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Whole Life Carbon Assessment

November 2023

ABERFELDY VILLAGE MASTERPLAN

Greengage

Brighter strategies
for greener projects

Client: The Aberfeldy New Village LLP

Project: Aberfeldy Village

Report: Whole Life Carbon Assessment

QUALITY ASSURANCE

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CONTENTS

Tables

Figures

1.0 EXECUTIVE SUMMARY

Greengage has been appointed by The Aberfeldy New Village LLP (the "Applicant") to conduct a Whole Life-Cycle Carbon Assessment (WLC) that follows the EN 15978 calculation methodology and further aligns by the guidelines set out in RICS Professional Statement UK - Whole Life Carbon Assessment for the Built Environment.

The assessment has been conducted at RIBA Stage 2/3 to inform the Applicant, the design team and the Greater London Authority (GLA) on the benchmark WLC performance for the new proposed residential-led mixed use development located at Aberfeldy Village, within the London Borough of Tower Hamlets (LBTH).

This WLC report was produced in response to the policies and aspirations of the GLA (Policy SI 2) and the London Borough of Tower Hamlets (LBTH) and will be submitted as part of the hybrid planning application for the Proposed Development. The report should be read in conjunction with the GLA Whole Life Carbon Assessment Template issued in Microsoft Excel Format (230720_Aberfeldy_village_gla_circular_economy_statements_template).

1.1 CARBON REDUCTION STRATEGIES

Energy strategy

An energy strategy has been produced for the Proposed Development as a key mechanism for reducing WLC of the development. In addition to a passive design approach, a strategy has been proposed that features highly efficient heat pumps to deliver heating and hot water throughout the development. In addition to heat pumps working at greater efficiency than gas boilers, the heat pumps can take advantage of the projected decarbonisation of the national grid.

Circular economy

The Proposed Development has taken care to consider Circular Economy in its design. The Circular Economy Statement, submitted as part of the planning application, details the strategy for recovery of materials in line with the circular economy model.

Estimated whole life-cycle carbon emissions

Table 1.1 below displays the results from the Proposed Development's assessments using SAP 10.0 carbon factors, with Table 1.1 and Figure 1.1 showing the breakdown by lifecycle module. The study has explored the implementation of carbon reduction measures within the development that include incorporating increased recycled content within steel reinforcement, a timber frame and a timber frame.

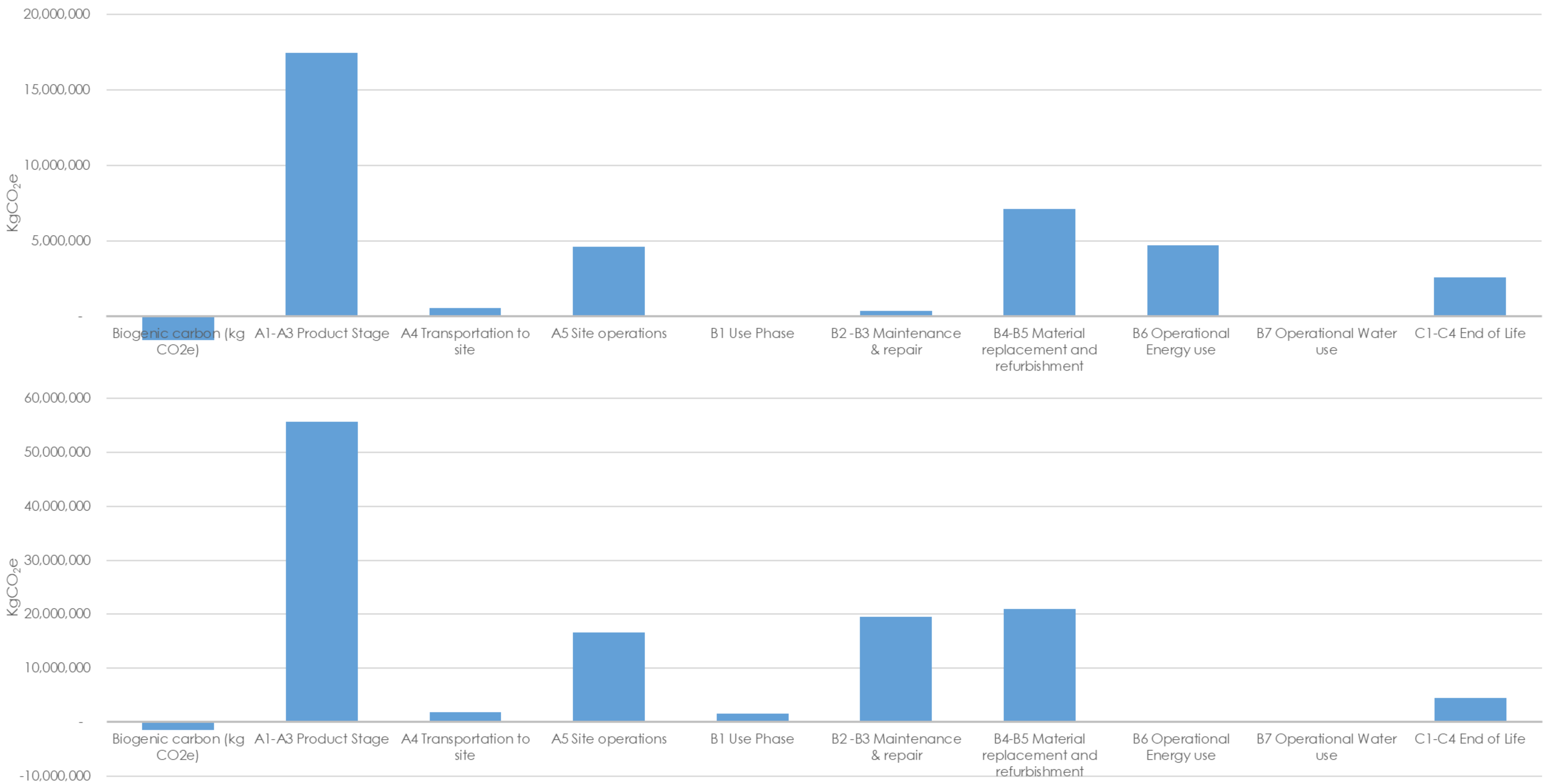
Table 1.1 Summary of WLC emissions for all phases

	Phase A		**Phases B-D**	
	Carbon at PC (A1-A5) ($kgCO_2e$)	Life-Cycle Carbon (A1-A5, B1-B7, C1-C4) ($kgCO_2e$)	Carbon at PC (A1-A5) ($kgCO_2e$)	Life-Cycle Carbon (A1-A5, B1-B7, C1-C4) ($kgCO_2e$)
0.1-0.2 Demolition	-	96,426	-	314,008
0.3-0.5 Facilitation works	-	-	-	-
1 Substructure	10,126,910	10,433,350	34,184,669	34,806,267
2.1-2.4 Superstructure	5,465,390	5,901,220	18,217,370	18,930,606
2.5-2.6 Superstructure	1,952,157	2,755,049	7,869,451	11,906,075
2.7-2.8 Superstructure	1,641,574	2,958,146	4,794,258	9,337,667
3 Finishes	1,168,466	3,561,933	1,835,126	7,837,977
4 Fittings, furnishings & equipment (FF&E)	225,359	666,946	622,047	1,867,280
5 Services (MEP)	1,713,923	4,322,561	6,293,724	33,720,410
6 Prefabricated buildings and building units	-	-	-	-
7 Work to existing building	-	-	-	-
8 External works	330,579	389,261	295,317	478,919
Site, Energy & Water	-	4,699,926	-	12,742
TOTAL – $kgCO_2e$	22,624,358	35,784,818	74,111,963	119,211,951
TOTAL – $kgCO_2e/m^2$	798	1,262	603	970

Table 1.2 Summary of Proposed Development's WLC emissions per module grouping for Phase A and Phases B-D

	Sequestered (or biogenic carbon)	Module A1-A3 Product stage	Module A4 Transportation to site	Module A5 Site operations	Module B1 Use phase	Module B2-B3 Maintenance & repair	Module B4-B5 Replacement & refurbishment	Module B6 Operational energy use	Module B7 Operational water use	Module C1-C4	Module D External impacts (not included in totals)
Phase A ($kgCO_{2e}$)	-1,587,619	17,435,779	577,962	5,714,588	2,307	357,014	7,124,344	4,696,402	3,524	2,564,488	-5,335,544
Phase B-D (kgCO2e)	-1,470,180	55,640,364	1,803,300	16,668,299	1,606,925	19,563,647	20,916,473	n/a	12,742	4,470,380	-51,954,053

Figure 1.1 WLC results for the Proposed Development showing life cycle emissions at each Life Cycle Module for Phase A (top) and Phases B-D (bottom)



2.0 INTRODUCTION

This report supersedes the WLCA Report dated October 2022 previously submitted in support of the Hybrid Application (LBTH Ref: PA/21/02377/A1 and GLA Ref: 2023/0300/S3) and should therefore be read on a standalone basis.

Following a resolution to refuse planning permission by the London Borough of Tower Hamlets (LBTH) Strategic Development Committee (SDC) in February 2023, and the subsequent direction that the Mayor of London will act as the local planning authority for the purposes of determining the Hybrid Application, the design of the scheme has been amended to accommodate second staircases in all buildings over 18m in height.

For the sake of completeness only it should be noted that the above referenced amendments follow previous amendments to the Hybrid Application, made prior to its consideration by the LBTH SDC, the assessments of which were set out within previous revisions of this WLCA. In summary the previously assessed charges were: the incorporation of Jolly's Green within the red line boundary, the removal of the previously proposed Block A3 and associated increase in open space and play space, an increase in the number of affordable rented family homes, and the inclusion of second staircases in lots F & I.

Further information is set out within the accompanying Covering Letter (as prepared by DP9 Ltd, dated November 2023) and the updated Planning Statement (as prepared by DP9 Ltd, dated November 2023).

Greengage have been appointed by The Aberfeldy New Village LLP to undertake a Whole Life-Cycle Carbon (WLC) Assessment of Aberfeldy Village, within the London Borough of Tower Hamlets (LBTH).

The hybrid application seeking detailed planning permission for Phase A and Outline planning permission for future phases, comprising:

Outline planning permission (all matters reserved) for the demolition of all existing structures and redevelopment to include a number of buildings (up to 100m AOD) and up to 140,591 (GEA) of floorspace comprising the following mix of uses: Residential (Class C3); Retail, workspace, food and drink uses (Class E); Car and cycle parking; Formation of new pedestrian route through the conversion and repurposing of the Abbott Road vehicular underpass for pedestrians and cyclists connecting to Jolly's Green; Landscaping including open spaces and public realm; and New means of access, associated infrastructure and highway works.

In Full, for residential (Class C3), retail, food and drink uses and a temporary marketing suite (Class E and Sui Generis), together with access, car and cycle parking, associated landscaping and new public realm, and open space. This application is accompanied by an Environmental Statement. This assessment is aligned to the planning application submission (RIBA Stage 2/3) and has been carried out in line with guidance provided by the GLA in the London Plan Whole Life-Cycle Carbon Assessments Guidance, March 2022 and the RICS Professional Statement on Whole Life Carbon.

This assessment aims to assess the WLC for the proposed residential led mixed-use building, defined as 'those carbon emissions resulting from the construction and the use of a building over its entire life, including its demolition and disposal.' Embodied carbon emissions have been accounted for, relating to raw extraction, manufacture and transport of material, construction emissions, maintenance, repair, replacement, demolition and end of life disposal. Operational carbon emissions have also been accounted for as part of this assessment, including both regulated and unregulated energy use.

This report should be read in conjunction with the 'GLA Whole Life Carbon Assessment Template' issued in Microsoft Excel Format.

