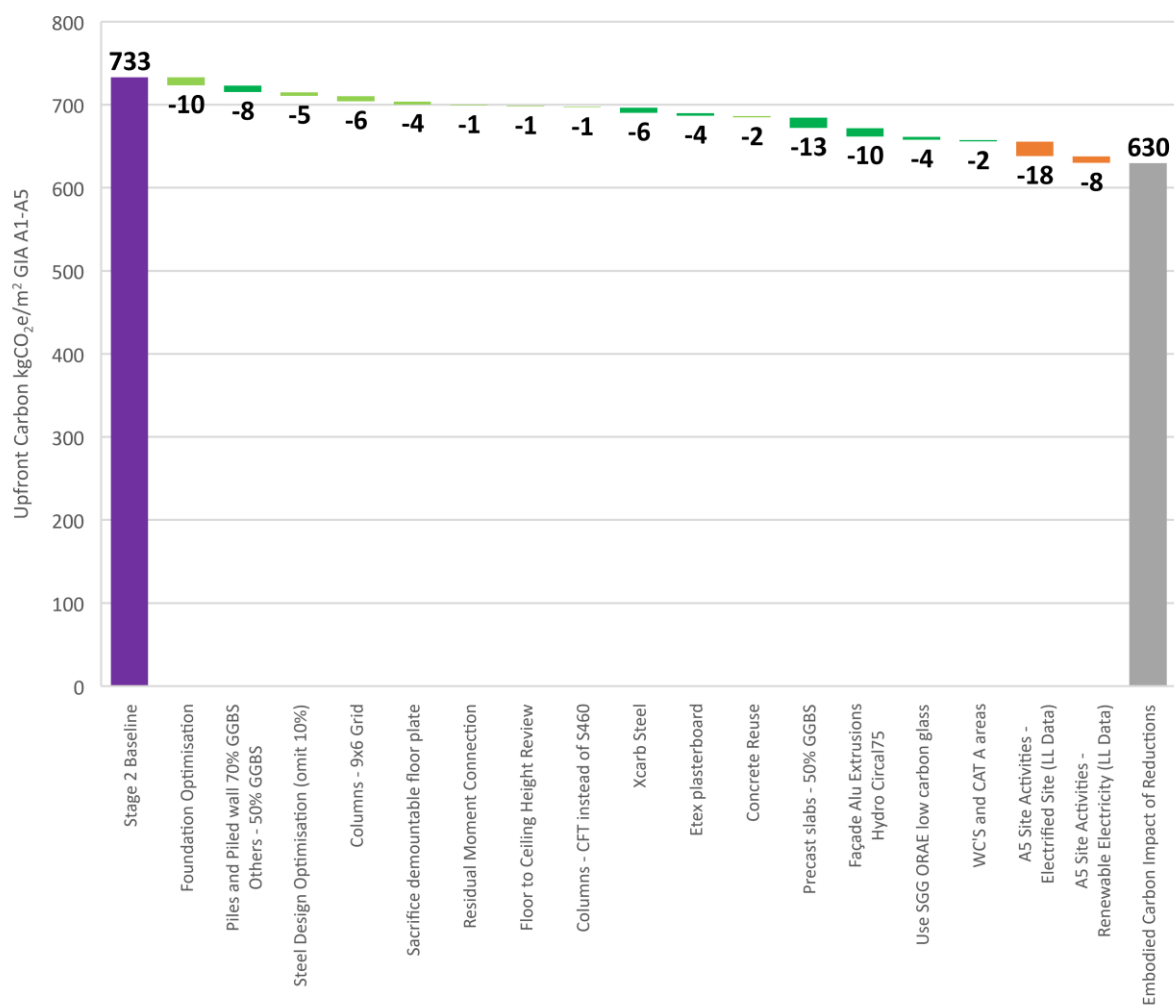
|   |                            |
|---|----------------------------|
|  | Material use efficiencies. |
|  | Material specification.    |
|  | Site activities.           |

**Table 8.0:** Cumulative reduction opportunities for upfront carbon with estimated reduction quantities provided in A1-A5 intensity.

