



BEROL QUARTER

Whole Lifecycle Carbon Assessment

WSP

BEROL QUARTER LIMITED

November 2022



Berol Quarter Limited

Berol Quarter, Ashley Road
Whole Life Carbon Assessment





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Executive summary

WSP has been appointed by Berol Quarter Limited to carry out a Whole Life Carbon (WLC) Assessment for the new build, refurbishment, and fit-out of Berol Quarter. The assessment was carried out in accordance with the GLA's Whole Life Carbon Assessment Methodology updated in March 2022 and The London Plan policy requirement (2021) SI 2 which requires all new major developments within the City of London that are referable to the Greater London Authority (GLA) to calculate and reduce the WLC associated with the Proposed Development.

The Whole Life Carbon for Berol Quarter is 846 kg CO₂e/m² (modules A-C, excluding B6 & B7; including sequestered carbon) which is significantly lower than the WLC benchmark of <1,200 for residential developments.

Table 1 - GLA Residential Benchmarks

	Module A1-A5 (Excluding Sequestered Carbon)	Modules B-C (Excluding B6 & B7)	Modules A-C (Excluding B6 & B7; Including Sequestered Carbon)
TOTAL kg CO₂e/m² GIA	495	377	846
WLC Benchmark	<850	<350	<1200

As can be observed by Figure 1, the largest contributor to the buildings WLC emissions is the A1-A3 Materials, accounting for approximately 53% of emissions. The majority of A1-A3 emissions are associated with the concrete, structural steel, and rebar. Replacement of materials (B4) was the second largest contributor to this which is likely due to the 20-year service life applied to MEP. MEP Services and Finishings, Furnishings and Equipment (FFE) contribution were estimated to be approximately 20% for MEP and 1% for FFE of the developments WLC emissions and consequently, figures may be over/under-estimated. There are very few carbon implications associated with the End of Life (EoL) (C1-C4).

TOTAL kg CO₂e kg CO₂e - Life-cycle stages

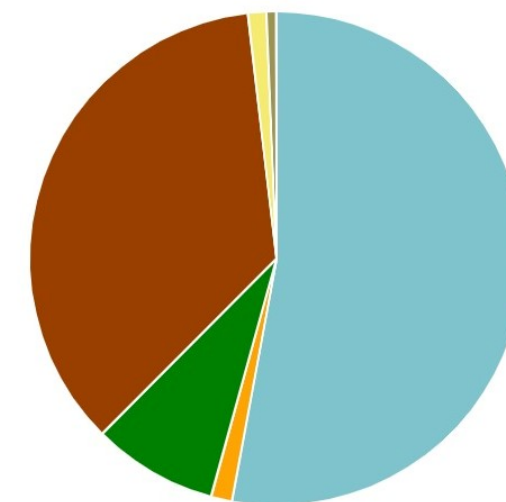


Figure 1 - Total kgCO₂e/m²- Lifecycle Stages (Excluding Sequestration)

1 Background

Climate change is one of the most important environmental challenges of our time. Global warming is becoming an increasing issue resulting from the release anthropogenic (man-made) greenhouse gas emissions into the atmosphere, these are known as carbon emissions. These emissions may have severe adverse environmental, economic, and social implications globally if temperatures continue to increase. International treaties and initiatives such as the Paris Agreement, adopted in 2015, aim to limit temperature rise to 1.5°C by reducing carbon emissions which are also associated with natural resource depletion and pollution. To achieve this the UK a has made a commitment to bring all their greenhouse gas emissions to net zero by 2040. The scale of the challenge to achieve this aim can be seen in Figure 1-1.

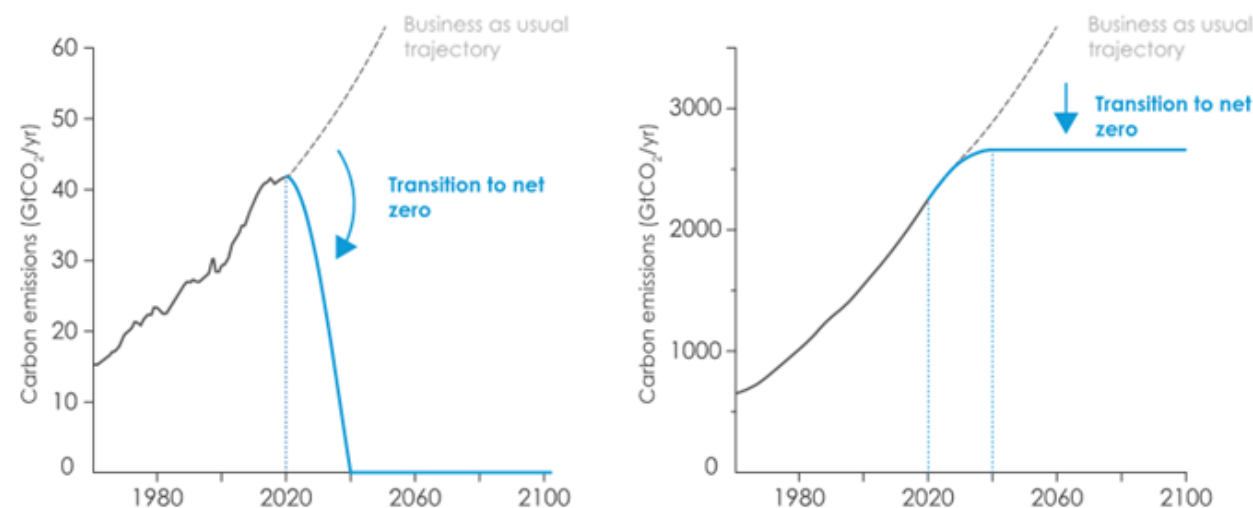


Figure 1-1 Illustration of Transition to Net Zero (LETI)

Large quantities of carbon emissions arise from the built environment and are attributable not only to the use of built assets (operational emissions) but also to their construction (embodied emissions). Operational emissions are attributable to the everyday running of a building whereas embodied emissions result from the production, procurement and installation of the building's materials and components (construction). Embodied emissions also include the lifetime emissions from maintenance repair, replacement, demolition, and disposal.

Operational emissions in the built environment are being addressed via building regulations reduction targets (Part L), local authority planning requirements, and sustainability assessment rating schemes such as BREEAM, LEED, Whole Life Carbon/Lifecycle Assessments etc. Embodied carbon emissions constitute approximately half of a building's whole life cycle impact and have not yet been fully addressed. To understand the project's total carbon impact, it is necessary to assess the operational and embodied emissions over

the whole life of the building. The consideration of both the operational, as well as embodied emissions over the projects expected life cycle constitutes a whole life approach.

Adopting a whole life approach means that the best opportunities for reducing lifetime emissions and avoidance of any unintended carbon emissions can be identified and provide the true picture of a building's environmental impact (of which carbon is just one of its factors) rather than focusing on operational emissions alone. For example, the quantity of embodied carbon for installing triple glazing rather than double can be larger than the operational benefit resulting from the additional pane. Consequently, whole life carbon must be well integrated into building design to achieve a lower carbon future. The principal benefits of conducting a WLC assessment include:

- Identifying and accounting for emission sources which is critical to achieve carbon reduction goals.
- Achievement of resource efficiency and cost savings through the re-use of existing materials and the minimisation of waste through design principles.
- Identification of the carbon benefits of using recycled material in addition to the benefits of designing for future recycling and reuse, reducing waste, and supporting the circular economy.
- Finding optimal, holistic, solutions for the development over its lifetime by considering both operational and embodied emissions.
- Improving lifetime resource efficiency and costs by identifying the impact of maintenance, repair, and replacement of components over the building's lifecycle, contributing to the future proofing of the asset's value.
- Encouragement of local sourcing of materials and short supply chains will consequently have positive carbon, social, and local economic benefits.
- Encouraging flexible design and durable construction, contributing to increased longevity and decreased obsolescence of buildings which also helps to reduce carbon emissions associated with their demolition and new construction.

2 Introduction

WSP has been instructed by Berol Quarter Limited to conduct a Whole Life Carbon (WLC) Assessment for their proposed Berol Quarter project.