3.0 BACKGROUND

3.1 CONTEXT AND DESCRIPTION OF THE PROPOSED DEVELOPMENT

This report is an update to the version of the Whole Life Carbon Assessment dated April 2022 that was submitted as part of a resubmission to an earlier hybrid planning application submitted to the London Borough of Tower Hamlets (LBTH) in October 2021 (LBTH Ref: PA/21/02377/A1 and GLA Ref: 2023/0300/S3). This updated version has been prepared in response to a reduction in the quantum of proposed residential floorspace and residential units proposed, through the removal of Block A3 from the proposed parameter plans. The proposals also seek to provide an increase in the number of affordable units being delivered as part of the development. Further information is set out within the accompanying Covering Letter (as prepared by DP9 Ltd, dated November 2023) and the updated Planning Statement (as prepared by DP9 Ltd, dated November 2023).

The sections of this report that are different from those contained in the resubmission version submitted in April 2022 are:

- Results; and
- Opportunities for reducing WLC.

The existing application site consists of the following buildings and hard landscaping areas:

- Blairgowrie Court;
    - A residential building ranging between three and six storeys constructed in the early 2000s. The layout internally is uniform with 30no. identical 2-bedroom dwellings, one central core and an external access deck.
    - The building is currently vacant, with all fixtures and fittings removed from kitchens and bathrooms.
- Aberfeldy Street West & East;
    - Both buildings are 3 storeys with residential units above a commercial use ground floor. They are understood to be constructed between the 1950-60s with central stair cores and external access decks.
    - The residential element of each building is currently vacant, with all fixtures and fittings removed from kitchens and bathrooms.
- Aberfeldy Neighbourhood Centre; and
    - A one storey building currently in use as community centre (including a nursery, computer suite and small café) of standard construction, built in the early 2000s.
- Lochnagar Street.
    - A currently vacant plot with overgrown vegetation.

Figure 3.1 Visualisation of an element of the Proposed Development. (Source: Morris + Company)

Hybrid application seeking detailed planning permission for Phase A and Outline planning permission for future phases, comprising:

Outline planning permission (all matters reserved) for the demolition of all existing structures and redevelopment to include a number of buildings (up to 100m AOD) and up to 140,591sqm (GEA) of floorspace comprising the following mix of uses: Residential (Class C3); Retail, workspace, food and drink uses (Class E); Car and cycle parking; Formation of new pedestrian route through the conversion and repurposing of the Abbot Road vehicular underpass for pedestrians and cyclists connecting to Jolly's Green; Landscaping including open spaces and public realm; and New means of access, associated infrastructure and highway works.

In Full, for residential (Class C3), retail, food and drink uses and a temporary marketing suite (Class E and Sui Generis), together with access, car and cycle parking, associated landscaping and new public realm, and open space.

This application is accompanied by an Environmental Statement.

Within the Detailed application, this includes residential (Class C3), retail, food and drink uses and a temporary marketing suite (Class E and Sui Generis), together with access, car and cycle parking, associated landscaping and new public realm, and private open space.

Full details of the consented and proposed schemes can be found in the accommodation schedule and drawing pack submitted alongside this assessment.

As confirmed in the accompanying Circular Economy (CE) statement and pre-demolition audit the buildings currently on site and no longer fit for purpose and do not meet current building standards. Consequently, the existing buildings will be demolished to make way for the development, which will provide signification improvements in relation to energy efficiency, climate adaptation and quality for residents.

3.2 BACKGROUND TO WHOLE LIFE-CYCLE CARBON ASSESSMENTS

The carbon emitted as a result of proposals for developments can be roughly divided into two overarching categories: the 'upfront' carbon embedded in products, materials, their transportation, and their construction (also referred to as the 'embodied' carbon) and the 'operational' carbon associated with the in-use energy consumption of the building once constructed.

Carbon emissions from operational use of buildings has been the subject of regulation for some time and has historically been the primary focus of reducing the impact of built environment projects. More recently, this focus has been expanded to also include carbon emissions associated with the building materials themselves and the carbon emitted through the construction of buildings, as well as their ongoing maintenance, refurbishment, and demolition.

The embodied carbon of a building can comprise a substantial portion of the overall carbon footprint of buildings, new or refurbished. Importantly, by 2050, ~40% of CO_2 emissions associated with the operation and construction of buildings will be from embodied carbon. As buildings become more energy efficient, and their operational carbon reduces, embodied carbon becomes significantly more important.

To acquire an overall understanding of a built project's total carbon impact, it is necessary to assess both the anticipated operational and embodied emissions over the whole life of the asset. This is often referred as 'Whole Life-Cycle Carbon' or Life Cycle Assessment (LCA).

A WLC approach identifies the overall best combined opportunities for reducing lifetime emissions and helps to avoid any unintended consequences of focusing on operational emissions alone.

The Circular Economy

The construction and operation of the built environment consumes 60% of all materials in the UK. At the end of life, materials are often diverted from landfill, but in reality, downcycled, reducing their value.

There is growing industry consensus that the way we design, build, operate and dispose of our buildings and associated facilities needs a major overhaul to reduce waste and increase efficiency. There is an incredible breadth of opportunity that this shift in approach will create across the entire supply chain.

Designing for longevity and adaptability and maximising the use of recycled and renewable materials could reduce greenhouse gas emissions while increasing innovation opportunities and economic growth. Replacing finite and fossil-based materials with responsibly managed renewable materials can decrease carbon emissions whilst reducing dependency on finite resources.

By considering the carbon emissions of a development from a whole life perspective, design decisions can be made to not only minimise embodied carbon in construction, but it can assist to produce a development which reduces resource consumption throughout its use, extending life cycles of products, maximising re-use of building components and ensuring that all components are considered as a 'product resource', rather than 'product waste'.

3.3 SUPPORTING DOCUMENTATION

To support this assessment, Greengage have reviewed the following documents produced in support of the planning application:

- Morris + Company - Design and Access Statement;
- Circle - Elemental Cost Plan; and
- Greengage Environmental Ltd - Circular Economy Statement.

4.0 POLICY, REGULATIONS AND GUIDANCE

4.1 POLICY DRIVERS

This section sets out current policy drivers and strategies developed by national governments, and a range of organisations throughout the world, in order to set out a blueprint for action.

National Policy

Climate Change Act 2008 (2050 Target Amendment)[1]

On 26th November 2008, the UK Government published the Climate Change Act 2008, the world's first long-term legally binding framework to mitigate against climate change. Within the original framework, the Act sets legally binding targets to increase greenhouse gas emission reductions through action in the UK and abroad from the 60% target to 80% by 2050. This was amended in 2019 to a revised target of a 100% reduction in carbon emissions by 2050, over the 1990 baseline emissions levels, known at the net-zero target.

Regional Policy

Greater London Authority, London Plan, 2021[2]

The London Mayor and Secretary of State formally approved the London Plan for publication and adoption in March 2021, which will run from 2021 to 2041, providing a longer- term view of London's development to inform decision making.

Within the London Plan, Policy SI2 'Minimising greenhouse gas emissions' requires major developments to be net zero-carbon. It also requires referable developments to calculate whole lifecycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.

Local Policy

Tower Hamlets Local Plan 2031 (adopted January 2020)

Whilst the Tower Hamlets Local Plan 2031, does not detail requirements relating to Whole Life Carbon directly, many policies discuss sustainable design and construction relating to its methodology. These include:

Policy S.SG2 Delivering sustainable growth in Tower Hamlets

"Development will be supported and is considered to contribute towards delivering the Local Plan vision and objectives and to be sustainable where it delivers managed growth through good design, … not resulting in unacceptable impacts on the natural environmental and it's assets, transport capacity or infrastructure"

Policy D.SG4 Planning and construction of new development

"Development is required to employ the highest standards of sustainable construction, including:

a. Sustainable construction methods, such as the use of sustainably sourced and recycled materials, and

b. The use of demolished material from the development site, where practicable, in order to minimise the transportation of waste and reduce carbon dioxide emissions"

Policy S.ES1 Protecting and enhancing our environment

Expects developments to minimise the use of natural resources through the following:

- "Reducing water use
- Following the energy hierarchy: be lean, be clean and be green
- Maximising climate change adaptation measures"

Policy D.ES7 A zero carbon borough

Expects developments to meet the following carbon emission reductions standard:

- "2016-2031 - Zero carbon (to be achieved through a minimum 45% reduction in regulated carbon dioxide emissions on-site and the remaining regulated carbon dioxide emissions to 100% - to be off-set through a cash in lieu contribution)"

4.2 TECHNICAL GUIDANCE

RICS Professional Statement UK – Whole Life Carbon Assessment for The Built Environment[3]

The RICS Professional Statement: Whole Life Carbon Assessment (WLC) for the Build Environment, released in 2017, seeks to standardise WLC assessment and enhance consistency in outputs by:

- *"providing specific practical guidance for the interpretation and implementation of the methodology in EN 15978 in carbon calculations. This is to achieve coherent and comparable results that can be used to benchmark the whole life carbon performance of built assets. The specific objectives of this professional statement are to:*
  - *a. provide a consistent and transparent whole life carbon assessment implementation plan and reporting structure for built projects in line with EN 15978;*
  - *b. enable coherence in the outputs of whole life carbon assessments to improve the comparability and usability of results;*
  - *c. make whole life carbon assessments more 'mainstream' by enhancing their accessibility and therefore encourage greater engagement and uptake by the built environment sector;*
  - *d. increase the reliability of whole life carbon assessment by providing a solid source of reference for the industry;*
  - *e. promote long-term thinking past project practical completion, concerning the maintenance, durability and adaptability of building components and the project as a whole; and*

f. *promote circular economic principles by encouraging future repurposing of building components, as well as of the project as a whole, through quantify."*

The Greater London Authority have adopted the RICS WLC methodology in their guidance methodology for Whole Life Carbon assessment of referable planning applications.

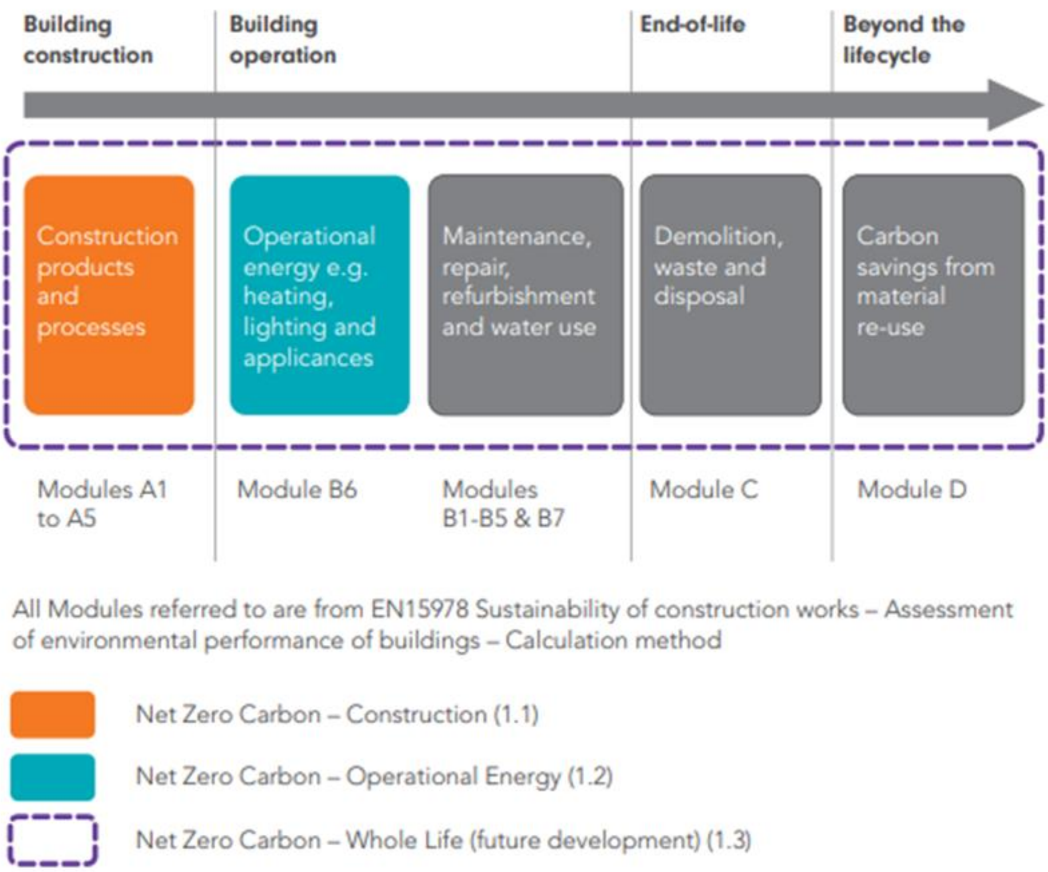
London Plan Guidance - Whole Life Carbon Assessments March 2022[4]

In March 2022 the GLA released guidance on the methodology to be followed and implemented for undertaking WLC assessments. The guidance also includes a set of WLC benchmarks for different building types against which developments should be compared.

