Ham Close Regeneration

Planning Application:

Whole Life Cycle Carbon Assessment

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Hill
Created for Living

rhp

LONDON BOROUGH OF RICHMOND UPON THAMES

Whole Life Cycle Carbon Assessment

Ham Close WLC

On behalf of Hill Residential

R06

Date: 16th September 2022

REVISION HISTORY

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CONTENTS

1. Executive Summary

This Whole Life Cycle Carbon Assessment (WLC) has been completed by Energist UK on behalf of Hill Residential ('the applicant'). It supports a full planning application for the redevelopment of Ham Close, Ham, Richmond Upon Thames, TW10 7PG. The proposed development comprises demolition of existing buildings on-site and phased mixed-use development comprising 452 residential homes (Class C3) up to six storeys; a Community/Leisure Facility (Class F2) of up to 3 storeys in height, a "Maker Labs" (sui generis) of up to 2 storeys together with basement car parking and site-wide landscaping.

This report sets out the carbon impact of the proposed and demonstrates the actions taken by the Design Team to reduce embodied carbon and explores future opportunities to reduce this further. At the Planning Stage, the report is based on the best available concept design information that the Design Team could provide. An 'As Built' WLC assessment will be completed at the Post Construction Stage based on actual project data.

This WLC Assessment has been completed in compliance with:

i) The London Plan (March 2022), Policy SI2 Minimising Greenhouse Gas Emissions.
ii) RICS Professional Statement. Whole Life Carbon Assessments for the Built Environment 2017.
iii) BS EN15978:2011- Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method.

The London Plan 2021, Policy SI2 states: 'Development proposals referable to the Mayor, should calculate whole life cycle carbon emissions through a nationally recognised Whole Life Cycle Carbon Assessment and demonstrate actions taken to reduce life cycle carbon emissions.

The Pre-planning workshops were carried out on the 22nd September and 11th November 2021 to determine the WLC principles applicable for the scheme. The high-level aspirations were discussed and potential improvements that could be implemented were reviewed.

The outcomes of the workshop are included within the Pre-Application tab of the March 2022 GLA WLC assessment template which accompanies this report.

All proposed buildings within this mixed-use redevelopment have been modelled in line with the March 2022 GLA Whole Life-Cycle Carbon Assessments guidance. The WLCA of the proposed design has been created using the best available Concept Design data and the estimated total carbon emissions are summarised here in Table 1.1 and table 1.2. The most significant use type for the development by area is residential therefore the closest GLA benchmark is Residential, so this has been used for comparison.

	WLCA Benchmark for Residential	Kg CO_2e/m^2 GIA over 60 years
Materials Embodied Carbon Module A1-A5 (excluding sequestration)	<850	708.25
In Use and End of life Module B-C (Excluding B6&B7)	<350	785.39
A-C (excluding B6 & B7, including sequestration)	<1200	881.81

Table 1.1 - Comparison with WLCA Benchmark

	Aspirational WLCA Benchmark for Residential	Kg CO_2e/m^2 GIA over 60 years
Materials Embodied Carbon Module A1-A5	<500	708.25
In Use and End of life Module B-C (Excluding B6&B7)	<300	785.39
A-C (excluding B6 & B7, including sequestration)	<800	881.81

Table 1.2 Comparison with Aspirational WLCA Benchmark

The design team has incorporated sustainable measures into the pre-planning concept design where feasible. The results in Table 1 show that the WLC emissions for the proposed design are within GLA WLCA benchmark for Residential A1-A5 (excluding sequestration), B–C (excluding B6&B7) and A-C (excluding B6 & B7, including sequestration), set out in Appendix 2 of the March 22 guidance. However, it should be noted that these benchmarks are for Residential, whereas the model includes the embodied carbon for proposed non-domestic, which has significantly higher B1-B5 emissions.