This report covers the WLC Assessment conducted for the project which provides a quantitative account of a development's emissions. This promotes an understanding of resource efficiency, illustrates the benefits of specifying end of life and encourages durable and flexible design. A WLC Assessment is required by the GLA at the following planning stages:

- Pre-application
- Planning application submission (RIBA Stage 2/3)
- Post construction (RIBA Stage 5/6, approximately 3 months post-completion)

This report covers the WLC assessment, which is submitted as part of the Planning Application Submission alongside other documents commissioned by the Applicant.

2.1 Background to the Development

The existing site comprises 2 Berol Yard, a currently vacant plot of land on Watermead Way, and Berol House, the former Berol pencil factory, which is now an existing office building, that runs north-south along Ashley Road. The Site was granted planning permission (HGY/2017/2044), as part of a wider hybrid application for 1 Berol Yard, 2 Berol Yard (college site) and Berol House, on 8 June 2018. The original intention was for the 2 Berol Yard plot to provide a new campus for ADA: National College for Digital Skills. Since the granting of the hybrid permission, the College has unfortunately pulled out of the scheme. As a result, BSD is revisiting planning permission ref. HGY/2017/2044 in the context of the loss of the ADA college and the subsequent marketing exercise. A new full planning application at the Berol Quarter site is now proposed comprising comprehensive refurbishment and extension of Berol House to provide high quality workspace and retail accommodation, alongside a new mixed use building accommodating Build to Rent (BtR) homes alongside commercial/retail space at the 2 Berol Yard plot.

2.2 Proposed Development

“Full planning permission for the refurbishment and extension of Berol House to include Use Class E floorspace and the redevelopment of 2 Berol Yard to provide new residential homes, Use Class E floorspace and associated landscaping, public realm improvements, car and cycle parking and other associated works.”

The redevelopment of this site will support the Tottenham Area Action Plan (2017) to regenerate Tottenham neighbourhoods through creating a high-quality public realm which supports residential and employment opportunities. With the development located within Tottenham Hale, one of the four neighbourhoods identified as development and regeneration areas within this Action Plan.

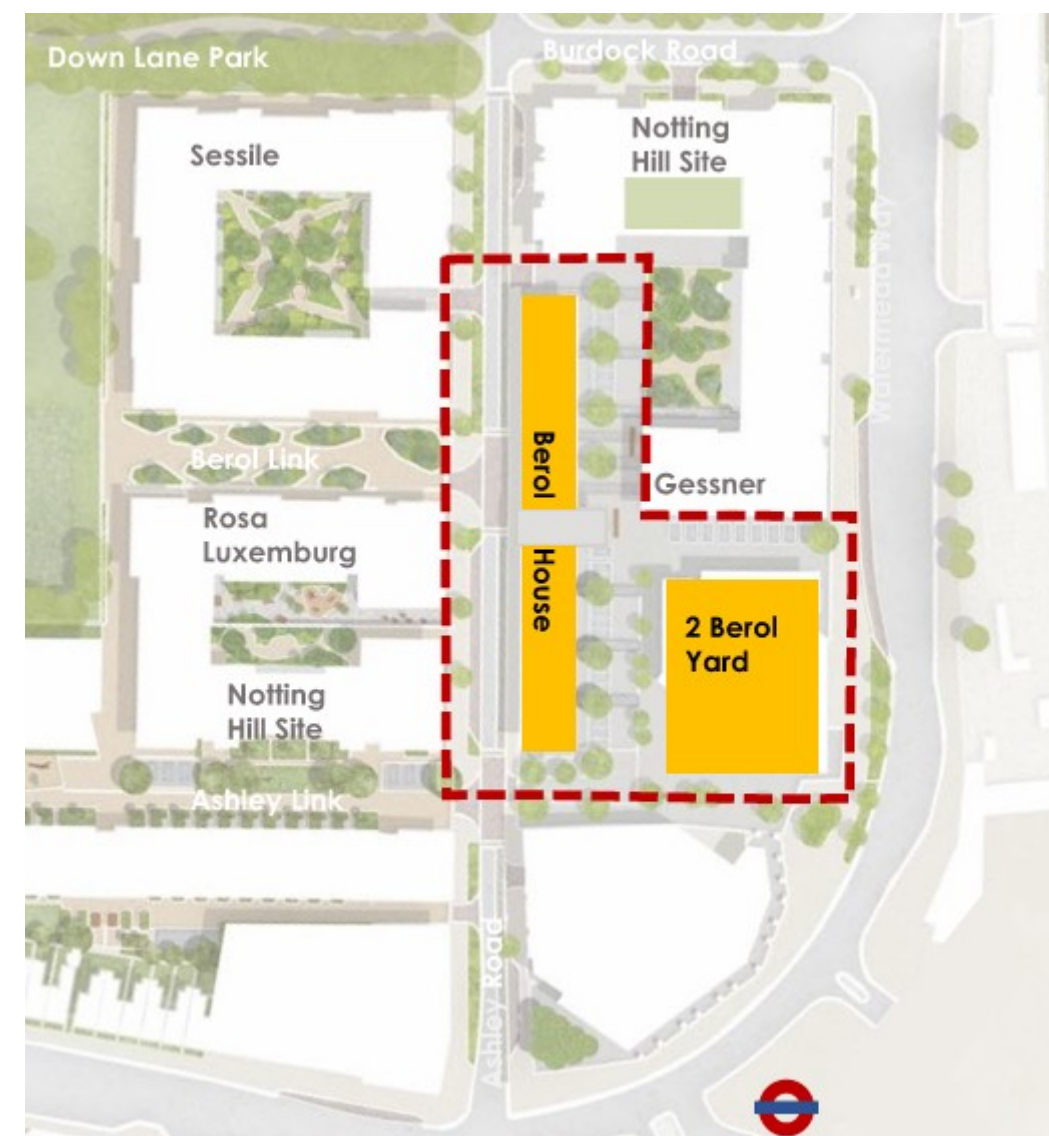


Figure 2-1 – CGI Image of the Proposed Development Site

3 Whole Life Carbon Assessment

3.1 Approach

Greater carbon reduction could be achieved if a Life Cycle Assessment (LCA) or Whole Life Carbon (WLC) Assessment is carried out at the early design stages. An early assessment means hotspots can be identified and rectified sooner in the design process. This results in a lower cost and reduced program impact on the overall project compared with an assessment being conducted at later design stages as seen in Figure 3-1. WSP has been commissioned to carry out a WLC Assessment at RIBA Stage 2 of the design process.