UK Green Building Council (UKGBC) - Net Zero Carbon Buildings: A Framework Definition[5]

In response to the UK Government legislation to achieve net zero carbon by 2050, the UKGBC has developed a Framework Definition that includes operational and embodied carbon emissions, see Figure 4.1. It is worth noting that the UKGBC approach has not set out a methodology for the appraisal of WLC, which is still being developed.

Figure 4.1 UKGBC Advancing Net Zero framework approach



London Energy Transformation Initiative (LETI) – Climate Emergency Design Guide[6]

LETI is a network of over 1,000 built environment professionals working together to put the UK on the path to a zero-carbon future. The voluntary group is made up of developers, engineers, housing associations, architects, planners, academics, sustainability professionals, contractors and facilities managers, with support and input provided by the GLA and London boroughs.

LETI has been established to support the transition of the capital's built environment to net zero carbon, providing guidance that can be applied to the rest to the UK.

The Climate Emergency Design Guide covers five key areas: operational energy, embodied carbon, the future of heat, demand response and data disclosure. The methodology includes setting the requirements of four key building archetypes (small scale residential, medium/large scale residential, commercial offices, and schools).

London Energy Transformation Initiative (LETI) – Embodied Carbon Primer[7]

The LETI Embodied Carbon Primer offers supplementary guidance to the Climate Emergency Design Guide and is intended to provide designers including architects, engineers, interior designers and urban designers with easy-to-follow best practice and toolkits for reducing embodied carbon in buildings.

London Energy Transformation Initiative (LETI) - Embodied Carbon Target Alignment[8]

This document has been produced to provide alignment in embodied carbon measurement and comparisons.

This paper summarises the following key points:

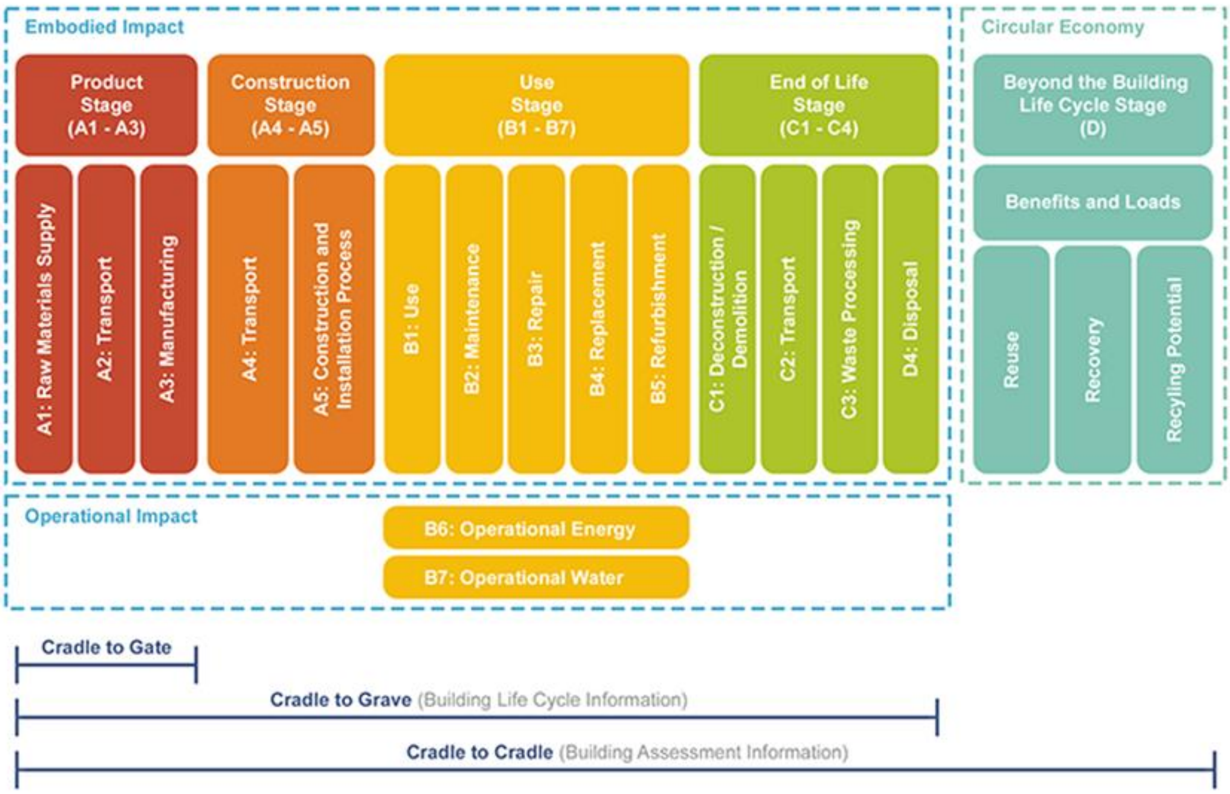
- The industry must push for embodied carbon reporting on all projects;
- A rating system should be introduced to allow quick comparison of ambition across various typologies and portfolios;
- Total embodied carbon targets have been introduced;
- Targets for retail have been developed;
- LETI and RIBA now have consistent embodied carbon targets;
- Data disclosure and breakdowns are key to ensuring reporting is valid and comparable; and
- There are two scopes that should be reported against: Upfront Carbon (modules A1-5, excluding sequestration), and total Embodied Carbon (A1-5, B1-5, C1-4, including sequestration).

5.0 METHODOLOGY

5.1 BOUNDARIES

The WLC model has included all life cycle stages detailed within the EN 15978 cradle-to-grave system boundary approach, as outlined below in Figure 5.1:

Figure 5.1 EN15978 System Boundaries



An overview of the system boundaries is described below:

Product stage

One Click LCA's extensive database of building materials was used to calculate the WLC emissions of the site because this allowed for the selection of materials that are representative of the materials itemised in the provided Cost Plan.

The Cost Plan has been used to provide an itemised list of materials and quantities, and in accordance with RICS guidance, generic environmental profiles have been allocated to materials where product details have not been specifically stated within the cost plan and specifications.

As per the RICS guidance the reference study period (RSP) is 60 years, which aligns with the operational design life of 60 years. The functional unit for the assessment is $kgCO2e/m^2$ GIA.

Demolition

RICS guidance acknowledges that *"Demolition works are often decoupled from new construction projects, hence the responsibility for any emissions arising from demolition is not necessarily solely attributable to the new build project"*.

As stated within the guidance *"New build projects assessed are considered to commence their development on a cleared, flat site for consistency purposes."* Accordingly, this is the approach taken for this assessment. However, London Plan Guidance WLCA requires pre-construction demolition to be considered. As such, the default figure of 50kgCO_{2e}/m^2 (GIA) has been applied to the full extent of the existing site, where applicable.

Construction stage

Construction activities have been assumed based on geographic location of the project and building area to calculate electricity, fuel, waste and transportation impacts of the development's construction. This is calculated using an algorithm within the One Click software.

Use stage

Operational energy demands (B6) have been based on the Energy Assessment which was produced to demonstrate compliance with GLA planning policy, based on Building Regulations Part L 2013 modelling.

It is noted that Part L modelling does not accurately represent a building's energy performance because it focuses solely on the carbon produced through the use of the building' services (heating, hot water ventilation and air conditioning) and lighting, known as regulated emissions. However, figures for any carbon emissions emitted from using appliances such as cooking and plug in appliances, known as unregulated emissions, were calculated separately.

Nevertheless, unregulated emissions depend greatly on occupant behaviour, therefore it is anticipated that the in-use emissions will change and are likely to increase once the development is in full occupation.

End-of-life stage

Emissions from deconstruction are calculated within the One Click software based on the known parameters of the building and its location, as well as details sourced from the Circular Economy Statement.

5.2 ASSESSMENT SCOPE

The assessment has been undertaken in accordance with the GLA guidance for undertaking WLC Assessments, which recommends the breakdown of building elements as set out in the RICS Professional Statement on Whole Life Cycle Carbon Assessment. As a result, the building model was broken down into the constituent element groups listed below, using schedules, plans, elevations and sections before conducting the LCA modelling.

- Demolition;
- Facilitating works;
- Substructure;
- Superstructure (frame, upper floors, roof, stairs and ramps, external walls, windows and external doors, internal walls and partitions, internal doors);
- Finishes;
- Fittings, furnishings and equipment;
- Building services;
- Prefabricated buildings and building units;
- Work to existing building; and
- External works (hard and soft landscaping, fencing, fixtures, drainage, services).

The guidelines of BS 15978:2011 and the RICS Professional Statement: Whole Life Carbon Assessment for the Built Environment have been followed in conducting the LCA and reporting the results. All EPDs used have been produced in line with the requirements of BS EN 15804:2012.

Additionally, as per the requirements, the assessment has taken place analysing the lifecycle stages described in Figure 5.1.

Operational carbon emissions have been calculated in alignment with Part L assessments undertaken for the development as part of the Energy Strategy for planning. This accounts for carbon emissions related to both regulated and unregulated energy uses (in line with Part L definitions), over the 60-year study period.

5.3 ASSESSMENT SOFTWARE

In accordance with the RICS guidance, One Click LCA has been used to model the LCA impacts of building materials for the development. One Click LCA is an online Building Life-Cycle Assessment software; it is an industry-leading platform developed by Helsinki based developer, Bionova.

Within One Click LCA materials are represented by Environmental Product Declarations (EPDs). EPDs are produced by manufacturers, which quantify the carbon emissions of a material or component.

Materials are allocated to, where possible, the exact EPD match or the closest representing material available. In allocating all building materials and elements within the building to a relevant EPD, One Click LCA calculates estimated total life-cycle carbon emissions for the development.

It should be noted that the LCA tool has a limited database of materials (albeit with regular updates). In the scenario where a specified material is not included, the most similar material in terms of its composition would be selected instead.

5.4 DATA SOURCES

The following data sources were used to construct the LCA model for the Proposed Development:

- One Click LCA material/components database;
- A project cost plan supplied by the project Quantity Surveyor was used to determine material build ups and material quantities; and
- The remaining elements' quantities and build ups were extracted from plans, elevations and sections. This allowed for an accurate representation of the building materials' environmental impact.

A more detailed list of data used per building element is included further in this report (see Table 6.1).

Where information has not been provided or is unavailable, the assumptions taken from the RICS professional statement guidance were adopted, as displayed in Appendix A.

5.5 CARBON EMISSIONS FACTORS

In line with the GLA guidance, the WLC emissions of the development have been analysed against SAP 10.0 carbon factors providing a point-in-time assessment.