The results in table 1 confirm that the proposed design can be considered a sustainable design. However, the results in table 2 show that the WLC emissions for the proposed design are not within the GLA Aspirational WLCA benchmark. Therefore, Guidance has been given to the Design Team in order to reduce the carbon emissions further as they enter Developed Design.

2. Introduction

2.1 Development Overview

This WLC Assessment has been prepared for the proposed development comprising demolition of existing buildings on-site and phased mixed-use development comprising 452 residential homes (Class C3) up to six storeys; a Community/Leisure Facility (Class F2) of up to 3 storeys in height, a “Maker Labs” (sui generis) of up to 2 storeys together with basement car parking and site-wide landscaping, as illustrated in Figure 2.1.

The report details the approach taken by the Applicant and Design Team to address the Whole Life Cycle Carbon principles and to incorporate these within the development design to reduce the overall WLC carbon emissions.

Figure 2.1 - Proposed Master Plan (Source BPTW DAS)

2.2 Policy Requirements

The GLA London Plan 2021 Policy SI2 Minimising Greenhouse Gas Emissions states:

'Development proposals referable to the Mayor should calculate whole life cycle carbon emissions through a nationally recognised Whole Life Cycle Carbon Assessment and demonstrate actions taken to reduce life cycle carbon emissions.'

'Operational carbon emissions will make up a declining proportions of a development's whole life cycle carbon emissions as operational carbon targets become more stringent. To fully capture a development's carbon impact, a whole life cycle approach is needed to capture its unregulated emissions (i.e. those associated with cooking and small appliances), its embodied emissions (i.e. those associated with raw material extraction, manufacturer and transport of building materials and construction) and emissions associated with maintenance, repair and replacement as well as dismantling, demolition and eventual material disposal). Whole life cycle carbon emission assessments are therefore required for development proposals referrable to the Mayor. Major non-referable development should calculate unregulated emissions and are encouraged to undertake whole life cycle carbon assessments.'

This policy sets out the requirement for WLC Carbon Assessments in referable schemes and recommends them for non-referable schemes. The guidance document for completing a WLC Assessment was first published in October 2020 and updated in March 2022. This includes requirements for assessment at the pre-application stage, planning application stage and post-construction stage.

Additional guidance documents are also referred to in the policy and these are to be used to inform WLC Assessments, these are:

i) RICS Professional Statement. Whole Life Carbon Assessments for the Built Environment 2017.
ii) BS EN15978:2011- Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method.
iii) Operational carbon emissions for non-residential uses should be reported using CIBSE TM54.

2.3 Life Cycle Modules

The GLA guidance refers to the RICS Professional Statement and BS EN15978 which note that WLC assessments should be undertaken against the four stages of the typical building life cycle listed below.

- Module A1-A5- Product sourcing and construction stages
- Module B1-B7- Use stages
- Module C1-C4- End of life stages
- Module D- Benefits and loads beyond the system boundary

These are split down into their constituent parts in Table 2 below

Product sourcing and construction stages	A1- Raw material extraction and supply
	A2- Transport to manufacturing plant
	A3- Manufacturing and fabrication
	A4- Transport to project site
	A5- Construction and installation process
Use stages	B1- Use
	B2- Maintenance
	B3- Repair
	B4- Replacement
	B5- Refurbishment
End of life	C1- Deconstruction demolition
	C2- Transport to disposal facility
	C3- Waste processing for reuse, recovery or recycling
	C4- Disposal
Benefits and loads beyond the system boundary	Reuse, recovery, recycling potential

Table 2.1 - Life cycle Modules

2.4 Methods

This WLC Assessment has been carried out using the RICS nationally recognised assessment methodology. The report demonstrates the actions taken to reduce WLC carbon emissions and recommendations. The assessment covers the development's carbon emissions across all life cycle modules over its lifetime. This accounts for:

- Operational carbon emissions (regulated and unregulated).
- Embodied carbon emissions.
- Any future potential carbon emissions benefits post end of life including benefits from reuse and recycling of building structures and materials.