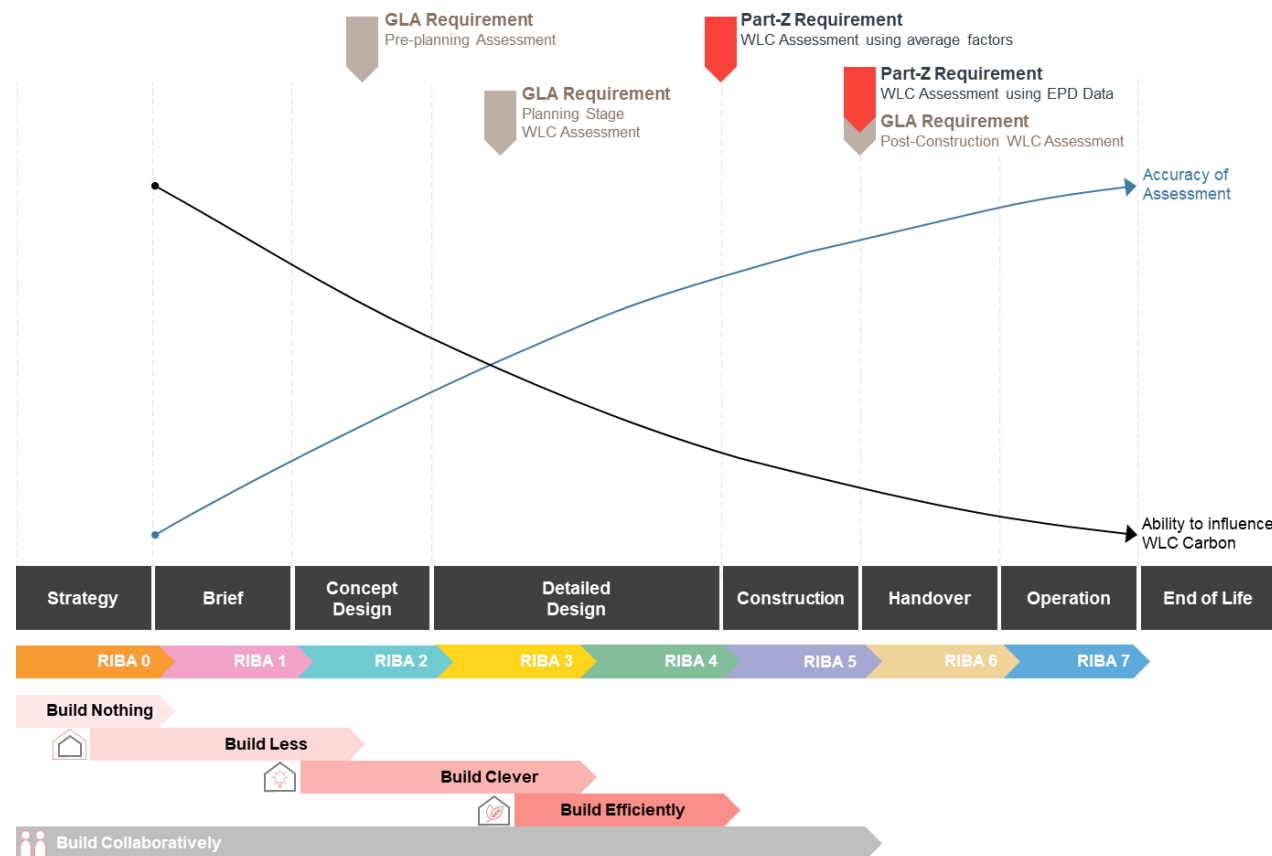


Figure 3-1 - Carbon Reduction at Key Design Stages

This section of the report summarises the methodology used for the Whole Life Carbon Assessment conducted for the Proposed Development which provides a quantitative account of a building's emissions.

3.2 Methodology

In line with the UK standard practice EN15978:2011 and the RICS Professional Statement Guidance for WLC Assessments for the Built Environment (2017), this assessment covers all modules from A1–C, while module D is reported separately as seen in Figure 3-2.

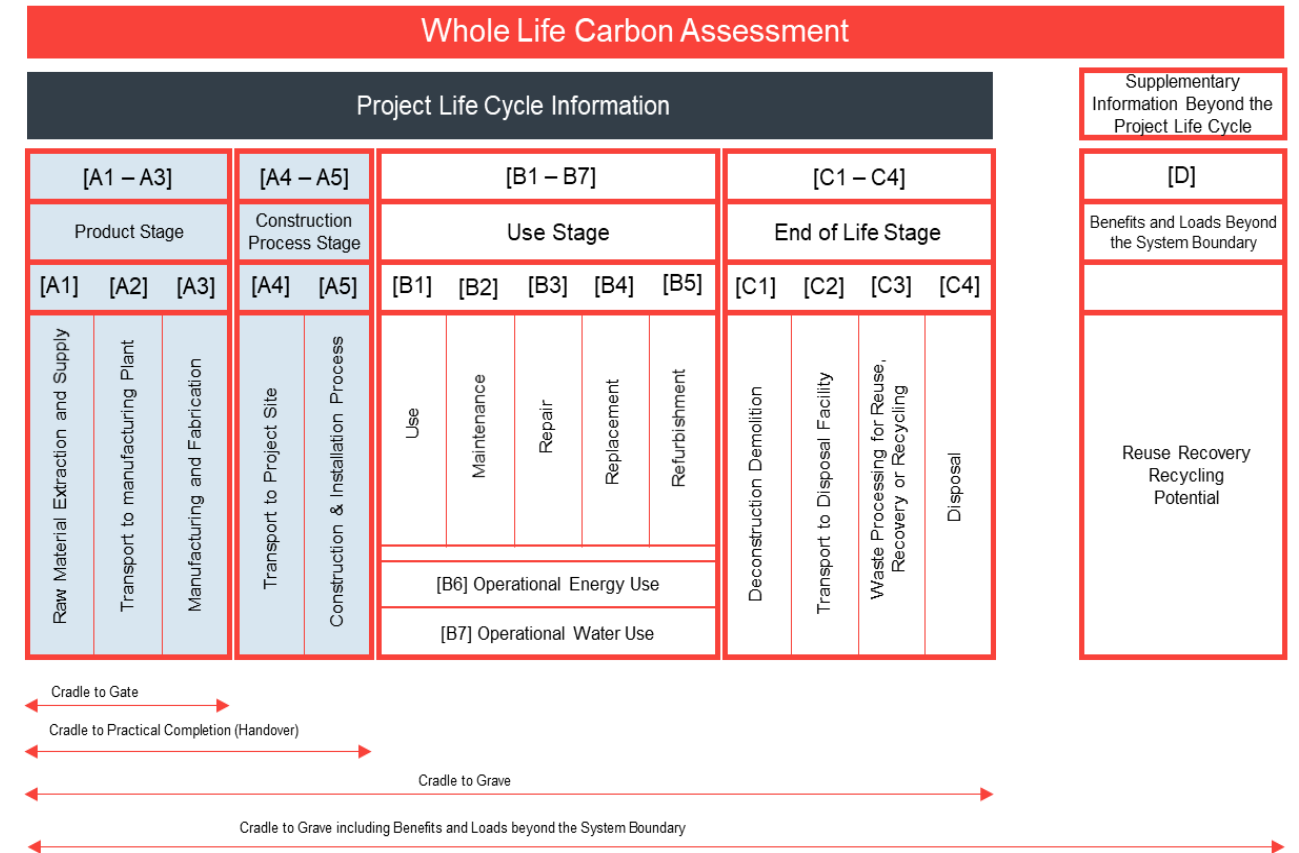


Figure 3-2 - LCA Modules in line with EN 15978 & RICS Guidance 2017

The four main stages are defined as follows:

- **Product (A1-A3 – also known as cradle to gate)**

These modules include the kgCO₂e released during extraction, processing, manufacture (including prefabrication of components or elements) and transportation of materials between these processes, until the product leaves the factory gates to be taken to site. Note that recycled content of a product affects the kgCO₂e released in modules A1-A3. Whether it is recycled after its end of life or not, does not affect the A1-A3 impact of the project being considered, this is taken into account in module D which is reported separately.

- **Construction Process (A4-A5)**

These modules include the kgCO₂e released during transportation of materials/products to site, energy usage due to activities on site (site huts, machinery use etc) and the

kgCO₂e associated with the production, transportation, and end of life processing of materials used on site.

■ **Use (B1-B7)**

These modules include the kgCO₂e released due to use, maintenance, repair, replacement, refurbishment and operational energy and water while the building is in use. Module B4 (replacement) is often the focus of the use stage when embodied carbon is being considered.

■ **End of Life (C1-C4)**

These modules include the kgCO₂e released during decommissioning, stripping out, demolition, deconstruction, transportation of materials away from the site, waste processing and the disposal of materials.

- There is one additional stage beyond the life cycle of the asset that is intended to provide a broader view of its environmental impacts: Benefits and loads beyond the system boundary (Module D).

This estimates any net kgCO₂e benefits of loads beyond the project's life cycle associated with but not limited to:

- Recycling of materials e.g., use of scrap steel (rather than virgin iron) in steelmaking on future projects
- Energy recovered from materials e.g., energy generated by incinerating timber products
- Full reuse of materials/products when compared to the standard practice/standard product it would be replacing

The software that was used to conduct the assessment was OneClick LCA. It has been approved by the BRE and it is compliant to BS EN 1598:2011, ISO 21929, ISO 14040 and EN 15804. The metric for assessing the carbon emissions is Global Warming Potential (GWP) which is expressed in units of CO₂ equivalent (CO₂e). Table 3-1 gives a breakdown of the building elements that have been included in the assessment. The analysis includes all of the building elements accounted for in the information provided by the Design Team.