| Item | Reduction Measure (Description)  | Intensity Reduction<br>kgCO <sub>2</sub> e A1-A5 |
|------|--|--|
| 1    | Foundation Optimization - Pile Caps + Piles instead of Raft + Piles  | -10.0  |
| 2    | High recycle content for substructures elements - in-situ concrete - Piles 70% GGBS (137.3 kgCO <sub>2</sub> e/m <sup>3</sup> A1-A5). Other elements - 50% GGBS (206 kgCO <sub>2</sub> e/m <sup>3</sup> ). | -8.0   |
| 3    | Steel Design Optimisation (omit 10%) from the new tonnage excluding connections, podium, truss and reused steel  | -4.6   |
| 4    | Optimize Column Grid - Reduce to a 9x6 Grid instead of 9x12  | -6.4   |
| 5    | Sacrifice demountable floor plate  | -3.8   |
| 6    | Residual Moment Connection - Residual Moment Connections would allow to reduce steel weights   | -1.3   |
| 7    | Review of the Floor to Ceiling Height - Cable Trays under the beam implies no rectangular openings into beams  | -1.3   |
| 8    | Columns - CFT columns instead of S460  | -1.3   |
| 9    | Xcarb Steel for Truss and bolt on podium structure   | -6.2   |
| 10   | Etex plasterboard (ceilings + walls)   | -3.7   |
| 11   | Reuse of existing building concrete (ribbed slabs)   | -2.0   |
| 12   | High recycle content - precast concrete -50% GGBS  | -12.7  |
| 13   | Extrusions made with high recycled content (Hydro Circal75 billet)   | -10.2  |
| 14   | Use SGG ORAE low carbon glass  | -4.0   |
| 15   | RAF - RMG600+ at WC'S and CAT A areas  | -1.9   |

| Item | Reduction Measure (Description)   | Intensity Reduction<br>kgCO <sub>2</sub> e A1-A5 |
|------|---|--|
| 16   | Lendlease Data - electrified site apart from HVO concrete pumps                                   | -17.9  |
| 17   | Lendlease Data - electrified site apart from HVO concrete pumps - electricity on renewable tariff | -8.1   |

- **Items 1,3,4,5,6,7 and 8** – provided by ARUP.
- **Items 13 and 14** – provided by 3XN.
- **Items 16 and 17** – provided by Lendlease.
- Other items calculated by Sweco.