The SAP 10.0 emission factors have been used for those materials manufactured within the UK aligning with the GLA's Energy Assessment Guidance. Where sourced from outside of the UK, local energy grid data has been used.

6.0 MODELLING INPUTS

This section summarises the inputs used to assess the WLC of the Proposed Development.

Operational carbon assessment

Operational carbon emissions are estimated as part of Meinhardt's Energy Strategy, submitted in support of the planning application.

The assessment of operational carbon emissions has been based on Part L of the building regulations methodology, as a sum of the regulated and unregulated carbon emissions.

Calculation of such emissions were based upon SAP calculations in line with the Part L1A methodology.

Embodied carbon and end-of-life assessment

The building elements assessed within this report align with the RICS Professional Statement: Whole Life Carbon assessment for the built environment and can be found within Table 6.1 below.

Table 6.1 Data used to assess the embodied carbon of the Proposed Development

Building element group	Building element (NRM level 2)	Basis for information
Demolition	0.1 Toxic/hazardous/ contaminated material treatment	Hazardous waste volumes were sourced from the Aberfeldy Village Phase A Cost Plan. For Phases B-D, this was extrapolated based on the maximum parameters for GIA (Sourced from the illustrative scheme accommodation schedule) from Phase A figures.
	0.2 Major demolition works	The GLA default figure of 50kgCO_{2e}/m^2 (GIA) has been applied to the full extent of the existing site, based upon the GIA of the existing structures. An allowance for site excavation was included sourced from the cost plan and used the average intensity of 1.39 kg CO_{2e}/m^3 cleared debris, as developed by OneClick LCA software.
0 Facilitating works	0.3 & 0.5 Temporary/enabling works	Temporary/enabling works has not been accounted for in the development.
	0.4 Specialist groundworks	No specialist ground works were included, where ground works have been accounted

Building element group	Building element (NRM level 2)	Basis for information
		for within the applicable substructure elements.
1 Substructure	1.1 Substructure	The specification and material quantities were sourced from the Aberfeldy Village Phase A Cost Plan. For Phases B-D, this was extrapolated based on the maximum parameters for GIA (Sourced from the illustrative scheme accommodation schedule) from Phase A figures in combination with the OneClickLCA Carbon Designer outputs.
2 Superstructure	2.1 Frame	The specification and material quantities were sourced from the Aberfeldy Village Phase A Cost Plan. For Phases B-D, this was extrapolated based on the maximum parameters for GIA (Sourced from the illustrative scheme accommodation schedule) from Phase A figures in combination with the OneClickLCA Carbon Designer outputs.
	2.2 Upper floors incl. balconies	The specification and material quantities were sourced from the Aberfeldy Village Phase A Cost Plan. For Phases B-D, this was extrapolated based on the maximum parameters for GIA (Sourced from the illustrative scheme accommodation schedule) from Phase A figures in combination with the OneClickLCA Carbon Designer outputs.
	2.3 Roof	The specification and material quantities were sourced from the Aberfeldy Village Phase A Cost Plan. For Phases B-D, this was extrapolated based on the maximum parameters for GIA (Sourced from the illustrative scheme accommodation schedule) from Phase A figures in combination with the OneClickLCA Carbon Designer outputs.

Building element group	Building element (NRM level 2)	Basis for information
	2.4 Stairs and ramps	The specification and material quantities were sourced from the Aberfeldy Village Phase A Cost Plan. For Phases B-D, this was extrapolated based on the maximum parameters for GIA (Sourced from the illustrative scheme accommodation schedule) from Phase A figures in combination with the OneClickLCA Carbon Designer outputs.
2 Superstructure	2.5 External walls	The specification and material quantities were sourced from the Aberfeldy Village Phase A Cost Plan. For Phases B-D, this was extrapolated based on the maximum parameters for GIA (Sourced from the illustrative scheme accommodation schedule) from Phase A figures in combination with the OneClickLCA Carbon Designer outputs.
	2.6 Windows and external doors	The specification and material quantities were sourced from the Aberfeldy Village Phase A Cost Plan. For Phases B-D, this was extrapolated based on the maximum parameters for GIA (Sourced from the illustrative scheme accommodation schedule) from Phase A figures in combination with the OneClickLCA Carbon Designer outputs.
2 Superstructure	2.7 Internal walls and partitions	The specification and material quantities were sourced from the Aberfeldy Village Phase A Cost Plan. For Phases B-D, this was extrapolated based on the maximum parameters for GIA (Sourced from the illustrative scheme accommodation schedule) from Phase A figures in combination with the OneClickLCA Carbon Designer outputs.

Building element group	Building element (NRM level 2)	Basis for information
	2.8 Internal doors	The specification and material quantities were sourced from the Aberfeldy Village Phase A Cost Plan. For Phases B-D, this was extrapolated based on the maximum parameters for GIA (Sourced from the illustrative scheme accommodation schedule) from Phase A figures in combination with the OneClickLCA Carbon Designer outputs.
3 Finishes	3.1 Wall finishes 3.2 Floor finishes 3.3 Ceiling finishes	The specification and material quantities were sourced from the Aberfeldy Village Phase A Cost Plan. For Phases B-D, this was extrapolated based on the maximum parameters for GIA (Sourced from the illustrative scheme accommodation schedule) from Phase A figures in combination with the OneClickLCA Carbon Designer outputs.
4 Fittings, furnishing and equipment (FF&E)	4.1 Fittings, furnishings & equipment incl. building related and non-building related	The specification and material quantities were sourced from the Aberfeldy Village Phase A Cost Plan. For Phases B-D, this was extrapolated based on the maximum parameters for GIA (Sourced from the illustrative scheme accommodation schedule) from Phase A figures in combination with the OneClickLCA Carbon Designer outputs.
5 Building services / MEP	5.1-5.14 Services incl. building-related and nonbuilding-related	The specification and material quantities were sourced from the Aberfeldy Village Phase A Cost Plan. For Phases B-D, this was extrapolated based on the maximum parameters for GIA (Sourced from the illustrative scheme accommodation schedule) from Phase A figures in combination with the OneClickLCA Carbon Designer outputs.
6 Prefabricated Buildings and Building Units	6.1 Prefabricated buildings and building units	No prefabricated elements are applicable.

Building element group	Building element (NRM level 2)	Basis for information
7 Work to Existing Building	7.1 Minor demolition and alteration works	No minor works were applicable for the new building.
8 External works	8.1 Site preparation works 8.2 Roads, paths, paving and surfacing 8.3 Soft landscaping, planting and irrigation systems 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	All external works materials and specification were sourced from the Aberfeldy Village Phase A Cost Plan. Drainage and water installations were estimated off the GIFA from the OneClickLCA input: • 0.184 kg/m^2 GIFA for sewage drainage allowance • 0.261 kg/m^2 GIFA for water supply piping network Further services such as ventilation system as well as Heating and electricity distribution system were also estimated based off the GIA from the OneClickLCA inputs.

Table 6.2 below highlights the life cycle modules utilised in assessing the building's life cycle impacts, alongside details on the source for such modules within the LCA conducted for this report.

Table 6.2 Comments on the data source used in each Life Cycle Module included in the assessment

Module	Description	Data Source
A1-A3 Construction Materials	Raw material supply (A1) includes emissions generated when raw materials are taken from nature, transported to industrial units for processing and processed. Loss of raw material and energy are also taken into account. Transport impacts (A2) include exhaust emissions resulting from the transport of all raw materials from suppliers to the manufacturer's production plant as well as impacts of production of fuels. Production impacts (A3) cover the manufacturing of the production materials and fuels used by machines, as well as handling of waste formed in the	Utilised EPDs within the One Click software which align with the products specified (where known) or the most applicable similar product. The sources list can be found in Appendix A.

Module	Description	Data Source
	production processes at the manufacturer's production plants until end-of-waste state.	
A4 Transportation to site	A4 includes exhaust emissions resulting from the transport of building products from manufacturer's production plant to building site, as well as the environmental impacts of production of the used fuel.	Transport distances were estimated based on typical average transport distances based on material type and project location, provided by One Click LCA.
A5 Construction/ installation process	A5 covers the exhaust emissions resulting from using energy during the site operations, the environmental impacts of production processes of fuel and energy and water as well as handling of waste until the end-of-waste state.	At this stage of design, the climate zone average construction impact was used and sized based upon the scale of the development, with demolition based upon the GLA default figure of 50kgCO2e/m2 (GIA).
B1-B5 Maintenance and material replacement	The environmental impacts of maintenance and material replacements (B1-B5) include environmental impacts from replacing building products after they reach the end of their service life. The emissions cover impacts from raw material supply, transportation and production of the replaced new material as well as the impacts from manufacturing the replaced material and handling of waste until the end-of-waste state.	B1 emissions relate only to the refrigerants within the services in this case. These refrigerant details were provided by the Mechanical & Electrical engineer, sourced from manufacturer datasheets of each system. The design team is yet to create a maintenance schedule for the Proposed Development due to the early stage of the design process. As such, figures for Maintenance (B2) have been estimated at 10 $kgCO_{2e}/m^2$ (GIA) Furthermore, figures for Repair (B3) have been estimated at 25% of the B2 emissions in line with the GLA guidance. Updated figures will be submitted at post completion once the schedule has been produced. Replacement (B4) and Refurbishment (B5) account for the technical service life of the building components, calculated using One Click LCA.

Module	Description	Data Source
B6 Energy use	The considered use phase energy consumption (B6) impacts include exhaust emissions from any building level energy production as well as the environmental impacts of production processes of fuel and externally produced energy. Energy transmission losses are also considered.	Energy consumption was calculated within the SAP calculations and the Energy assessment. These were input into One Click under the SAP 10.0 energy embodied carbon factor.
B7 Water use	The considered use phase water consumption (B7) impacts include the environmental impacts of production processes of fresh water and the impacts from wastewater treatment.	Water consumption was calculated based upon the BSRIA 'Rules of Thumb (5th edition) Table 22.
C1-C4 Deconstruction	The impacts of deconstruction include impacts for processing recyclable construction waste flows for recycling (C3) until the end-of-waste stage or the impacts of pre-processing and landfilling for waste streams that cannot be recycled (C4) based on type of material. Additionally, deconstruction impacts include emissions caused by waste energy recovery.	Deconstruction/demolition and Transport, waste processing and disposal are sourced from One Click LCA default values based upon GIFA.
D External impacts/end-of life benefits	External benefits for re-used or recycled material types include the positive impact of replacing virgin-based material with recycled material and the benefits of the energy which can be recovered from the materials.	End of Life (D) utilised One Click LCA's default end of life scenarios. See Appendix B for more detail.

6.2 LIMITATIONS

The WLC was completed for the planning submission using the cost plan available at the time of analysis. However, as exact products or specifications have not been finalised, generic materials were specified, and default transport distances and service life of products were used in accordance with the RICS guidance where specific information is not currently known.

This use of generic information can be reviewed and the allowances in the design of the model can be refined as the detailed design develops.

7.0 RESULTS

7.1 EMBODIED CARBON ASSESSMENT

Figure 7.1 shows the overall carbon breakdown up to practical completion, showing the contribution of the main building elements incorporating emissions from modules A1-A3 (product stage), A4 (transport) and A5 (site operations). Table 7.1 shows how this result, as well as the life cycle one (excluding B6-B7), compare against GLA benchmarks for the predominant building use (Residential).

Figure 7.1 Estimated embodied carbon of the Proposed Development, broken down by main building elements.