Table 3-1 - Building Elements Included Based on Stage 2 Information

	Building element (NRM level 2)	Basis for information
Demolition	0.1 Toxic/hazardous/contaminated material treatment	There were no major demolition works included in the information provided.
	0.2 Major demolition works	
0 Facilitating works	0.3 & 0.5 Temporary or enabling works	Excavation quantities provided by the Design Team.
	0.4 Specialist groundworks	
1 Substructure	1.1 Substructure	Material quantities were provided by the Cost Consultant, quantities to be aligned with Cost Plan.
2. Superstructure	2.1 Frame	Material quantities were provided by the Cost Consultant, quantities to be aligned with Cost Plan.
	2.2 Upper floors incl. balconies	
	2.3 Roof	
	2.4 Stairs and ramps	
	2.5 External walls	Material quantities were provided by the Cost Consultant, quantities to be aligned with Cost Plan.
	2.6 Windows and external doors	
	2.7 Internal walls and partitions	
	2.8 Internal doors	
3 Finishes	3.1 Wall finishes	Material quantities were provided by the Cost Consultant, quantities to be aligned with Cost Plan.
	3.2 Floor finishes	
	3.3 Ceiling finishes	
4 Fittings, furnishings, and equipment (FF&E)	4.1 Fittings, furnishings & equipment incl. building-related* and non-building-related**	Allowance accounted for based on 1% of the total WLC figure.
5 Building services/MEP	5.1–5.14 Services incl. building-related* and nonbuilding-related**	Allowance accounted for based on 20% of the overall WLC figure.
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	Minor demolition quantities were extracted from the Pre-redevelopment/demolition Audit.
8 External works	8.1 Site preparation works	Excluded from the assessment due to lack of available data.
	8.2 Roads, paths, paving and surfacing	Material quantities were provided in the Cost Consultant, quantities to be aligned with Cost Plan.
	8.3 Soft landscaping, planting and irrigation systems	Excluded from the assessment due to lack of available data.
	8.4 Fencing, railings, and walls	
	8.5 External fixtures	
	8.6 External drainage	
	8.7 External services	
	8.8 Minor building works and ancillary buildings	

A minimum of 95% of the material quantities allocated to each building element category is accounted for at each stage of the assessment. The information used for this assessment is quality assured as material quantities received from the Design Team are anticipated to align with the cost plan, based on Stage 2 information.

3.3 Targets and Benchmarks

A range of targets and benchmarks have been published across the industry by a number of different bodies. These have been summarised below. It is important to note that, as this assessment has been conducted based on Stage 2 design information, the RIBA targets mentioned below are not applicable as these are 'built' rather than 'design' targets. They have however been left in as a reference and to provide context on the impacts associated with modules B1-5 and C1-4 as the LETI targets relate only to upfront Embodied Carbon (A1-A5).

The London Plan (2021)

The London Plan (2021) is the Spatial Development Strategy for Greater London. "It sets out a framework for how London will develop over the next 20-25 years and the Mayor's vision for Good Growth." The London Plan (2021) requires all new major developments within the City of London that are referable to the Greater London Authority (GLA) to submit a WLC assessment alongside their planning applications.

Greater London Authority (GLA)

In March 2022 the GLA released an update of their Whole Life-Cycle Carbon Assessment guidance. The document includes information on design principles and WLC benchmarks to aid planning applicants in designing buildings that have low operational and embodied carbon. This report follows the GLA's Whole Life Carbon Guidance updated in March 2022.

Table 3-2 – GLA Residential Benchmarks

	Module A1-A5 (Excluding Sequestered Carbon)	Modules B-C (Excluding B6 & B7)	Modules A-C (Excluding B6 & B7; Including Sequestered Carbon)
WLC Benchmark	<850	<350	<1200
Aspirational WLC Benchmark	<500	<300	<800

London Energy Transformation Initiative (LETI)

LETI was established to support the transition of the capital's built environment to net zero carbon. Despite being originally aimed at London they have been widely adopted across the sector in the UK and provide a useful reference point for the upfront embodied carbon of building designs.

Royal Institute of British Architects (RIBA)

RIBA released an initial (2019) version of their 2030 Challenge which set out total embodied carbon (A1-A5, B1-B5, C1-C4) performance targets, rather than the upfront (A1-A5) targets that were published by LETI. These original figures were not comparable as the scopes used by RIBA and LETI were not consistent. In 2021 RIBA revised their 2030 challenge and their scopes now align to enable comparison using a coloured banding system shown below.

The Aligned Targets (LETI & RIBA)

For Upfront Embodied Carbon, Figure 3-3, the LETI 2020 target for offices is Band C at 600 kgCO₂e/m². The LETI 2030 target is Band A at 350 kgCO₂e/m². For Whole Life Embodied Carbon, Figure 3-4, The RIBA 2030 Built Target for offices is Band B at 750 kgCO₂e/m².

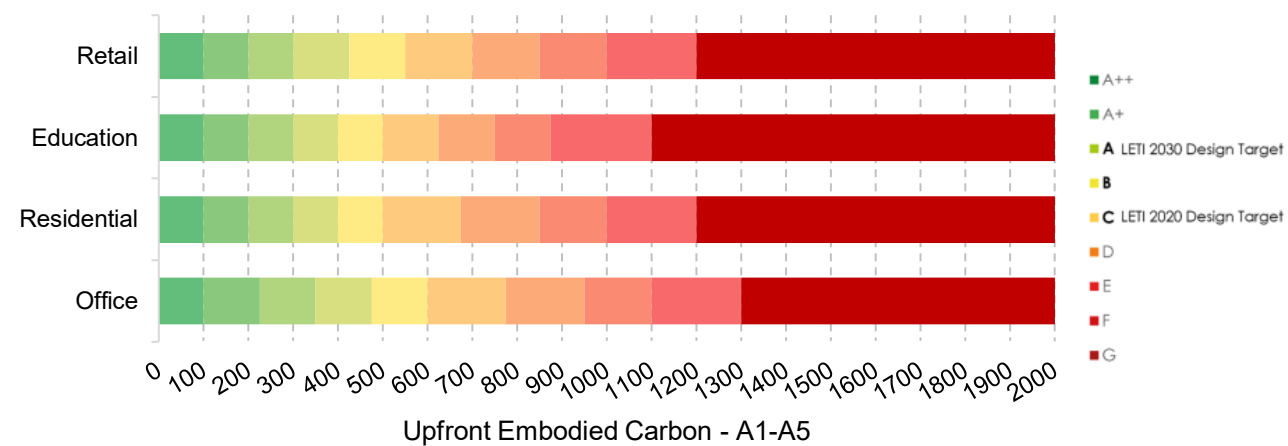


Figure 3-3 - Upfront Embodied Carbon Targets (Design)

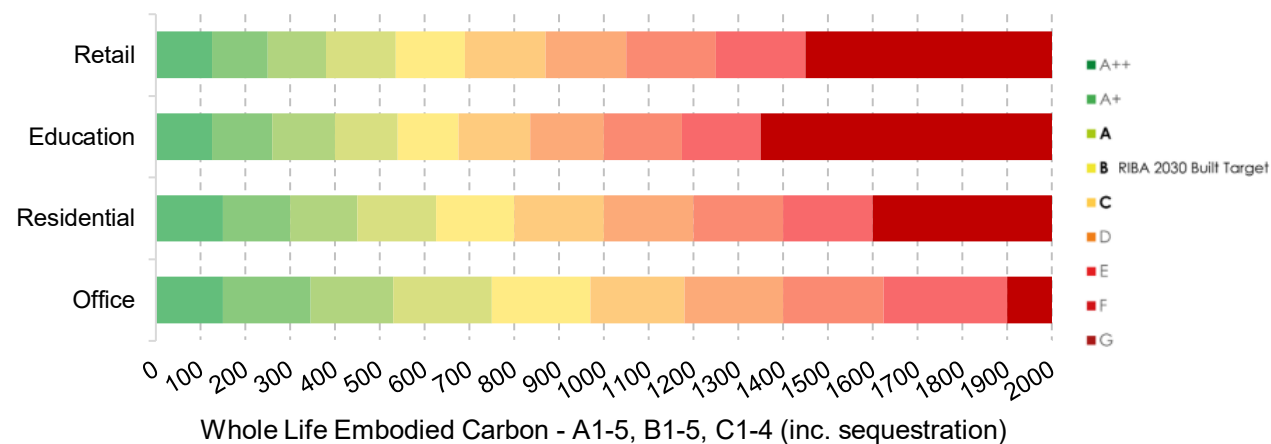


Figure 3-4 - Whole Life Embodied Carbon Targets (Built)

