Life Cycle Carbon Assessment

for

Charities Aid Foundation

The Firs, Church Grove
London Borough of Richmond Upon Thames
Hampton Wick
KT1 4AL

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CONTENTS

INTRODUCTION

Mecserve Ltd have been appointed by Charities Aid Foundation to carry out a whole Life Cycle carbon Assessment (LCA) for the proposed The Firs scheme at Church Grove.

The aim of the LCA is to calculate and compare the global warming potential of the proposal to demolish the existing property and build a new block of flats with the option to retain, refurbish and extend the existing building to provide equal floor space and number of residential units.

1.1 PROPOSED DEVELOPMENT

The proposed development is located at The Firs, Church Grove in the London Borough of Richmond Upon Thames. The development proposed is the demolition of the existing property and redevelopment of the site to provide a four-storey (plus basement storey) detached property comprising nine self-contained residential units (3 x 2-bedroom and 6 x 1-bedroom); the proposals also include hard and soft landscaping, new boundary treatment, secured cycle storage for 9 units, covered bin and recycling store, car waiting area and car parking for 9 units on basement level.

For a detailed description of the proposed design, please refer to the Design and Access Statement prepared by Flower Michelin Architects.

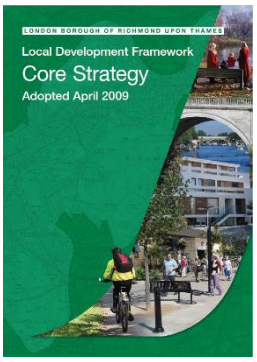
Figure 1 Bird's eye view of existing Building

Figure 2 Proposed scheme – The Firs, Church Grove Road view

2. OVERVIEW OF RELEVANT POLICIES

2.1 LOCAL POLICIES

LONDON BOROUGH OF RICHMOND UPON THAMES CORE STRATEGY (ADOPTED APRIL 2009)



The Core Strategy, adopted in April 2009, contains strategic policies to guide the future development of the Borough. It sets out the Strategic Planning Framework for the Borough for the next 15 years taking account of others plans and strategies and is the delivery mechanism for the spatial element of the Community Plan.

The following is the review of the London Plan and the Local Plan polices for Climate Change mitigation and Climate Change Adaptation followed by measures implemented in the proposed development to meet the applicable policy requirements.

Policy CP1 Sustainable Development

1.A The policy seeks to maximise the effective use of resources including land, water and energy, and assist in reducing any long term adverse environmental impacts of development. Development will be required to conform to the Sustainable Construction checklist, including the requirement to meet the Code for Sustainable Homes level 3 (for new homes), Ecohomes "excellent" (for conversions) or BREEAM "excellent" (for other types of development). This requirement will be adjusted in future years through subsequent DPDs, to take into account the then prevailing standards in the Code for Sustainable Homes and any other National Guidance and ensure that these standards are met or exceeded. The following principles will be promoted: -

1.B Appropriate location of land uses Facilities and services should be provided at the appropriate level locally, taking account of the network of town centres identified in policy CP8. Higher density residential and mixed-use developments to be in town centres, near to public transport to reduce the need to travel by car.

1.C Making best use of land the use of existing and proposed new facilities should be maximised through management initiatives, such as co-location or dual use. Redevelopment of sites should normally only take place where there can be an increase in the number of housing units and/or quantity of commercial floorspace.

1.D Reducing environmental impact The environmental benefits of retaining and, where appropriate, refurbishing existing buildings, should be compared against redevelopment. Development should seek to minimise the use of open land for development and seek to maintain the natural vegetation, especially trees, where possible. Local environmental impacts

of development with respect to factors such as noise, air quality and contamination should be minimised.

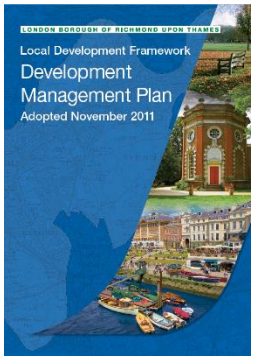
1.E Environmental gain to compensate for any environmental cost of development will be sought.