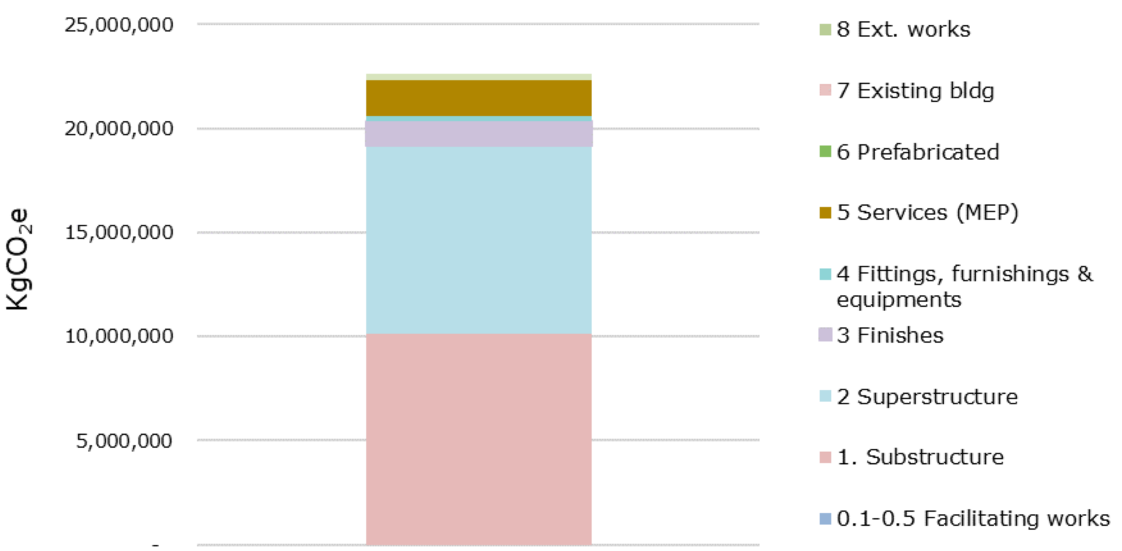


Table 7.1 Embodied carbon result in comparison with GLA's benchmarks for Residential

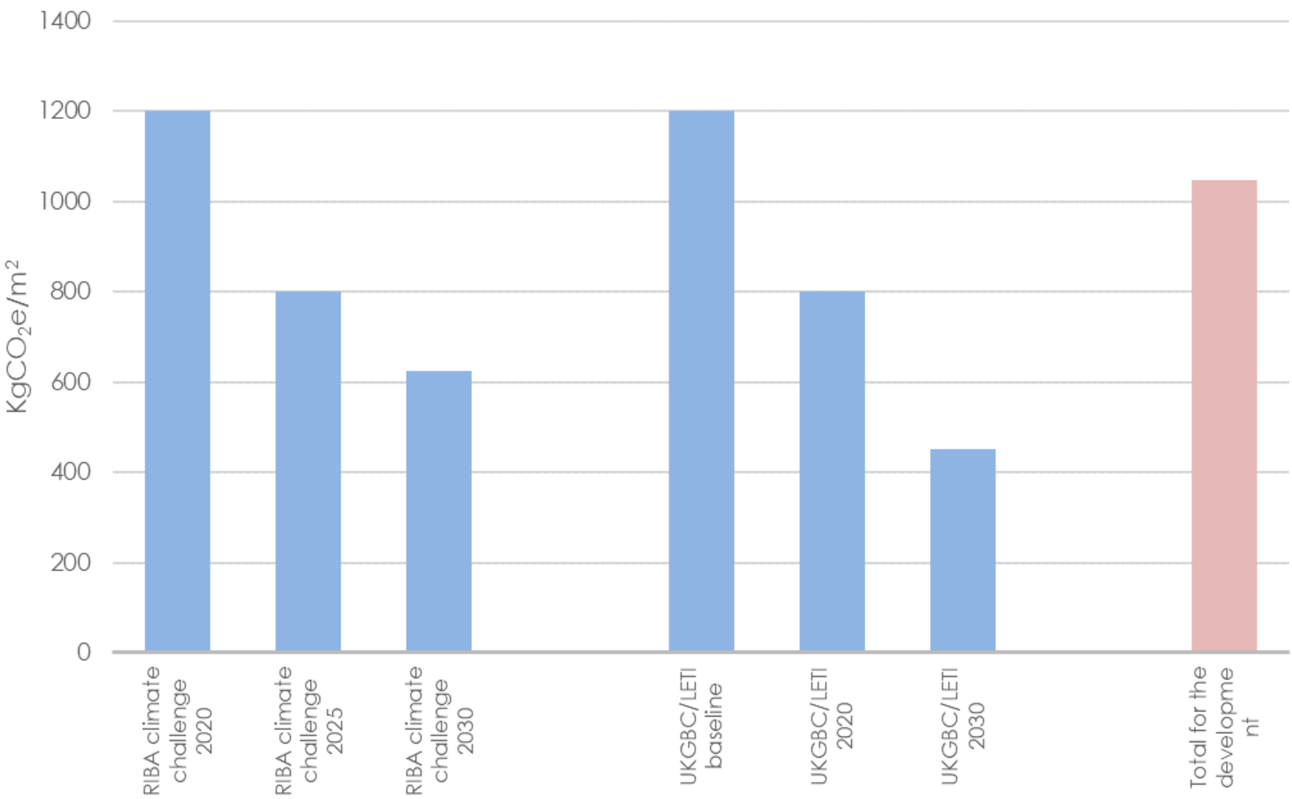
	Phase A	Phases B-D	GLA WLC Benchmark	GLA Aspirational WLC Benchmark
Modules A1-A5	798	603	850	500
	$kgCO_2e/m^2$		$kgCO_2e/m^2$	$kgCO_2e/m^2$
Modules B-C (excluding B6 & B7)	354	379	350	300
	$kgCO_2e/m^2$		$kgCO_2e/m^2$	$kgCO_2e/m^2$

Through the WLC assessment, it can be demonstrated that improvements to the existing development through implementing 60% recycled steel content within concrete reinforcements, 20% Ground Granulated Blast Furnace Slag (GGBS) within concrete mixes and a timber frame in Plot J achieve a 1,096$kgCO_{2e}/m^2$ GIA (A-C inc. sequestration (excluding B6 & B7)) carbon emission figure for Phase A. Similarly, for Phases B-D the same improvement measures (minus a timber frame) achieve a 970$kgCO_{2e}/m^2$ GIA (A-C inc. sequestration (excluding B6 & B7)) carbon emission figure. Both these carbon emission figures are currently achieving a saving over the GLA benchmark overall, with both phases below the Module A1-5 benchmark but slightly above the B-C benchmark.

Nevertheless, Figure 7.1 demonstrates that superstructure, a concrete frame, remains the highest contributor to the total emissions. Further improvements can be achieved by implementing increasing levels of GGBS within concrete mixes as well as precast concrete columns which are explored in Section 8.0.

A further benchmark comparison exercise was made to include other industry targets, such as those produced by RIBA and LETI. Results are summarised in Figure 7.2 below.

Figure 7.2 Comparison of the Proposed Development's results (A1-A5) with industry benchmarks.



7.2 OPERATIONAL CARBON ASSESSMENT

As per the GLA and RICS Whole Life Carbon guidance the operational carbon emissions have been calculated across a 60-year lifetime. The energy breakdown is provided within Table 7.2 where the estimated total operational carbon emissions including both regulated and unregulated are 9,100tCO_{2e} SAP 10.0 conditions for Phase A, whilst due to its outline stage Phases B-D have been unable to be modelled at this stage and will be confirmed later in the design process. Table 7.4 summarises the detailed results for the assessment under the SAP 10.0 energy factors.

Table 7.2 Energy consumption within the development

Phase	Area (m^2)	Regulated - Gas ($kWh/m^2/year$)	Regulated - Electricity ($kWh/m^2/year$)	Unregulated - Electricity ($kWh/m^2/year$)	$kgCO_2e$ (SAP 10.0)
Phase A	28,360	60.18	12.84	10.11	9,100,226
Phases B-D	122,858	n/a	n/a	n/a	n/a

7.3 ACTIONS TAKEN TO REDUCE WLC EMISSIONS

Energy strategy

Primarily, the energy strategy for the project is a key mechanism for reducing WLC of the development. The building utilises Combined Heat & Power (CHP) systems in conjunction with boilers and Air Source Heat Pump system (ASHP), varying across the plots. Across Phases B-D this will be provided via a new site wide heat network supplied by the heat pumps.

EON have identified a potential source of waste heat from a data centre to the south of the outline application site on the south side of the A13. Investigations are ongoing to determine the feasibility of connecting the original masterplan site heat network and the areas within this outline application to this source of waste heat in the future.

In addition to heat pumps working at greater efficiency than gas boilers, the heat pumps can take advantage of the projected decarbonisation of the national grid (previously discussed), and therefore is expected to be lower in WLC terms than traditional gas boiler servicing strategy for plots utilising heat pumps.

In order to limit the demand for hot water, the development will be provided with water-efficient fixtures and fittings.

Cooling is only proposed to be provided in those non-residential areas through split or multi-split heat pump systems.

Embodied carbon

Carbon reduction options were adopted in RIBA Stage 2/3 design. These are detailed as follows:

- Aspiration to include recycled steel content, where possible and otherwise not affected by material availability.
- Aspiration to include cement replacement, where possible and otherwise not affected by curing times associated with the construction process.

Table 7.3 below provides a summary of carbon reductions analysed for the Proposed Development.

Table 7.3 Key actions taken to reduce embodied carbon ahead of presenting the assessment results

Actions	Specification	Carbon reduction	
		$kgCO_2e$	$kgCO_2e/m^2$ GIA
Phase A			
Substructure/ Substructure- use cement replacement for concrete	Implementing 20% GGBS within all substructure and superstructure concrete mixes	567,200	20
Substructure - timber frame	Incorporating a timber frame in Plot J as opposed to a concrete frame	595,560	21
Substructure/ Substructure- increase recycled content within steel reinforcement	Increase 60% recycled content to 97% in reinforcement steel	2,836,000	100
Total savings over life cycle (A1-A5, B1-B5, C1-C4)		3,998,760	141
Phases B-D			
Substructure/ Substructure- use cement replacement for concrete	Implementing 20% GGBS within all substructure and superstructure concrete mixes	7,862,912	64
Substructure/ Substructure- increase recycled content within steel reinforcement	Increase 60% recycled content to 97% in reinforcement steel	17,200,120	140
Total savings over life cycle (A1-A5, B1-B5, C1-C4)		80,349,232	204

Re-use and recovery

The Circular Economy statement details the strategy for recovery of materials in line with the circular economy model. The benefits of recovered materials have been accounted for in this assessment, using One Click LCA benchmarks and assumptions due to uncertainty in the quantity of replacement materials. A more detailed analysis is recommended at a further stage when more accurate data is available.