Lifecycle Stage	Assumptions
Construction Process Stage (A4 – A5)	Transportation to site (A4) - calculated using RICS assumptions: 50 km (locally sourced materials like concrete -mix) 300 km (national sourced materials) 1500 km (internationally sourced within the EU) Site operations including construction waste (A5) - based on the project value per £1 million (as per the RICS guidance).
Use Stage (B1 – B5)	Use (B1) includes the impact of refrigerant leakage at leakage rate of 5% a year and 10% end of life recovery per refrigerant. Maintenance (B2) and Repair (B3) have been accounted for in the results, expressed as a % of material repaired per year. Replacement (B4) and Refurbishment (B5) is based on the product specific service life and where applicable, RICS default service life.
Operational Energy Use (B6)	Based on the Energy Strategy (dated October 2022).
Operational Water Use (B7)	Based on 53L per person per day for a commercial development (Berol House) and 105L per person per day for residential (2 Berol Yard).
End of Life Stage (C1-C4)	Based on End of Life (EoL) Market Scenarios (see End of Life Scenarios (Module D)).
Benefits and Load Beyond System Boundaries (D)	

4 Assumptions

Assumptions were made at each lifecycle stage, which can be observed in Table 4-1.

Table 4-1 - Assumptions Made at Lifecycle Stages

Lifecycle Stage	Assumptions
Product Stage (A1 – A3)	Calculated using EPDs which align with the exact product and/or material specification or the most applicable similar product.

4.1 Building Life

This Whole Life Carbon Assessment was conducted assuming a 60-year lifecycle. It is accepted that many structures will have a longer useful life, however a cut-off value has been assumed in accordance with the RICS Guidance to ensure that End of Life (EoL) scenarios and their associated emissions are accounted for in the assessment.

4.2 End of Life Scenarios (Module D)

The Proposed Development has been designed and constructed to reduce material demands as far as practicable and will use systems, elements and materials that can be reused and/or recycled at the end of their useful life.

The building structure has been designed with the industry design life of 50 years (as per the British Standards and Eurocodes).

“Modularity will be a key element in the design of Berol House which favours the future disassembly and reuse of components.” Building information will be stored using material passporting and BIM to allow for end-of-life strategy, future reuse, disassembly, and waste reduction/avoidance. “Given the size of the development, it is likely that all parties (engineers, architects, sub-contractors) will also produce and issue 3D model information. This would then be archived as part of the O&M documentation so that materials and manufacturers are known”.

The Proposed Development will follow the default EoL scenarios (UK Statistics on Waste (2016) from DEFRA) for metals and timber whilst construction and demolition-related items will follow the London Plan Policy Targets.

5 Results

The assessment presented is based off the current energy mix of the national grid. The Whole Life Carbon for Berol Quarter is 846 kgCO₂e/m² (Modules A-C, excluding B6 & B7; including sequestered carbon) which is lower than the current GLA benchmark of <1200 kgCO₂e/m². This considers all lifecycle stages introduced earlier in the report.

The benefits associated with the biogenic materials equate to 26 kgCO₂e/m². Carbon savings have also been achieved by specifying low carbon materials where feasible. Up to 20% GGBS cement replacement is anticipated to be used for the Proposed Development, in line with RICS guidance, to achieve a carbon saving of circa 23 kgCO₂e/m² when compared to virgin concrete.

The results of the WLC assessment are shown below. The results are illustrated in three main breakdowns, firstly by lifecycle stage, Figure 5-1, secondly by building element, Figure 5-2, and thirdly, by lifecycle stage and building element, Table 5-1.

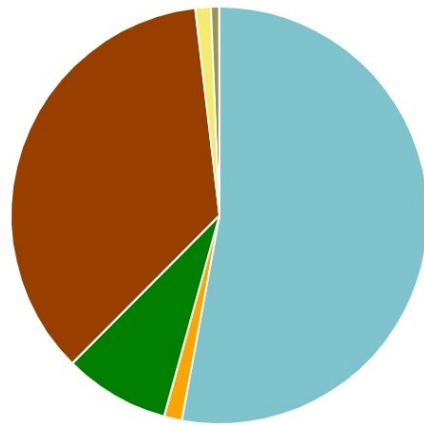
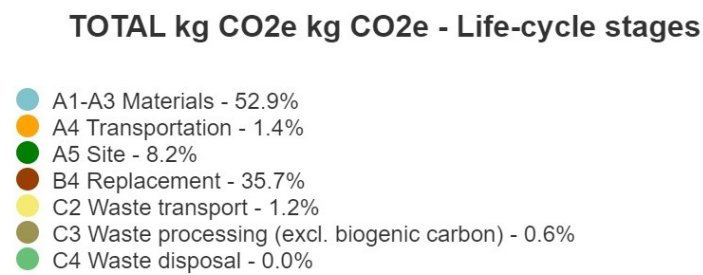


Figure 5-1 - Total kgCO₂e/m²- Lifecycle Stages (Excluding Sequestration)

As can be observed by Figure 5-1, the largest contributor to the buildings WLC emissions are the A1-A3 Materials, accounting for approximately 53% of emissions. The majority of A1-A3 emissions are associated with the concrete, structural steel and rebar. Replacement of materials (B4) was the second largest contributor to this which is likely due to the 20-year service life applied to MEP. MEP Service and FFE contribution were estimated to be approximately 20% for MEP and 1% for FFE of the developments WLC emissions and consequently, figures may be over/under-estimated. There are very few carbon implications associated with the End of Life (EoL) (C1-C4).

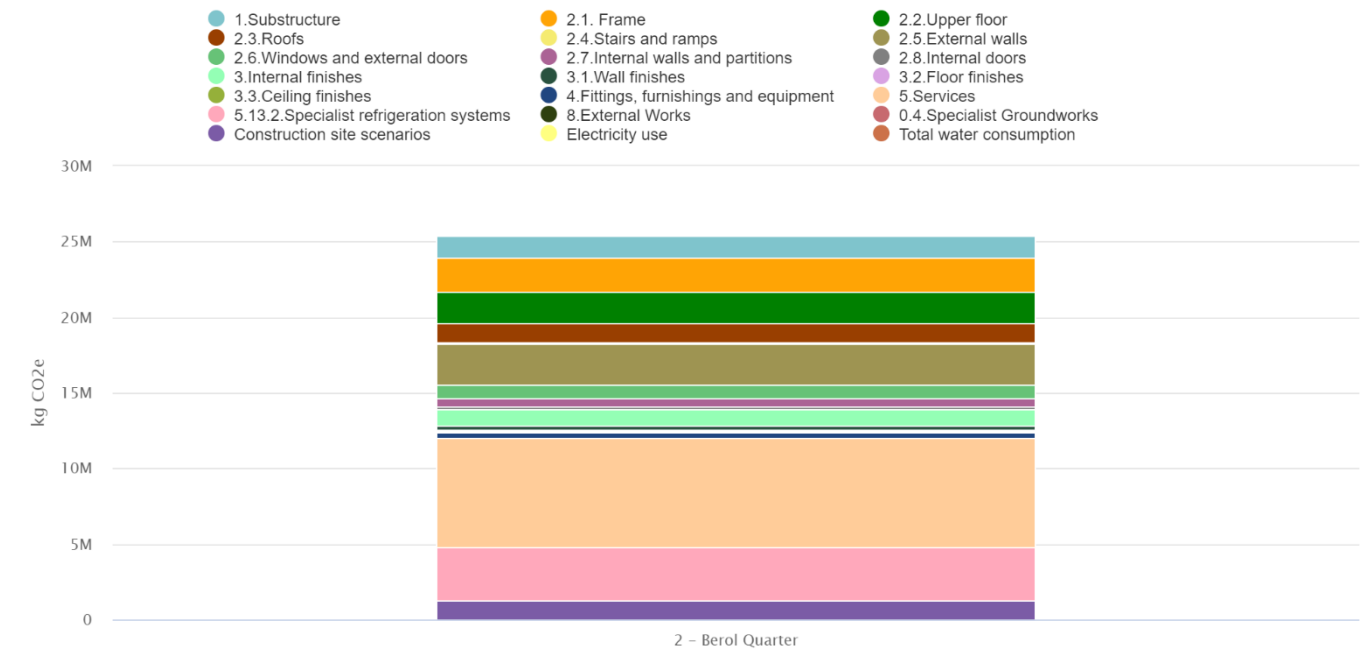


Figure 5-2 - Total kg CO₂e – Building Elements

As can be observed by Figure 5-2, excluding MEP Services, the external walls are the largest contributor to the building element's carbon emissions, followed by the concrete and steel frame, the upper floors, and the substructure.