The core strategy then explains point 1.D above as following:

"Retaining and refurbishing existing buildings will normally be a more sustainable option if the embodied energy in the building and the impacts of removing and disposing of construction waste are taken into account and if the resulting building is fit for purpose. On this basis, redevelopment will generally only be appropriate if there is a more sustainable construction, a building that will last longer or an improved layout which may include an increase in the number of units or floorspace"

2.2 THE DEVELOPMENT MANAGEMENT PLAN (DMP) (ADOPTED NOVEMBER 2011)

Climate Change is the rise in average global temperature due to increasing levels of greenhouse gases in the earth's atmosphere (primarily CO2) that prevent the radiation of heat into space.



Buildings and spaces built today should respond to climate change issues and adapt to mitigation and adaptation measures. The London Plan through its policies addresses these issues and will require London Boroughs to consider how their developments will function in the future in the context of changing climate.

The Development Management Plan (DMP) (adopted November 2011) of London Borough of Richmond Upon Thames takes forward the strategic objectives in the Core Strategy and is consistent with it and with National Regional Policies.

Policy DM HO 1 Existing Housing

Existing Housing (including conversions, reversions and non self-contained accommodation)

Existing housing should be retained. Redevelopment of existing housing should normally only take place where:

1. it has first been demonstrated that the existing housing is incapable of improvement or conversion to a satisfactory standard to provide an equivalent scheme; and if this is the case:

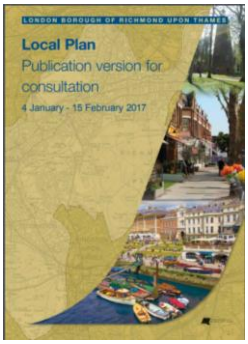
2. the proposal improves the long-term sustainability of buildings on the site; and
3. the proposal does not have an adverse impact on local character; and
4. the proposal provides a reasonable standard of accommodation, including accessible design, as set out in Policy DM HO 4 'Housing Mix and Standards' and other policies.

The policy then explains that "As set out in the Core Strategy Policy CP1, retaining and refurbishing existing buildings will normally be a more sustainable option if the embodied energy in the building and the impacts of removing and disposing of construction waste are taken into account and if the resulting building is fit for purpose. There should first be full consideration as to whether existing housing can be improved or converted to a satisfactory standard. Proposals for redevelopment will be assessed for benefits on the balance of the quality of housing provision including sustainability, design and amenity considerations including impacts on traffic and parking, in accordance with other relevant policies."

2.3 LOCAL PLAN (UNDER REVIEW BY SECRETARY OF STATE)

The Local Plan (previously known as Local Development Framework) sets out the priorities for the development of the borough and will be used for making decisions on planning applications. It consists of a number of planning documents and guidance.

The local plan was going to be adopted in Spring 2018, but it is currently under review by the secretary of state.



Policy LP 38 Loss of Housing

A. Existing housing should be retained.

B. Proposals for reversions and conversions should assess the suitability of the property and design considerations.

C. Redevelopment of existing housing should normally only take place where:

a. it has first been demonstrated that the existing housing is incapable of improvement or conversion to a satisfactory standard to provide an equivalent scheme; and, if this is the case
b. the proposal does not have an adverse impact on local character; and
c. the proposal provides a reasonable standard of accommodation, including accessible design, as set out in LP 35 Housing Mix and Standards.

3. LIFE CYCLE CARBON ANALYSIS

3.1 METHODOLOGY

We have used One Click LCA software to calculate the whole life carbon impact of the proposed new build development in comparison with a refurbishment scenario i.e. retaining and extension of the existing building. The Life Cycle Assessment has been developed in line with the RICS professional standards and guidance "Whole Life Carbon Assessment for the built environment", 1st edition, Nov2017.

According to RICS guidance, the fundamental objective of whole life carbon measurement is the mitigation of carbon impact in the built environment. Better understanding and consistent measurement of the whole life carbon emissions of built projects will in turn enable comparability of results, benchmarking and target setting to achieve carbon reductions.