As the most significant use type for the development by area is residential the GLA benchmark for Residential has been used for comparison.

2.4.1 Operational

The calculated operational carbon emissions from energy and water consumption are calculated separately using the Standard Assessment Procedure (SAP 10) methodology for residential buildings and TM54 methodology for commercial buildings. SAP10 emission factors are considered to represent current grid emissions, and these have been used in line with GLA requirements.

Energist UK has undertaken sample SAP calculations for representative dwellings. These encompass the different dwelling types for the proposed development and are a fair expectation of the likely unit mix of the proposals.

2.4.2 Embodied Carbon

Energist UK has used One-Click life cycle software to model each proposed building based on estimated bills of quantities provided by the design team. One-Click is an approved software tool recognised by the GLA and is a dedicated Life Cycle Assessment (LCA) tool containing generic and average life cycle indicators representative of the typical UK supply chain. The tool allows the embodied impacts for all the specified materials to be modelled using One Click's dedicated database which is integrated into the software.

All building elements have been included in the study in line with Table 6 of the RICS Professional Statement 2017. At this initial planning stage, exact data and specific material suppliers are not known in most instances. Therefore, the WLC Assessment is based on project estimates and default figures within the One-Click template library to give as accurate a baseline as possible. As a result, high-level observations are given for reductions in embodied emissions.

2.5 Key Assumptions,

The materials information and quantity has been provided by the Design team, in the form of materials schedules and email information. The general base build is ready-mix reinforced piled foundations, concrete slabs and frame; flat concrete slab and insulated inverted roof. External walls are external leaf brickwork with insulated metal stud. Internal walls are insulated metal stud with plasterboard.

Building services comprise of centralised air source heat pumps serving all dwellings.

Table 3 below sets out the key assumptions used within the study to determine the Whole Life Cycle Carbon of the proposed development.

Environmental Indicator	Embodied Carbon CO_{2eq}
Study Period	60 years in line with GLA Guidance
Functional Units	Kg CO_{2eq} per m^2 GIA in line with GLA Guidance
Assessment Scope	All materials used within the proposed development's red line boundary in line with RICS PS
Material Specification	All materials information included within the study is taken from materials schedules and email information from The Design Team. Recycled content in materials has been included in line with RICS PS Table 6. For example, cement replacement has been used for piling, substructure and superstructure. Steel reinforcement bar recycled content of 97% and 20% for steel sections

	has been used.
Modules B2 – B3 emissions	Emissions for modules B2 -B3 were calculated in line with paragraph 2.5.12 of the WLCA March 22 guidance.
Default Values	Where product-specific data is not available, default values from the One-Click database were used unless specified.
Material Lifespans and Transport Distances	One-Click default material lifespans and transport distances are in line with RICS PS Table 7 and have been used unless specifically stated.
Operational Energy and Water Modelling	The estimated annual energy consumption has been taken from the Planning Stage sample SAP and TM54 modelling and multiplied for a 60-year building life.
Construction site	One-Click default construction site impacts were used which are in line with RICS PS methodology.

Table 2.2 - Key Assumptions

2.6 Limitations

Whole Life Cycle Carbon Assessments can be difficult to accurately apply and are only as good as the information available. This assessment has been completed in line with current industry best practice standards (RICS PS 2017 and BS EN 15978) however, the following limitations should be noted:

- This study has been made using the estimates provided at this stage of the project.
- The One-Click database includes standard assumptions for waste factors, life expectancy, recycled content and transport distances for each material type. These might not be reflective of the as-built data for this project. The Circular Economy Statement end of life scenarios have been used where possible.
- There is a degree of imprecision at this early stage, therefore the major impacts should be focused on for improvement.
- The embodied carbon of building services is still a new area within the industry and available data is limited. Approximations have therefore been used to represent the proposed systems using existing datasets within the software.

3. Results and Analysis

3.1 Baseline Results

The design information has been fed into the One-Click software and exported to the GLA WLCA spreadsheet. Results are shown in Table 4 and Table 5 below.