7.4 PROPOSED DEVELOPMENT: ESTIMATED WLC EMISSIONS.

Table 7.4 One Click LCA output, evidencing WLC emissions for all modules, utilising SAP 10.0 Carbon factors for operational energy use for Phase A

Building element group	Sequestered (or biogenic carbon)	A1-A3 Product stage	A4 Transport to site	A5 Site operations	B1 Use phase	B2 Maintenance	B3 Repair	B4-B5 Replacement and Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / Demolition	C2 Waste transportation	C3 Waste processing	C4 Waste Disposal	D External impacts (not included in totals)	TOTAL kgCO2e
0.1-0.2 Demolition	-	-	-	-	-	-	-	-	-	-	96,426	-	-	-	-	96,426
0.3-0.5 Facilitating works	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 Substructure	-198,177	6,989,570	338,739	2,798,601	-	-	-	-	-	-	-	212,353	290,038	2,226	-1,447,598	10,433,350
2.1-2.4 Superstructure	-288,766	4,661,940	200,867	602,583	-	68,822	17,205	98,219	-	-	-	147,315	393,099	-65	-1,164,860	5,901,220
2.5-2.6 Superstructure	-442,619	1,566,089	9,899	376,169	-	79,145	19,786	679,612	-	-	-	14,302	447,988	4,678	-431,800	2,755,049
2.7-2.8 Superstructure	-346,408	1,440,718	8,454	192,402	-	17,205	4,301	1,195,286	-	-	-	32,197	349,433	64,558	-68,254	2,958,146
3 Finishes	-213,708	889,343	3,200	275,923	-	41,293	10,323	2,196,151	-	-	-	7,267	352,390	-250	-425,386	3,561,933
4 Fittings, furnishings and equipment (FF&E)	-	204,829	441	20,090	-	3,441	860	424,575	-	-	-	1,147	11,088	475	-14,201	666,946
5 Building Services (MEP)	-	1,400,103	2,386	311,434	2,307	68,822	17,205	2,499,900	9,100,226	3,524	-	6,092	12,749	1,563	-1,727,240	13,426,312
6 Prefabricated buildings and building units	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 Work to existing building	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8 External works	-97,941	283,188	13,975	33,416	-	6,882	1,721	30,600	-	-	-	6,205	105,695	5,520	-56,205	389,261
TOTAL $kgCO_2e$	-1,587,619	17,435,779	577,962	4,610,617	2,307	285,611	71,403	7,124,344	9,100,226	3,524	96,426	426,877	1,962,480	78,705	-5,335,544	40,188,642
TOTAL $kgCO_2e/m^2$	-55.98	614.80	20.38	162.57	0.08	10.07	2.52	251.21	320.88	0.12	3.40	15.05	69.20	2.78	-188.14	1,417.09

Figure 7.3 WLC emissions broken down into modules for Phase A

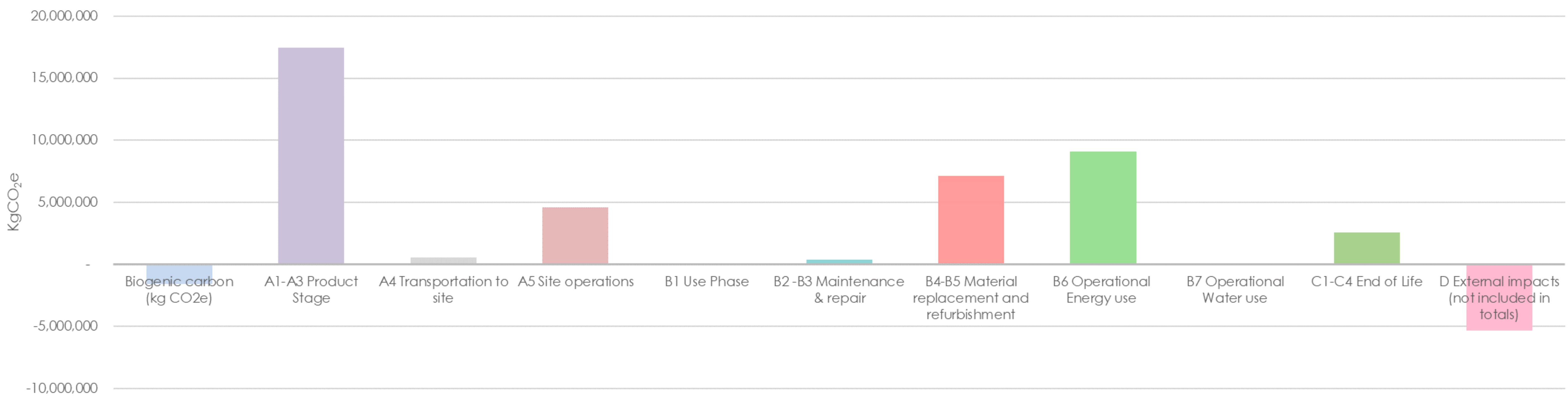


Figure 7.4 WLC emissions broken down into elements (Excludes B6 and B7) for Phase A

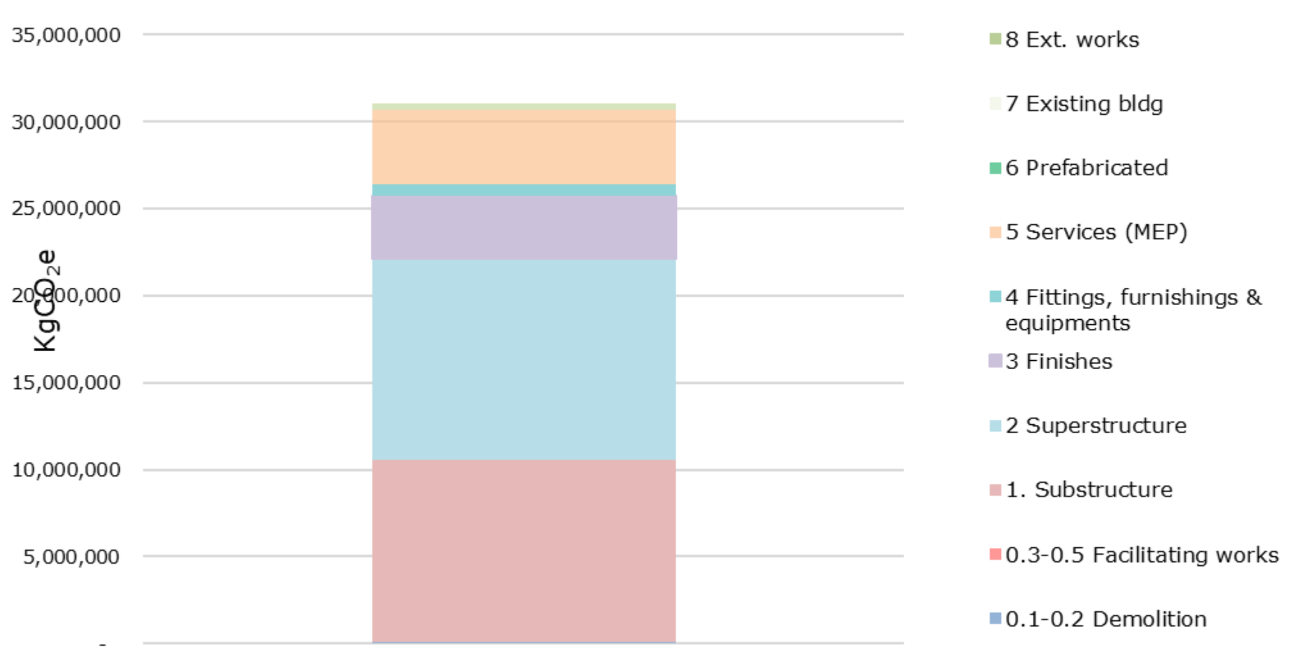


Figure 7.5 WLC emissions broken down into elements (%) (Excludes B6 and B7) for Phase A

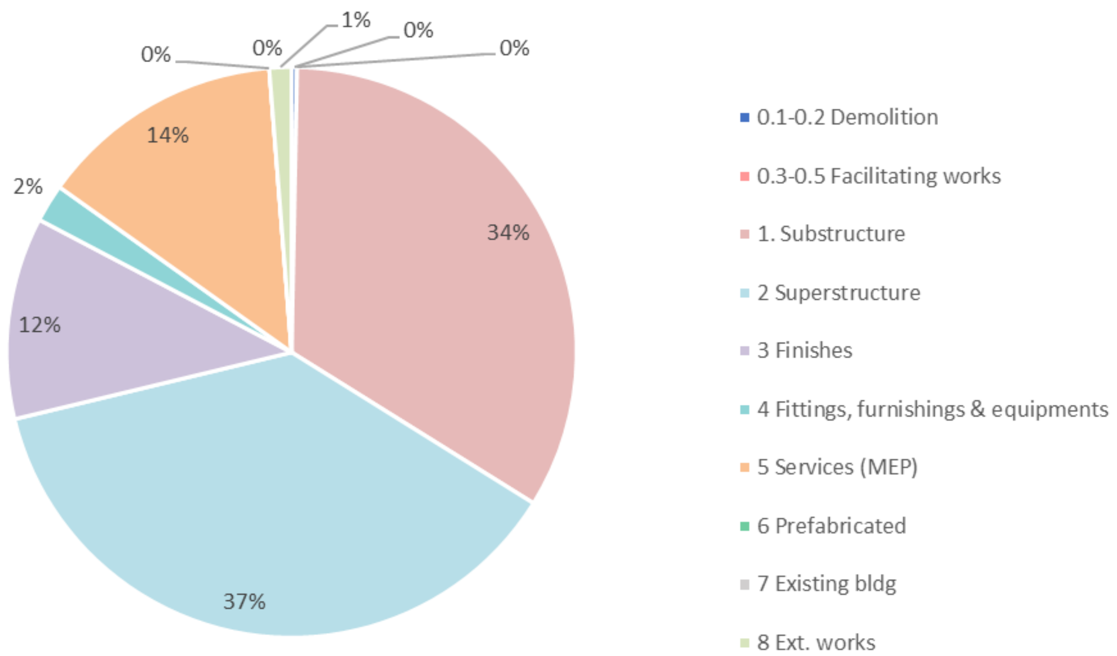


Table 7.5 One Click LCA output, evidencing WLC emissions for all modules, utilising SAP 10.0 Carbon factors for operational energy use for Phases B-D

Building element group	Sequestered (or biogenic carbon)	A1-A3 Product stage	A4 Transport to site	A5 Site operations	B1 Use phase	B2 Maintenance	B3 Repair	B4-B5 Replacement and Refurbishment	B6 Operational energy use	B7 Operational water use	C1 Deconstruction / Demolition	C2 Waste transportation	C3 Waste processing	C4 Waste Disposal	D External impacts (not included in totals)	TOTAL kgCO2e
0.1-0.2 Demolition	-	-	-	-	-	-	-	-	-	-	314,008	-	-	-	-	314,008
0.3-0.5 Facilitating works	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1 Substructure	-19,273	18,490,445	931,024	14,763,200	-	-	-	-	-	-	-	555,122	85,723	26	-16,625,059	34,806,267
2.1-2.4 Superstructure	-45,953	16,674,257	769,980	773,133	-	-	-	41,609	-	-	-	578,908	138,527	143	-20,772,432	18,930,606
2.5-2.6 Superstructure	-	7,482,099	35,773	351,580	-	-	1,332,637	2,593,538	-	-	-	45,468	14,930	50,050	-1,229,478	11,906,075
2.7-2.8 Superstructure	-661,140	4,299,646	20,860	473,752	-	-	-	4,069,753	-	-	-	37,581	1,074,923	22,292	-1,639,306	9,337,667
3 Finishes	-743,814	1,641,751	7,835	185,540	-	-	22,690	5,354,400	-	-	-	24,114	1,343,738	1,721	-1,684,299	7,837,977
4 Fittings, furnishings and equipment (FF&E)	-	603,619	1,896	16,533	-	-	-	1,213,061	-	-	-	6,903	23,553	1,716	-64,663	1,867,280
5 Building Services (MEP)	-	6,175,018	19,130	99,575	1,606,925	-	18,208,320	7,516,516	-	12,742	-	38,427	52,081	4,418	-9,846,110	33,733,152
6 Prefabricated buildings and building units	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7 Work to existing building	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8 External works	-	273,530	16,802	4,985	-	-	-	127,596	-	-	-	5,038	623	50,344	-92,706	478,919
TOTAL $kgCO_2e$	-1,470,180	55,640,364	1,803,300	16,668,299	1,606,925	-	19,563,647	20,916,473	-	12,742	314,008	1,291,562	2,734,099	130,711	-51,954,053	119,211,951
TOTAL $kgCO_2e/m^2$	-11.96649494	452.8835252	14.67792435	135.6712523	13.079531	0	159.2378759	170.2491758	0	0.103715346	2.555863117	10.51263675	22.25413936	1.063919717	-422.8788775	970.323064