Table 5-1 – Estimated WLC Emissions for Each Lifecycle Module and Building Element

	Carbon Sequestration	A1-A3 Product Stage	A4 Transportation to Site	A5 Site Operations	B1 Use Phase	B4 Replacement	B6 Operational Energy Use (Regulated & Unregulated, SAP10 Carbon Factor)	B7 Operational Water Use	C1-C4 End of Life	D External Impacts (not included in totals)	Total kg CO ₂ e
Substructure	-70,572	1,351,929	79,117	54,732	0	0	0	0	118,157	-321,630	1,533,363
Superstructure: Frame	-78,436	1,999,926	79,271	81,736	0	0	0	0	129,967	-1,075,229	2,212,464
Superstructure: Upper Floors	0	1,810,037	112,334	85,512	0	0	0	0	89,407	-393,784	2,097,290
Superstructure: Roof	0	423,938	11,246	33,855	0	735,754	0	0	37,775	-65,823	1,242,569
Superstructure: Stairs and Ramps	0	62,612	3,772	2,843	0	0	0	0	2,840	-14,795	72,067
Superstructure: External Walls	-2,820	1,692,559	6,753	100,642	0	878,791	0	0	32,104	-697,670	2,708,030
Superstructure: Windows and External Doors	0	872,713	962	42,861	0	0	0	0	8,415	-1,060,433	924,951
Superstructure: Internal Walls and Partitions	-9,223	515,943	2,586	49,704	0	0	0	0	34,713	-122,537	593,723
Superstructure: Internal Doors	-66,851	65,126	245	0	0	66,381	0	0	67,860	-41,668	132,761
Finishes	-526,076	467,008	4,568	66,540	0	1,109,308	0	0	624,629	-937,294	1,745,977
Fittings, furnishings & equipment	-20,240	58,062	445	2,368	0	296,047	0	0	20,942	0	357,625
Services (MEP)	0	2,388,735	4,594	31,240	0	4,825,218	31,118,935	619,223	19,279	-2,711,294	39,007,226
External works	0	14,002	1,557	607	0	0	0	0	245	-1,287	16,410
Unclassified/Other	0	0		1,260,000	0	0	0	0	0	0	1,260,000
TOTAL kg CO₂e	-774,218	12,896,595	307,458	1,812,642	0	10,240,522	31,118,935	619,223	1,186,333	-7,443,443	57,407,490

5.1 Performance Against GLA Benchmarks

The estimated carbon emissions associated with the development were compared against the GLA benchmarks for residential developments. The residential benchmarks were used as although the development will be mixed use the majority of the GIA will be used for residential purposes. This is in accordance with the GLA’s WLC Guidance. Table 5-2 shows a breakdown of the estimated WLC performance of the development in comparison with GLA Residential benchmarks.

Table 5-2 - Development & GLA WLC Benchmarks for Residential Development.

	Module A1-A5 (Excluding Sequestered Carbon)	Modules B-C (Excluding B6 & B7)	Modules A-C (Excluding B6 & B7; Including Sequestered Carbon)
TOTAL kg CO₂e/m² GIA	495	377	846
WLC Benchmark	<850	<350	<1200
Aspirational WLC Benchmark	<500	<300	<800

Table 5-2 shows that the Proposed Development is estimated to produce lower upfront embodied carbon (modules A1-A5 excluding sequestered carbon) than the WLC benchmark of <850 whilst at the same time exceeding the aspirational benchmark of <500. This is likely due to the largescale retention of the existing structure in Berol House reducing the requirement for new materials and the specification of materials with a longer service life. The specification of at least 20% GGBS cement replacement has reduced the WLC of the development by approximately 687,365 kg CO₂e (23 kg CO₂e/m²) when compared to virgin materials.

The whole life carbon of the development (lifecycle stages A-C (excluding stages B6 & B7)) equates to 846 kgCO₂e/m² which is lower than the WLC benchmark of <1200. Excluding the MEP Services, the external walls, Figure 5-2, are the most significant contributor to this which is likely due to the use of more carbon intensive materials, such as curtain walling, being used in this section of the development. Additionally, material replacement (B4) is estimated to account for approximately 36% of embodied emissions with (excluding MEP replacement) finishes being the most significant contributor to these as multiple finish replacements will be necessary throughout the lifecycle of the development (i.e., coats of paint).

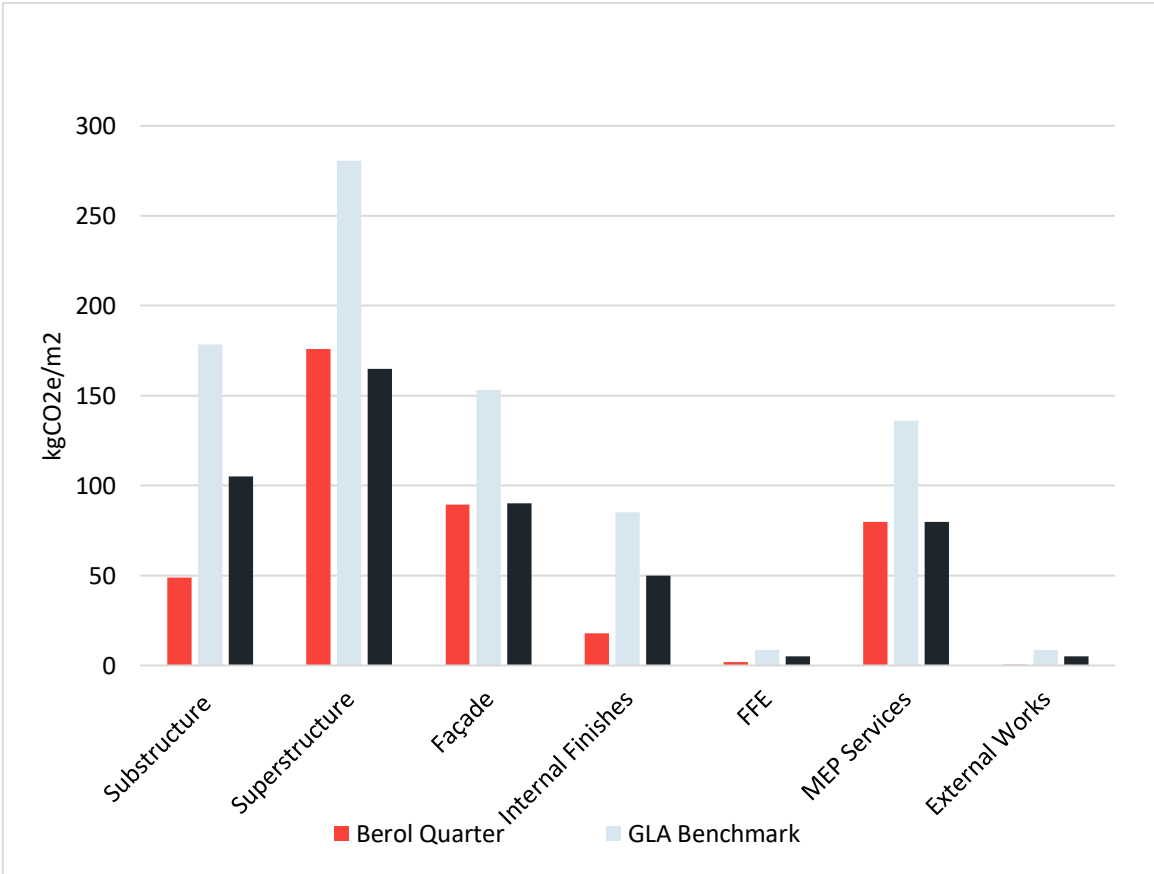


Figure 5-3 - Upfront Carbon (A1-A5) of Berol Quarter Compared to a Typical Residential Development