Life Cycle Module	Description	Kg CO_{2eq} over 60 years
Materials Embodied Carbon Module A1-A5 (excluding sequestration)	Construction materials Transport Construction site	30,213,220
In Use and End of life Module B-C (Excluding B6&B7)	Use Maintenance Repair Replace Refurbishment	7,908,838
A-C (excluding B6 & B7, including sequestration)	Construction materials Transport Construction site Re-use, recycling or disposal	37,134,098

Table 3.1 - WLC Assessment Results (Total Kg CO2eq over 60 years)

Life Cycle Module	Description	Kg CO_{2eq}/m^2 GIA
Materials Embodied Carbon Module A1-A5 (excluding sequestration)	Construction materials Transport Construction site	708.25
In Use and End of life Module B-C (Excluding B6&B7)	Use Maintenance Repair Replace Refurbishment	185.39
A-C (excluding B6 & B7, including sequestration)	Construction materials Transport Construction site Re-use, recycling or disposal	881.81

Table 3.2 - WLC Assessment Results (Kg CO2eq/m2 GIA)

The WLC Assessment baseline results demonstrate that for each block, the highest contributors to overall emissions are the A1-A5 modules, as expected.

3.2 Comparison with the GLA Benchmark

The WLC Assessment baseline has been compared to the GLA benchmarks for Apartments.

	GLA Residential Benchmark CO_2e/m^2 GIA over 60 years
Materials Embodied Carbon Module A1-A5 (excluding sequestration)	<850
In Use and End of life Module B-C (Excluding B6&B7)	<350
A-C (excluding B6 & B7, including sequestration)	<1200

Table 3.3 - WLC Assessment Results

It can be seen by comparing Table 3.2 that the development's carbon emissions are in line with the GLA benchmarks for modules A1-A5, B-Cand A-C.

All efforts have been made to reduce the embodied carbon during conception design. However, additional measure(s) have been identified for further reduction during the Technical Design.

In line with the GLA Guidance, Energist has appraised options for reducing WLC carbon emissions in the next section. The recommendations for further embodied carbon reduction can be implemented during the Technical Design and Construction Stage to achieve the design performance and avoid any performance gap between the Planning Stage WLC and the Post Construction Stage WLC.

4. Options Appraisal

4.1 Proposed Design

The highest contributors to the WLC carbon emissions are broken down by life-cycle stages in figure 4.1 below.

Figure 4.1 Global warming, kg CO2e - Life-cycle stages

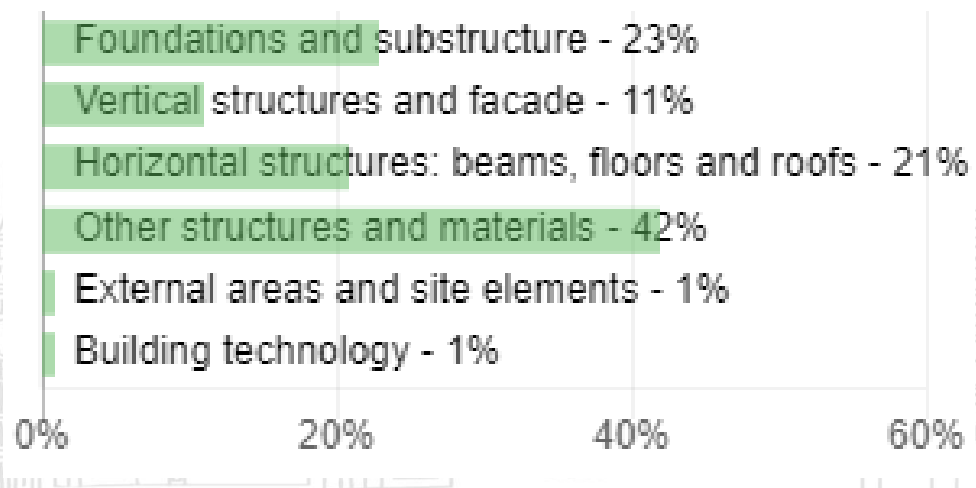

Figure 4.2- Embodied carbon by structure - A1-A3

The top 4 materials with the highest lifetime emissions contributors to modules A1-A5 are:

- Ready-mix concrete
- Brick
- Ferrous Metals | Steel | Reinforcement and Metal suds
- Building services equipment including working fluid

The results show that the worst offending materials for embodied emissions are the concrete and steel used for substructure and superstructure elements. These should be the elements with the highest focus for improvements as they will generate the largest reductions.

The assessment has shown that these materials are the highest contributors to the overall WLC carbon emissions of the proposed development. Priority should be given to reducing the emissions of these products and options have been appraised in the following sections to do this along with other high-level recommendations.

4.2 Cement Replacement

The RICS PS Table 6 baseline figure for cement replacement is 20%. To reduce the environmental impact of concrete, Ready-mix concrete with 40% cement replacement was used for all foundation, slabs and frame elements. Further cement replacements are possible (up to 75% for substructure), alternatively, hollow-core pre-cast concrete slabs can be considered.

4.3 Window Frames

The base model includes aluminium frames to all residential and retail openings. Aluminium is a very carbon-intensive material. Significant savings can be achieved by replacing aluminium windows with composite frame/hybrid aluminium, PVC or timber frame. The calculated savings are for embodied energy only, further savings are likely due to the increased thermal performance of timber.

PVC window frames can be considered as these are significantly better than aluminium but could be improved further by using timber-framed windows which have significantly lower embodied carbon. However, the benefits of these reduces over the building lifetime due to higher maintenance and replacement costs but there is an overall lifetime emissions reduction.

4.4 Working Fluid Type

Working fluid within the air source heat pumps has been modelled using R407C and R513A refrigerant for residential and R410A for commercial units, during this high-level assessment. This has a high Global Warming Potential (GWP) as shown in the below refrigerant summary table. The working fluid used is under review and is likely to change to a Class A refrigerant with a GWP nearer to 600 once different systems have been reviewed.

Refrigerant	GWP $KgCO_2eq/Kg$	Advantages	Disadvantages
R410a	2125	Established and common. Good performance.	High GWP
R407c	1825	Established and common. Good performance	High GWP
R22	1810	Established and common. Good performance	High GWP
R134a	1430	Established and common. Good performance.	High GWP
R32	700	0.7kg of R32 in a 3kw split system with an equivalent performance to 1kg of R410a. Lower cost than R410a.	Slightly flammable. Polyolester oil is not miscible with R32 so new oil is required.
R-513A	572	Relatively lower GWP	Polyol ester (POE) oil

		Good performance. No stratospheric ozone impact. Non-toxic and non-flammable (ASHRAE A1 Class).	is the recommended lubricant for the protection of motor windings with R-513A.
R-1234yf	1	Significantly lower GWP	Slightly less efficient. Higher cost. Less availability. Significant additional expertise to install and then maintain.
R-744 (CO_2)	1	Significantly lower GWP	Less efficient Significant additional expertise to install and then maintain. Significantly more expensive.
R-1234ze	1	Significantly lower GWP. Coefficient or performance (COP) ratio better than traditional refrigerants. Non-flammable	Cooling capacities 25% lower than R134a
R-717 (Ammonia)	0	No GWP.	Slightly less efficient. Toxic in high concentrations Flammable. High cost.

Table 7 - Refrigerant Summary

5. Further Observations

The below observations have been made based on the overall WLC principles and potential improvements that could be considered as the development enters the Technical Design Stages.

In addition to the options appraised in the previous section, the 16 WLC principles within the accompanying WLC Pre-Application Stage Report Submission Note should be reviewed to find any further savings that can be made.