Figure 7.6 WLC emissions broken down into modules for Phases B-D

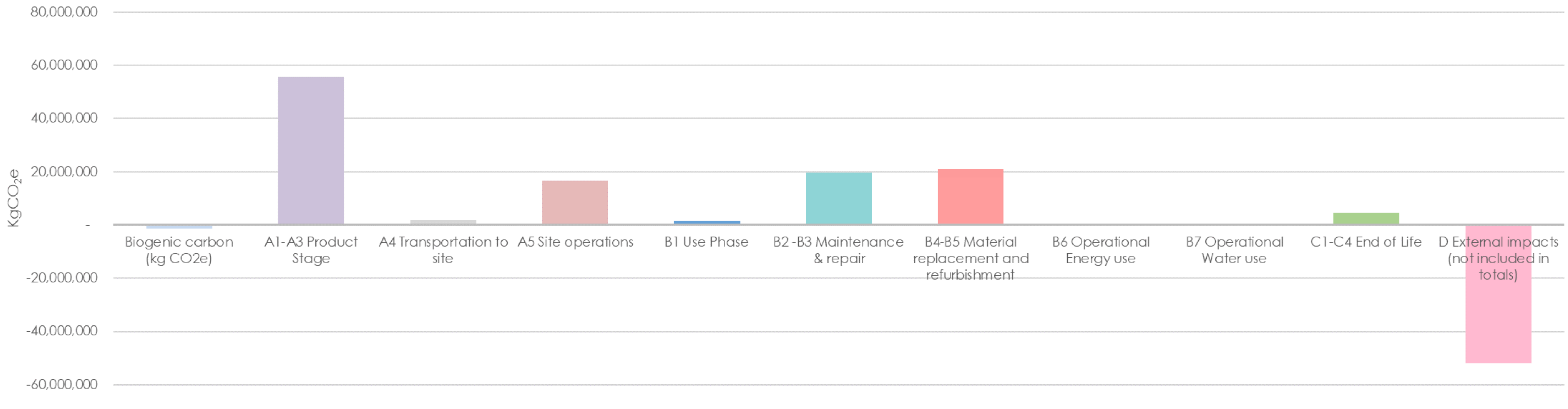


Figure 7.7 WLC emissions broken down into elements (Excludes B6 and B7) for Phases B-D

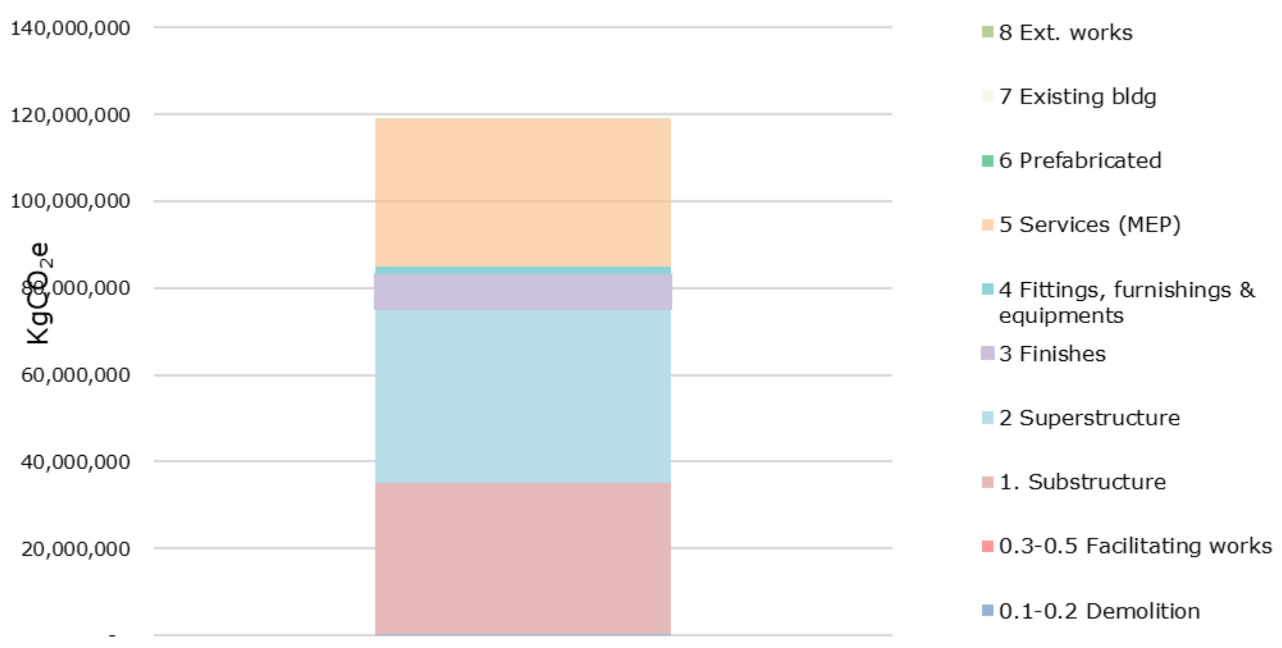
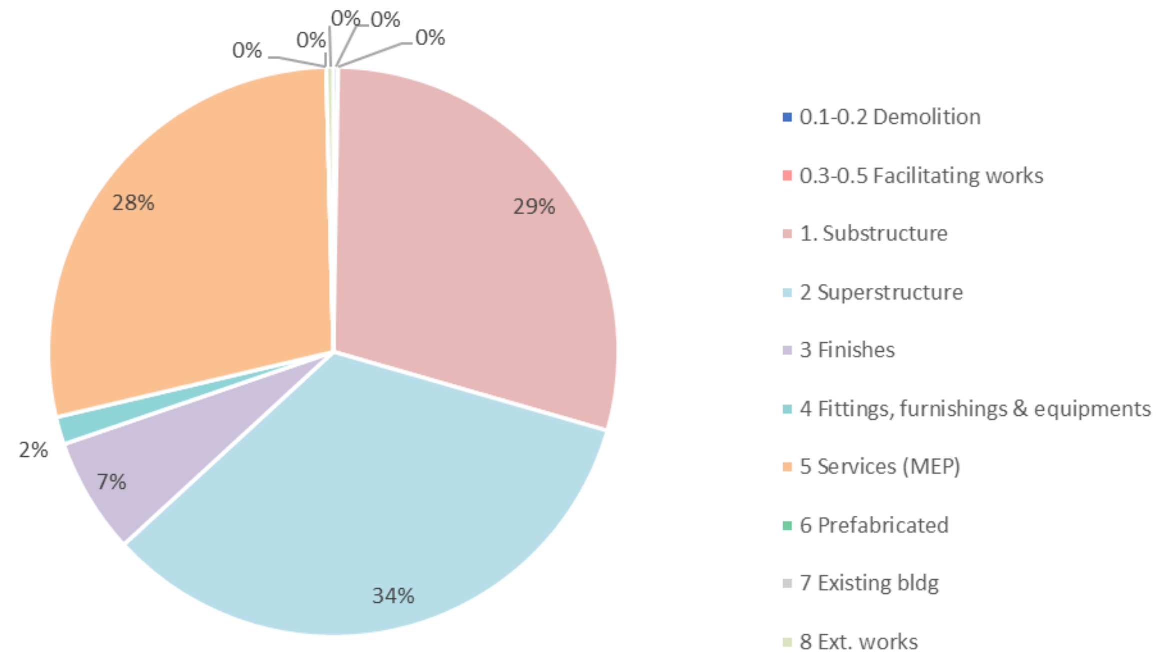


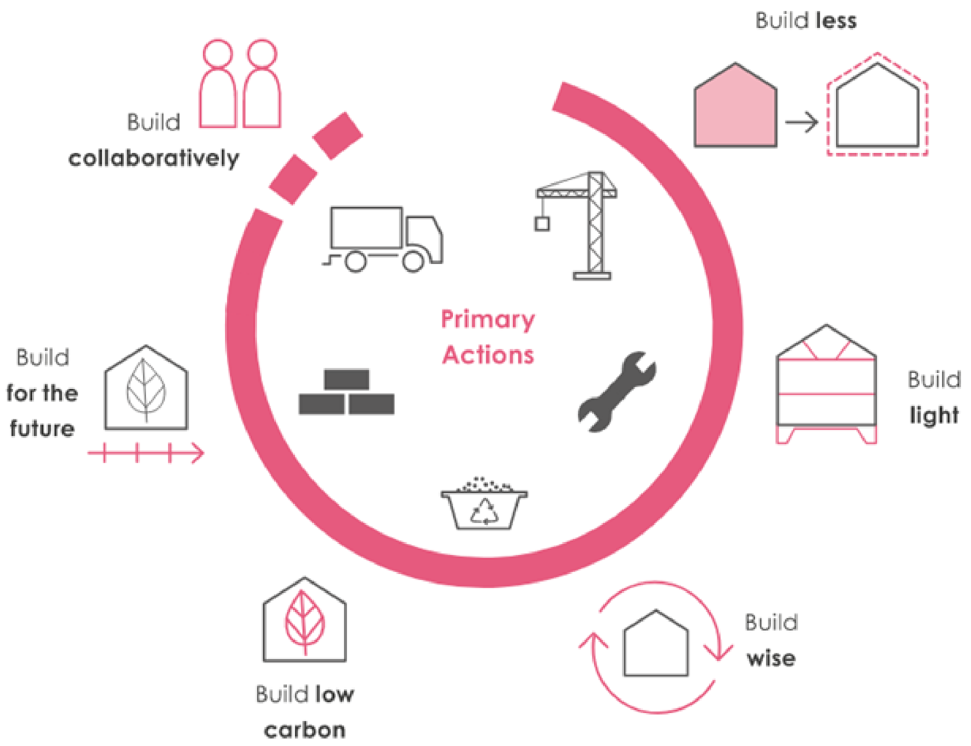
Figure 7.8 WLC emissions broken down into elements (%) (Excludes B6 and B7) for Phases B-D



8.0 OPPORTUNITIES FOR REDUCING WLC

Greengage produced a summary of observations compiled through the review of the design information provided and the completion of the WLC assessment. In developing these observations, best practice guidance within the LETI Embodied Carbon Primer has been followed, see Figure 8.1 below.

Figure 8.1 Embodied Carbon reduction actions from LETI embodied carbon primer



It should be noted that these carbon reduction material suggestions have been considered in reference to carbon embodiment only, and other influencing factors, such as fire safety, cost implications and viability must be taken into account and assessed by suitably qualified team members before adoption in the design.

In general, for the specification of materials for the development, it is encouraged to choose suppliers with established procedures for selection of Environmental Product Declarations (EPDs) and make a clear specification of products and manufacturers during the following stages.

8.1 BRICKS

In respect to brick the following observations are made:

- Local reclaimed brick should be sourced wherever possible;

- Consider blockwork with high recycled content. An unfired brick system with much lower embodied carbon may be suitable for internal non-load bearing walls, such as Kenoteq (which can be load bearing as well), which makes bricks from 90% recycled content;
- Consideration should be given for the use a mortar which is softer than the brick. Hard concrete mortars cannot be removed easily from brickwork, resulting in damaged and broken bricks. Whereas soft mortars (lime) are easier to remove and the brick can therefore be reused;
- Reuse damaged bricks within aggregates; and
- Consideration should be given for a mortar mix that is low in embodied carbon but strong enough for the purpose, whilst allowing the brick to be easily reclaimed.