3.2 COMPARISON SCENARIOS

With regards to this project, the purpose of the whole life carbon assessment is to compare the scheme as proposed with the scenario that the existing house would be kept but would be upgraded and extended. To make the comparison relevant and use the same basis, we are comparing the two following scenarios:

A. The new building as proposed. The main material that will be used to build this development is Cross Laminated Timber (CLT), which has a very low whole life cycle carbon emission impact. The new development will also use the latest construction methodologies, will be very airtight and very energy efficient. The new development will have 35% lower carbon emission in comparison with Part L1A 2013, in line with Richmond council requirements.

B. The Second scenario will keep the existing building and will extend it to achieve the same number of dwellings. This is to ensure the basis of comparison is similar. It is assumed that the existing building will be renovated in accordance with Part L1B guidance and standards. It is also assumed that the extension in this scenario will be built on the basis of Part L1A 2013 standard. For this hypothetical scenario, we have also assumed that the carbon emissions will be reduced by 35% in comparison with the baseline set by the council and GLA. The baseline for this scenario is made up of the existing building's emission rate (for the refurbished parts) and Part L1A 2013 Target Emission Rate for the new extension. This will be compliant with the council policy. The second scenario will be less energy efficient in comparison with the first strategy as achieving the planning carbon targets for this strategy is less onerous and, therefore, there is no need for installation of significant renewable energy system (photovoltaics). It is also notable that achieving Part L1B

standards is easier than achieving Part L1A standards, as Part L1B allows for various difficulties and restrictions in upgrading and insulating an existing building.

3.3 THE LIFE CYCLE ASSESSMENT SCOPE AND SYSTEM BOUNDARIES

The LCA analysis carried out has considered the carbon emissions emitted during the below life cycle stages of the two scenarios.

Product Stage			**Construction Process Stage**		**Use Stage**							**End-of-Life Stage**				**Benefits and loads beyond the system boundary**		
Raw material supply	Transport	Manufacturing	Transport to building site	Installation into building	Use/application	Maintenance	Repair	Replacement	Refurbishment	Operational energy use	Operational water use	Deconstruction/demolition	Transport	Waste processing	Disposal	Reuse	Recovery	Recycling
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	B6	B7	C1	C2	C3	C4	D	D	D
x			x	x	x					x	x	x				x		

Description of the life cycle stages and analysis scope are provided in the table below:

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 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.
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.
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 replacing new material as well as the impacts from manufacturing the replacing material as well as handling of waste until the end-of-waste state.
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 taken into account.
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 waste water treatment.
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.
D External impacts/end-of-life benefits	The external benefits include emission benefits from recycling recyclable building waste. Benefits for re-used or recycled material types include positive impact of replacing virgin-based material with recycled material and benefits for materials that can be recovered for energy cover positive impact for replacing other energy streams based on average impacts of energy production. These should be reported separately and not included in the total environmental impact.

3.4 ASSESSED IMPACT CATEGORIES

The metric for assessing the climate change impacts of greenhouse gas (GHG) emissions is Global Warming Potential (GWP). This is a relative measure of how much heat is trapped by a greenhouse gas in the atmosphere. The results of the LCA are reported in terms of $kgCO_2$ equivalent ($kgCO_2e$) i.e. the GWP of a gas is calculated in relation to CO_2.

Impact category	**Unit**	**Description**
Global warming potential (greenhouse gases)	$kgCO_2$ eq	Describes changes in local, regional, or global surface temperatures caused by an increased concentration of greenhouse gases in the atmosphere. Greenhouse gas emissions from fossil fuel burning has been strongly correlated with two other impact categories: acidification and smog. Often called "carbon footprint".

3.5 ANALYSIS MATERIAL SCOPE

The purpose of this study is to compare the carbon emissions emitted during the life span of the two options described above. Where same materials are to be used for both scenarios, e.g. internal finishes and external works construction, these have been excluded from the comparison.