- Revision of the early stage estimated material quantity/Bill of quantity and consider reduction of slab thickness and or steel reinforcement as applicable.

- Consider the specification of hollow core concrete slab (with 50% cement replacement) for upper floors.

- Steel Reinforcement (rebar) - The typical steel rebar in the UK has 97% recycled content and the RICS PS requires 97% recycled content for base specification. Therefore, further reductions in steel rebar are difficult as there are not many different steel manufacturers with products in the UK market.

- Structural steel sections - Steel has inherently high embodied CO2. the RICS PS requires 20% recycled content for base specification, but reductions can be made by procuring structural steel with 90% recycled content or structural steel from arc furnace production suppliers which can have 1/3 the embodied carbon. Sourcing suppliers who have signed up to SteelZero will also ensure embodied energy is reduced as they have committed to net zero steel by 2050.

- Pre-demolition audit: The results of this will be reviewed to determine any elements of the building that can be re-used or repurposed.

- Produce a maintenance and Repair Schedule for the proposed buildings to fulfil and enhance the life expectancy of the building materials. This will reduce the need to replace and refurbish the building elements and reduce the B2-B3 emissions as well as C1-C4 emissions.

- Reduce finishing materials. Leaving exposed concrete in core and stairwells will reduce the embodied carbon from fit-out items. Where finishes are required, ensure these have a high life expectancy: for example, vinyl flooring has double the life expectancy of carpet so will have significantly lower lifetime replacement carbon costs.

- Produce a Sustainable Procurement Plan detailing procedures for local procurement. At the Post Construction Stage actual transport distances will be used so emissions will be reduced the closer these have been procured from site.

- Review any further opportunities for lightweight construction as the design develops and ensure an optimised structural design is in place. The largest contributors are steel and concrete so any reductions that can be made to reinforcement percentage and pile size will have a significant impact.

- Maximise timber use. Timber has a negative carbon figure due to the sequestration of carbon from its growth. Consider using timber stud walls where possible or using timber frame in low rise areas.

- Review the building service equipment including working fluid based on detail design as opposed to BSRIA Rule of thumb.

- The SAP data used during this stage are based on representative samples of each block. Therefore, the energy consumption is estimated. The calculated energy data for each residential dwelling will only be available at RIBA stage 4 Technical design.

6. CONCLUSIONS

Energist UK have completed a Whole Life Cycle Carbon (WLC) Assessment on Energist UK on behalf of Hill Residential for the proposed redevelopment of Ham Close, Ham, Richmond Upon Thames, TW10 7PG. This is in support of the planning application for the proposed development. The purpose of the assessment is to demonstrate that the proposed development is in line with GLA benchmarks and that options have been appraised and implemented to provide a more sustainable design.

This WLC Assessment has been prepared in line with the GLA's London Plan Policy SI2 and using the methodology detailed in GLA Whole Life Cycle Carbon Assessment Guidance (March 2022), the RICS Professional Statement 2017 and BS EN15978:2011. The carbon emissions for the A1-A5 and B-C life cycle stages have been compared to the GLA benchmarks as shown below and are within the typical benchmark levels. This indicates that the proposed development incorporates the most feasible sustainable design options.

	GLA Benchmark for Residential	Block E CO_2e/m^2 GIA over 60 years
Materials Embodied Carbon Module A1-A5	<850	647.86
In Use and End of life Module B-C (exc B6&B7)	<350	161.70
A-C (excluding B6 & B7, including sequestration)	<1200	801.81

Table 10: Comparison to GLA Benchmark

Energist UK has taken the following steps to reduce the overall CO_2eq for the proposed development:

- Use of EPD Certified ready mixed concrete with 40% cement replacement for concrete foundations, frames and slabs.
- Use of EPD Certified steel Reinforcement with 97% recycled material.
- Use of EPD Certified structural steel with a minimum of 90% recycled material.
- Use of EPD Certified Aluminium windows and doors with 60% recyclable aluminium.