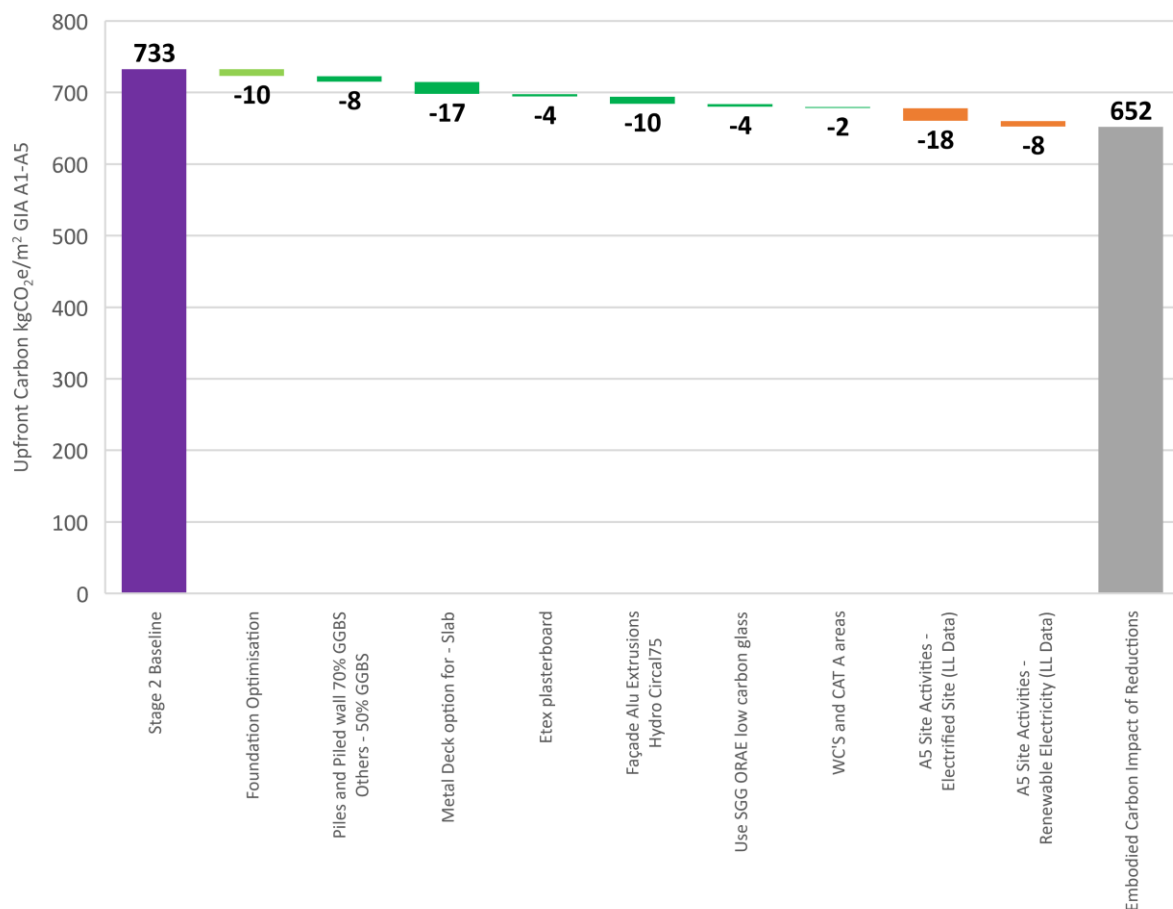


**Figure 1.0:** Cumulative waterfall chart with further reduction opportunities for upfront carbon with estimated reduction quantities provided in A1-A5 intensity.

All of the reduction opportunities above are based on information available at this stage in the design. However, it is worth noting that they will need to be re validated with updated information as the design progresses and more detail is known for certain elements i.e., there is no guarantee that these quantified reductions will remain static throughout the design stages. They should instead be seen as

indicative opportunities to be reviewed and revisited as the project moves through the design stages and a greater granularity in detail is available.

ARUP identified a separate reduction opportunity associated with an alternative metal decking upper floor system. A high-level reduction of -17 kgCO<sub>2</sub>e A1-A5 was estimated for this intervention measure. As in reality this reduction measure would have several knock-on implications to other reductions listed in the figures above, it cannot be included in the same cumulative waterfall/table. However, to illustrate its potential as an alternative route to reducing the impact for ET the waterfall chart below includes the metal decking strategy with other measures not anticipated to be influenced by this measure.



**Figure 2.0:** Alternative cumulative waterfall chart with metal decking solution to upper floors with other reduction opportunities for upfront carbon with estimated reduction quantities provided in A1-A5 intensity.

It is worth highlighting current industry shifts in relation to the use of GGBS as a means to reduce carbon emissions in concrete. Firstly, Sweco has been made aware of forthcoming increase to the carbon content of GGBS in 2024. Based on a reallocation of its status as a coproduct, rather than a biproduct, in the steel manufacturing process.

Secondly there is a general understanding that, as a constrained or limited resource, the over specification of GGBS in one project may limit its availability in others. Hence a question is raised over its effectiveness to reduce greenhouse gas (GHG) emissions at a global scale. This is all to say that the reductions above, which are based on GGBS percentages currently, may be better understood in terms of their respective carbon factors rather than stated GGBS percentages. That way emerging cement

replacement technologies i.e., alternatives to GGBS, can be considered in the context of delivering the same carbon factor.

Sweco would like to emphasise that caution should also be exercised when considering the reduction in A5 site activities. In the recently released RICS WLCA PS 2<sup>nd</sup> edition, specific reference is made to the fact that green or renewable tariffs must not be taken into account when reporting the carbon impact of grid electricity consumed. Following this guidance, the -8 kgCO<sub>2</sub>e/m<sup>2</sup> GIA reduction above would not be accepted.