The Upfront Carbon for Berol Quarter was compared to a typical residential development (typical element % contributions were extracted from the GLA WLC Guidance (March 2022)) and were significantly lower than the WLC benchmark (A1-A5 Excluding Sequestered Carbon) which is likely due to the largescale building and material retention at Berol House with development at this site being solely a retrofit and expansion scheme. Although 2 Berol Yard is a new building the use of low carbon materials and the specification of materials with increased service lives has likely resulted in A1-A5 carbon savings. It must be noted that the typical % contributions of each building element are based on new constructions. As can be observed by Figure 5-3, all building elements are performing better than the GLA benchmark in addition to the substructure, façade, internal finishes, FFE, MEP and external works performing better than the aspirational benchmark for a typical residential development in London (GLA benchmark). Carbon savings have been achieved due to the chosen timber formwork which offers sequestered carbon benefits, in turn, reducing the embodied carbon of the frame. Due to FFE (estimated 1%), and MEP (estimated 20%) being assumed it is possible that their impact could be over or underestimated.

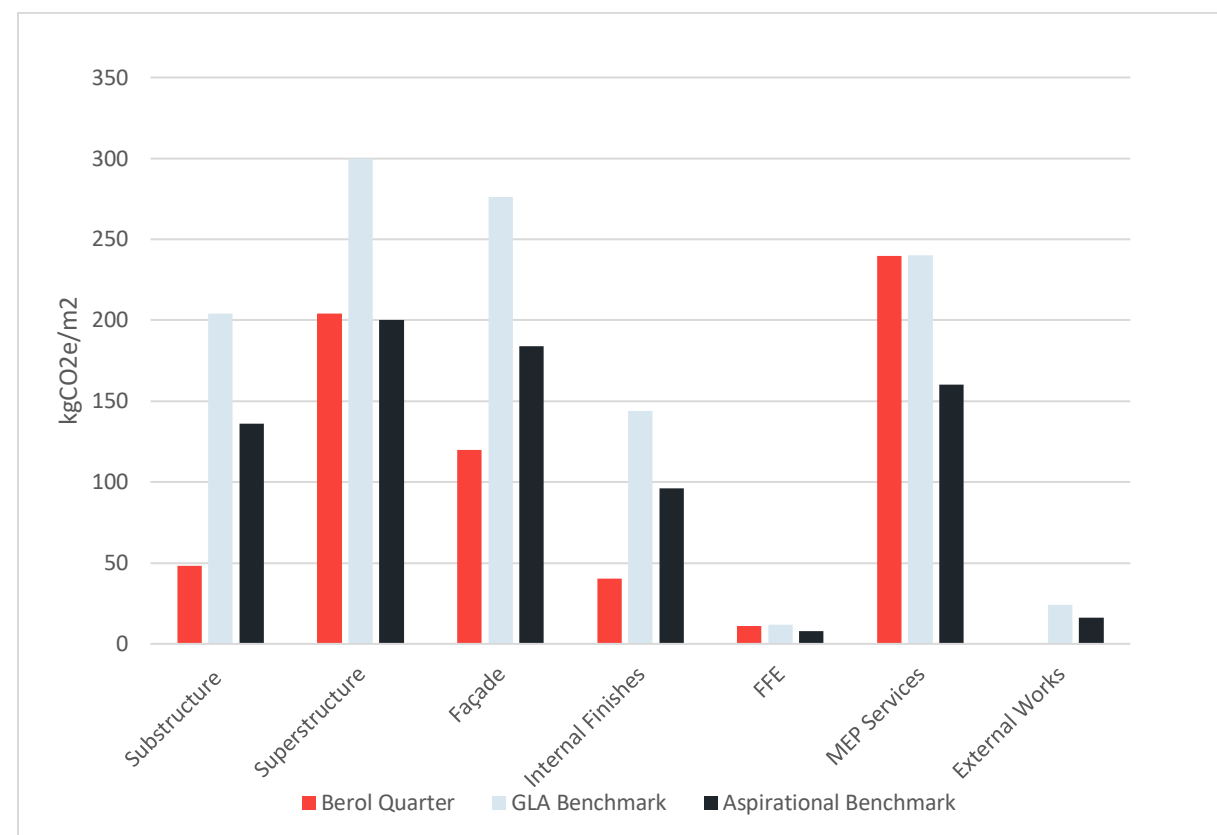


Figure 5-4 - Embodied Carbon (Modules A-C (Excluding B6 & B7; Including Sequestered Carbon)) of Berol Quarter Compared to a Typical Residential Development

Figure 5-4 shows a breakdown of each building element's embodied carbon in comparison with a typical residential development in London (typical element % contributions were extracted from the GLA Guidance (March 2022)). It must be noted that the typical % contributions of each building element are based on new constructions. Figure 5-4 shows that all building elements, minus FFE and MEP services, are performing better than the GLA benchmark whilst the substructure, façade and external works are all performing better than the aspirational GLA benchmark for a typical residential development. The superstructure is performing only slightly worse than the aspirational benchmark for residential developments. The retention of Berol House has likely significantly lowered the embodied carbon associated with the building on this site, with priority being given to the retention and reuse of the existing façade, foundations, slabs, columns, and beams. In turn, this contributes to the reduced need for demolition, excavation and new materials required.

The use of 20% GGBS in concrete for the substructure, superstructure, and façade of the development could be increased to up to 70% GGBS which would achieve carbon savings of 1,718,294 kg CO₂e, in comparison to the Proposed Development. The embodied carbon of

FFE and MEP services were estimated and consequently, it is possible that their impact could be over or underestimated.

5.2 Opportunities for Reducing WLC

Reduce/Reuse/Recycling of Materials

Table 5-3 – Preliminary Identification of types of waste (Extracted from Waste Management Plan)

Material	Proposed Waste Management Action		
	Reduce	Re-use	Recycle
Brick			
Concrete Brick		✓	
Plasterboard		✓	
Timber Decking	✓		✓
Screed		✓	
Insulation	✓		✓
Precast Planks			
Roof Screed		✓	
Insitu Concrete		✓	
Paving		✓	
Pea Shingle		✓	
Hardcore		✓	

Best practice waste reduction measures developed in line with the waste hierarchy to reduce, reuse, and recycle will also be incorporated into the construction of the new building which includes the use of the Pre-redevelopment Report to understand the potential for salvaging components.

Designing for Longevity, Adaptability & Flexibility

The Proposed Development has ensured that the principles of Circular Economy are embedded into the design of the project by ensuring the design is flexible and adaptable, therefore increasing the building's lifecycle. The layered design of the building enables independent layers to be upgraded or replaced. Furthermore, any waste that is generated during the construction, operation, maintenance, and refurbishment/de-construction of the project in the future has been reduced as much as possible.