8.2 CONCRETE

In respect to concrete the following observations are made:

- Using concrete as a finish can reduce the need for other materials. In addition, exposed areas of concrete can optimise the thermal mass performance. Thermal mass, with adequate ventilation, can be used to control daytime peak temperatures of a space and therefore reduce or minimise the need for air-conditioning. The areas where this can be done would need to be carefully considered. The durability of concrete also offers further savings through a reduction in the need for maintenance and repair (compared to a painted finish for example);
- The concrete's environmental impact can be further reduced by increasing the percentage of ground granulated blast furnace slag (GGBS) or pulverised fuel ash (PFA);
- Construction and demolition (C&D) waste and waste glass can be recycled within aggregates to reduce the use of virgin materials and reduce the amount of reusable materials sent to landfill;
- A significant reduction in embodied carbon could be achieved by using voided biaxial slabs, or slimming off the excess. For example, reducing a floor slab from 200mm to 190mm;
- Adopting standardised detailing would enable formwork to be re-used multiple times and would allow for repetition of reinforcement;
- Design for Manufacture and Assembly (DfMA). For example, pre-cast hollow core planks can be used elsewhere at the end-of-life if the screed is broken, allowing future change of use;
- Design for future flexibility, for example by over designing such as considering a structural grid that would support a variety of uses would enable the buildings to be adapted for future uses, reducing the need for complete demolition; and
- Another consideration factor is the transportation of concrete. If in-situ concrete could be sourced from a nearby concrete plant (i.e. 10-25 km away), this could further reduce the carbon impact of the concrete.

8.3 GLASS AND FACADES

In respect to glass the following observations are made:

- In accordance with the Overheating Assessment, the solar gain performance of the glazing should be considered under a climate change scenario to ensure a balance between the retention of heat and the ability to provide a thermally comfortable environment during the lifespan of the buildings;
- Typically, timber framing is the best option in respect to embodied carbon. It has a longer life span than polyvinyl chloride (PVC) and a better thermal performance than steel or aluminium. Aluminium cladding of timber frames can reduce maintenance and increase the expected life span of the product. However, consideration should be given to the ease of maintenance, weight and durability;
- The adoption of standard sizes for the glazing can support the re-use of the product at the end-of-life stage;
- Options should be considered for the use of aluminium with higher recycled content to reduce the use of virgin materials and the associated embodied carbon emissions. Polyester Powder Coating (PPC) aluminium should also be sought in lieu of Anodised Aluminium due to the reduced embodied carbon content;
- The curtain walling and windows are carbon intensive material and require high levels of maintenance. Considering timber framed or combi curtain walling and windows will reduce their impact; and
- Select low carbon panel product, such as Rockpanel or Steico, for insulation to reduce the carbon impact of the façade further.

8.4 STEEL

In respect to steel the following observations are made:

- Always consider the recycled content of steel elements withing the specification;
- Internal partitioning contributes a significant proportion of the embodied carbon emissions, which can be attributed to the metal framing system. The replacement of this system with a timber stud system or concrete blocks with high recycled content can significantly reduce carbon emissions;
- Procure steel that is manufactured from an electric arc furnace rather than a blast furnace and incorporate recycled materials; and
- Steel products should be specified with an EPD as there are plenty available and this can significantly reduce the environmental impact.

8.5 TRANSPORTATION AND PROCUREMENT

The following observations are made:

- The RICS recommended transport distances have been adopted. Consideration should be given to the use of locally sourced material suppliers and material products with a certified Environmental Product Declaration (EPD); and
- Recycled aggregates should only be considered within the design when they are locally available, otherwise transportation impacts exceed the intended benefits. The use of recycled aggregates within a project also enables credits to be awarded under BREEAM.

8.6 FURTHER CONSIDERATIONS

The façade and roof are under constant wear from the environment, can lead to frequent repairs and maintenance. By using durable materials, this not only reduces the cost and frequency of refurbishment but also reduces the use of material replacement and its associated carbon footprint.

Improvement could be expected in ceilings and raised floors by specifying reused and recycled materials:

- Considering reclaimed raised access floor;
- Considering raised access floor made from Calcium Sulphate or other recycled materials;
- Considering metal ceiling units with high recycled steel content, rather than aluminium; or
- Opting for exposed services and a higher ceiling height in lieu of installing a suspended ceiling altogether.

Trialling the use of innovative low carbon materials, such as cement-free concrete, on noncritical areas, such as temporary works before attempting to use them more widely on permanent works.

Consideration of offsite fabrication, modularisation and standard sizes to reduce building complexity and embodied energy use in production.

Limitations and exclusions are present in some elements within the analysis, in particular building services, fixtures and fittings, unregulated energy demand and decarbonisation. Therefore, the embodied carbon emissions and proposed observations may change if the WLC model was to be modelled with more detailed information.

Furthermore, a clearer understanding on the quantities, material types and product suppliers will also influence the embodied carbon emission performance and observations made, especially in suppliers with an EPD are chosen. This is typical and expected within WLC assessments as the assessment is considered to be an ongoing and iterative process, refined and enhanced as project information becomes available through the development process.

In respect to building services, the following observations could be considered if they become included within the LCA model:

- Optimise the provision of building services and size by adopting load reduction measures, carrying out detailed load assessments, and carefully considering the requirements for flexibility and back-up. Alongside the completion of operational energy modelling; and

- In accordance with the proposed energy strategy specify equipment that has:
  - Low refrigerant GWP and leakage;
  - High thermal efficiency;
  - Long lifetime;
  - Light weight;
  - Materials with low embodied carbon;
  - Materials that can be demounted, disassembled and reused; and
  - Products with EPDs.

Table 8.1 below provides a summary of carbon reductions analysed for the Proposed Development to be considered in the following stages.

Table 8.1 Embodied carbon reduction options to be considered at further stages

Actions	**Specification**	**Carbon reduction**	
		$kgCO_{2e}$	$kgCO_{2e}/m^2$ GIA
Phase A			
Substructure - include cement replacement	Implement 35% GGBS in Substructure concrete mixes	822,440	29
Substructure- include cement replacement	Implement 50% GGBS in superstructure slabs and columns concrete mixes	1,106,040	39
Substructure- - include precast elements and cement replacement	Implement precast concrete columns with 40% GGBS	56,720	2
Total savings over life cycle (A1-A5, B1-B5, C1-C4)		1,985,200	70
Phases B-D			
Substructure - include cement replacement	Implement 35% GGBS in Substructure concrete mixes	3,562,882	29
Substructure- include cement replacement	Implement 50% GGBS in superstructure slabs and columns concrete mixes	5,528,610	45
Substructure- - include precast elements and cement replacement	Implement precast concrete columns with 40% GGBS	245,716	2
Total savings over life cycle (A1-A5, B1-B5, C1-C4)		9,337,208	76

9.0 CONCLUSIONS

This assessment completed at RIBA Stage 2/3, informs the Applicant, the design team and the GLA on the benchmark WLC performance for the Proposed Development. The report has summarised the WLC assessment undertaken for the hybrid planning application at Aberfeldy Village, London Brough of Tower Hamlets, in line with the GLA guidance and RICS Professional Statement on Whole Life Cycle Carbon Assessment.

This report is to be read in conjunction with the GLA Whole Life Carbon Assessment Template' issued in Microsoft Excel Format, as part of the planning submission for the development.

Reduction measures through incorporating 97% recycled content within concrete mixes, timber frame for Plot J (Phase A) and incorporating cement replacement in concrete mixes aids in achieving the WLC benchmark, with a figure of 1,096kgCO_{2e}/m^2 and 970kgCO_{2e}/m^2 for Phase A and Phases B-D respectively, compared to the 1,200 kgCO_{2e}/m^2 benchmark.

Further improvement to WLC could be achieved through increasing the levels of cement replacement in concrete mixes and precast elements.

In addition, there remains considerable opportunity to enhance the WLC assessment and improve its accuracy, as the design develops.

The most intensive carbon emitters have been identified to highlight the products that have the most significant contribution to the overall emissions. Suggestions have also been provided to reduce the carbon intensity of these products.

To effectively address WLC throughout the continuation of the design process, it will be important to implement the following next steps:

- It is recommended that the design team adopt a strategy for reducing the carbon emissions over this WLC model baseline through the technical design phase (RIBA Stage 4) with the intention of producing future models as the design and construction develops to confirm a reduction in 'as-designed' and 'as-constructed' WLC emissions over the baseline;
- Products and manufacturers with EPDs should be specified during RIBA Stage 4 and the material's carbon footprint data considered during procurement;
- The proportion of Portland Cement replacement in concrete products should be at least 35% to represent the results in this report. Increased quantities should be explored following an assessment of the suitability of the product for the application considered; and
- Publicly disclose and report to the RICS embodied carbon database.

Table 9.1 below summarises actions that should be undertaken as the scheme achieves planning approval and moves into the detailed design stages.

Table 9.1 WLC actions to undertake after planning approval

Action	Time	Effect on WLC
Update the WLCA model with further project information relating to building services, finishes and FF&E.	Early RIBA Stage 4	WLC will increase
Review design options to assess impact on WLC, with a view to developing a strategy to deliver an improvement over the baseline embodied carbon emissions.	Mid RIBA Stage 4	WLC could decrease
Undertake final 'as-designed' WLCA to represent final design.	End of RIBA Stage 4	Neutral change in WLC or possible decrease
Undertake 'as-constructed' LCA to represent final as-built development.	End of RIBA Stage 5	Neutral change in WLC or possible decrease

- END -

APPENDIX A ASSUMPTIONS FROM RICS PROFESSIONAL GUIDANCE

	Material	Details	Specification
1.	Concrete	Piling	C32/40 20% cement replacement [1]
		Substructure	C32/40 20% cement replacement [1]
		Superstructure	C32/40 20% cement replacement [1]
		Generic concrete	C16/20 0% cement replacement [1]
2.	Steel	Reinforcement bars	97% Recycled Content [2]
		Structural steel sections	20% Recycled Content [3]
		Studwork/Support frames	Galvanised steel, 15% Recycled Content [4]
3.	Blockwork	Precast concrete blocks	Lightweight blocks for building envelope
			Dense blocks for other uses
4.	Timber	Manufactured structural timber CLT, Glulam, etc.	100% FSC/PEFC [5]
		Formwork	Plywood
		Studwork/Framing/Flooring	Softwood
5.	Aluminium	Cladding panels	Aluminium sheet, 35% Recycled Content [6]
		Glazing frames	Aluminium extrusions, 35% Recycled Content [6]
6.	Plasterboard	Partitioning/Ceilings	Min. 60% Recycled Content [7]
7.	Insulation	To floors, roofs & external walls	PIR

Material specification assumption for 'baseline building' as per RICS Professional Statement.

Transport scenario	km by road*	km by sea**
Locally manufactured e.g. concrete, aggregate, earth	50 [1]	-
Nationally manufactured e.g. plasterboard, blockwork, insulation	300 [1]	-
European manufactured e.g. CLT, façade modules, carpet	1,500 [2]	-
Globally manufactured e.g. specialist stone cladding	200 [3]	10,000 [3]

Material transport assumption for 'baseline building' as per RICS Professional Statement.

Building part	Building elements/components	Expected lifespan
Roof	Roof coverings	30 years
Superstructure	Internal partitioning and dry lining	30 years
Finishes	Wall finishes: Render/Paint	30/10 years respectively
	Floor finishes Raised Access Floor (RAF)/Finish layers	30/10 years respectively
	Ceiling finishes Substrate/Paint	20/10 years respectively
FF&E	Loose furniture and fittings	10 years
Services/MEP	Heat source, e.g. boilers, calorifiers	20 years
	Space heating and air treatment	20 years
	Ductwork	20 years
	Electrical installations	30 years
	Lighting fittings	15 years
	Communications installations and controls	15 years
	Water and disposal installations	25 years
	Sanitaryware	20 years
	Lift and conveyor installations	20 years
Facade	Opaque modular cladding e.g. rain screens, timber panels	30 years
	Glazed cladding/Curtain walling	35 years
	Windows and external doors	30 years

Material life span assumption for 'baseline building' as per RICS Professional Statement.