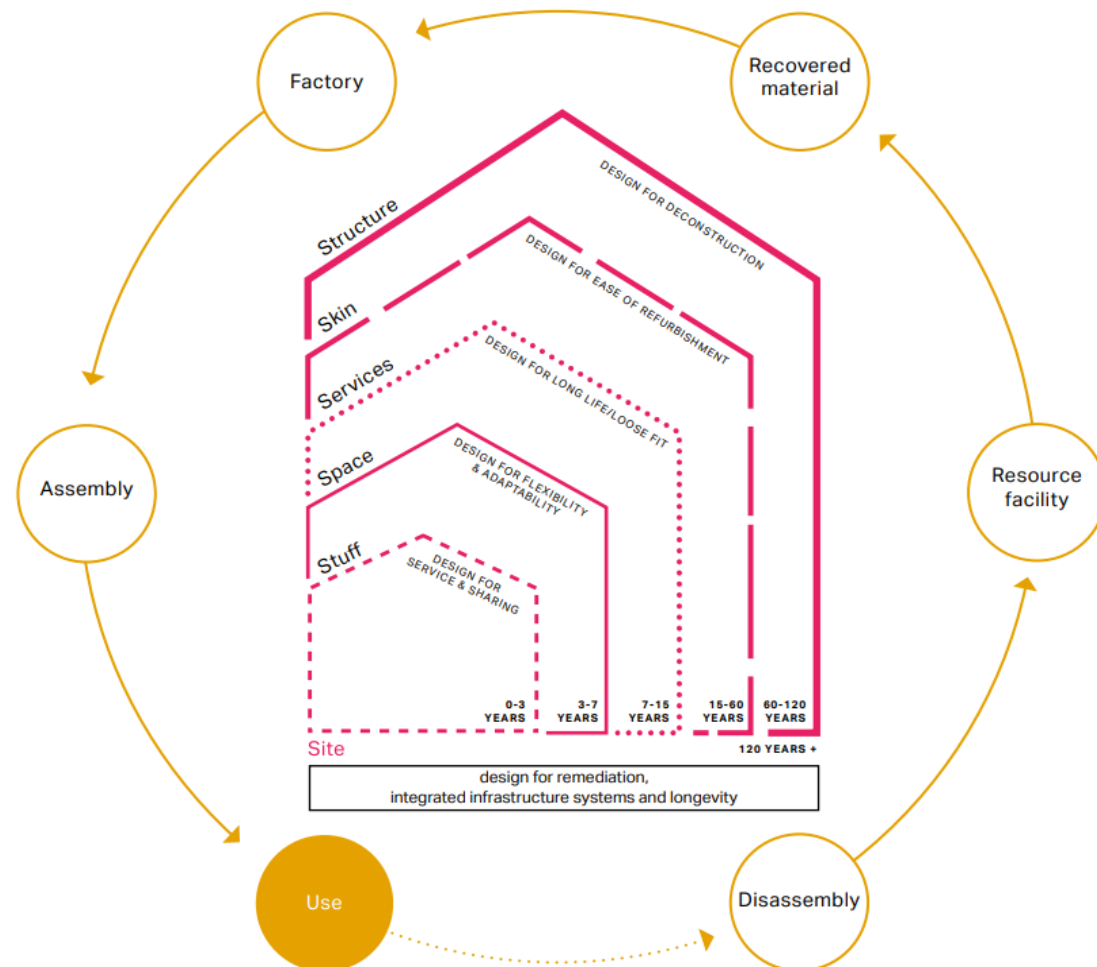


Figure 5-5 - 'Building in Layers' Diagram

Designing for Material Efficiency & Maximising Recycled Content

A Circular Economy Workshop was held with the Design team, during which material efficiency was discussed. This topic is a priority for the design team and one of the key considerations during detailed design. Potential measures for reducing the material demand and for designing out waste has been and will be further explored by all key design team disciplines at each design stage. Material efficiency seeks to optimise the use of materials within building design, procurement, construction, maintenance, and end of life; with the aim being to reduce the quantities of new materials used in the development. It is anticipated that

at least an average of **20% or more** of the material used in the development will contain reused or/and recycled content. Using products with recycled materials can significantly reduce the embodied carbon of a building in comparison with using virgin materials.

Responsible Sourcing & Specification of Materials

The responsible sourcing of materials will be a key consideration in the selection of suppliers. A Sustainable Procurement Strategy should be produced for the Proposed Development prior to commencement of construction to control this aspect. Materials from suppliers who participate in responsible sourcing schemes such as the BRE's BES 6001:2008 Responsible Sourcing Standard will be prioritised.

All timber specified will be sourced from schemes supported by the Central Point of Expertise for Timber Procurement such as Forest Stewardship Council (FSC) accreditation—which ensures that the harvest of timber and non-timber products maintains the forest's ecology and its long-term viability.

Where viable the design team will specify materials that are grown or made locally. Likewise, the appointed contractor will be asked to prioritise local sourcing of materials.

Energy Strategy

As can be observed in the Energy Strategy (November 2022), the energy demand of the Proposed Development has followed the London Plan Energy Hierarchy (BE LEAN – BE CLEAN – BE GREEN – BE SEEN). The proposals for the scheme have been developed in accordance with the desire to achieve an energy efficient and sustainable development.

Product Specification

The specific design of a product/material can have a significant impact on carbon emissions at the product stage (A1-A3). This is due to the components of the products/material requiring intense carbon treatment in addition to their transportation prior to fabrication. This means that the embodied carbon of the same product/material by different manufacturers will have different carbon implications. With the aim of tackling this issue EPDs which align with the exact product and/or material specification or the most applicable similar product were used throughout the WLC Assessment.

Designing for Re-use & Recovery

A Pre-redevelopment Audit for the project is required as part of the Circular Economy Statement. This has identified any materials that can be recovered and re-used within the Proposed Development. Building information will be stored “through the use of BIM technologies and Material Passports” to allow for end-of-life strategy, future reuse, disassembly, and waste reduction/avoidance. The benefits of the recovered materials have been accounted for in the WLC Assessment and replace virgin materials where applicable.

5.3 Opportunities for Further Reducing WLC

Minimising Quantities of Other Materials

During the construction stage the Principal Contractor will be required to set targets for energy and water used on site and ensure measures are put in place to minimise consumption of these resources. These could consist of:

- Low carbon energy sources used during construction phase (renewable sources of energy and offset of main utilities)
- Use of highly efficient plant and battery power energy storage

Specifying Higher Recycled Content of Materials

Specifying higher recycled content in materials will reduce the need for virgin materials to be used and consequently reduce the carbon footprint of the development. For example, the development proposes to use an average of 20% GGBS concrete. However, if the recycled content is 50%, a total carbon saving of approximately 1,016,103 kg CO₂e (34 kg CO₂e/m²) could be achieved in comparison with the current Proposed Development. Furthermore, a total carbon saving of circa 1,718,294 kg CO₂e (57 kg CO₂e/m²) could be achieved in comparison with the current Proposed Development if the recycled content was increased to 70%.

6 Conclusion

This report has set out the Whole Life Carbon emissions estimated for the Proposed Development. The assessment was carried out in accordance with the GLA's Whole Life Carbon Assessment Methodology updated in March 2022 and The London Plan policy requirement (2021) SI 2 which requires all new major developments within the City of London that are referable to the Greater London Authority (GLA) to calculate and reduce the WLC associated with the Proposed Development.

The Proposed Development is estimated to produce lower upfront carbon (modules A1-A5 excluding sequestered carbon) than the WLC benchmark of <850. The WLC of the development is also estimated to be significantly lower than the benchmark of <1200.

The efficient use of materials in addition to designing out waste throughout the design and construction process has led to significant reductions in embodied emissions which can be observed throughout this report. The A1-A3 materials are the largest contributor to lifecycle stage emissions with material replacement (B4) being the second largest contributor to this, accounting for approximately 36% of WLC emissions. The transportation (A5) of materials accounts for only 8% of whole life emissions whilst, excluding the MEP Services, the external walls are the largest contributor to the building element's carbon emissions, followed by the frame, and the upper floors.

The obtention and use of the product specific EPDs should be prioritised for the proposed construction materials in order to be able to optimally quantify and manage the WLC of the Proposed Development.

The estimated WLC emissions for the Proposed Development are 846 kg CO₂/m² (modules A-C excluding B6 & B7, including sequestered carbon) and 1046 kg CO₂e/m² for B6-B7 which were measured in line with the TM54 methodology and using the latest SAP10 carbon factor over a 60-year period.

This report is aligned with the London Plan (March 2021) and Whole Life Carbon Guidance (updated in March 2022). Consequently, the Proposed Development is meeting all relevant policy requirements whilst also being energy efficient and sustainable (performing better than the GLA benchmark).

In accordance with the GLA guidance, it is anticipated that an 'As Built' Assessment will be required at Post-Construction Stage 6 (upon commencement of RIBA Stage 6, prior to building handover).



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