The LCA analysis included following building elements:

Group	Element	Included	Comments
SUBSTRUCTURE	*Foundations, basement floor & retaining wall*	*Yes*	We have assumed that both scenarios will feature a basement of the same floor area. Therefore, the basement RC retaining wall and basement floor RC slab are the same in terms of construction and areas for both scenarios.
SUPERSTRUCTURE	*Frame*	*Yes*	The new build scenario will be constructed by prefabricated CLT panels whereas the refurbishment scenario will feature typical conventional cavity brick walls with a RC frame (slabs and columns).
	Upper floors	*Yes*	The proposal will feature prefabricated CLT panels for the upper floor elements as opposed to conventional RC floor slabs used in the refurbishment scenario.
	Roofs	*Yes*	The proposal will feature prefabricated CLT panels for the roof elements as opposed to conventional RC roof construction used in the refurbishment scenario.
	Stairs	*No*	The stairs construction has not been considered in our study. However, a timber framed staircase used in the proposal as opposed to a RC stair installed in the refurbishment scenario would minimise the environmental impact of the proposed scheme further.
	External Walls	*Yes*	The proposal will feature prefabricated CLT panels for external walls as opposed to conventional cavity brick walls used in the refurbishment scenario.
	Windows & External doors	*Yes*	Timber framed double glazed windows of same materials and areas have been assumed for both options. Their impact in terms of embodied carbon has been considered in the

			LCA.
	Internal Walls and Partitions	*Yes*	Internal wall studs of same construction and area have been assumed for both scenarios. CLT party walls have been assumed for the new build case as opposed to conventional brick wall for the refurbished option.
	Internal Doors	*Yes*	Internal timber doors of same materials and areas have been assumed for both options. Their impact in terms of embodied carbon has been considered in the LCA.
INTERNAL FINISHES	*Wall/ Floor/ Ceiling Finishes*	*No*	These have been assumed to be the same in both scenarios and therefore have been excluded from the analysis.
BUILDING FITTINGS & FURNISHINGS	*Fixed fittings and equipment*	*No*	These have been assumed to be the same in both scenarios and therefore have been excluded from the analysis.
BUILDING SERVICES/ MEP	*Services equipment/ Sanitary fittings*	*Yes*	The majority of the building services systems and fittings have been assumed to be the same in both scenarios and therefore have been excluded from the analysis. Only the Mechanical Ventilation with Heat Recovery (MVHR) units and Photovoltaic (PV) panels have been included in the calculation. The proposal will feature MVHR units in each flat and PV panels installed on the roof. The refurbishment scenario assumes MVHR units only for the new extension and no PV panels.
EXTERNAL WORKS	*Site works/ Drainage/ External services*	*No*	These have been assumed to be the same in both scenarios and therefore have been excluded from the analysis.

3.6 ENVIRONMENTAL DATA SOURCES

One Click LCA EN-15978 compliant tool was used in the assessment. The tool supports CML (2002 - November 2012 or newer) methodology and all assessed impact categories. All of the datasets in the tool follow EN 15804 standard.

3.7 PROJECT DATA SOURCES AND ASSUMPTIONS

The proposed building construction scenarios were calculated in One Click LCA based on design data described in the below table. As the analysis is carried out at planning stage and the study includes the comparison between the proposal and a hypothetical scenario, various assumptions had to be made.

Area of analysis	Data sources
Material quantities (A1-A3)	Planning drawings of the existing house and the proposed development issued by Flower Michelin Architects.
Building material transport distances (A4)	Given that at this stage, specific sourcing information is unavailable, transport scenarios for UK-based projects, given in Table 7 of the RICS guide, have been used in the LCA. Typical average transport distances provided by the calculation tool, based on material type, were also used in the assessment.
Construction and installation process (A5)	Calculation tool average construction process emissions based on project size were used in the analysis.
Material service life (B1-B5)	At this stage default values from One Click LCA database were used, based on the type of materials included in the assessment.
Building use phase energy consumption (B6)	SAP 2012 calculations were completed for both the new build scenario and the refurbishment scenario and the energy consumption figures were input in the LCA. Results included both the regulated energy use i.e. energy used for heating, hot water, lighting and ventilation as well as unregulated energy from appliances and cooking, calculated in line with the BRE methodology. The latter has been assumed the same for both scenarios.
Operational water use (B7)	This has been assumed the same for both scenarios and, therefore, excluded from the assessment.

4. ANALYSIS RESULTS

The following table summarises the analysis results, in terms of Global Warming Potential, for both scenarios for stages A - C.

The Firs, Church Grove	**Scenario A:** New build proposal	**Scenario B:** Refurbishment and extension of existing property
Global Warming Potential (GWP)	1,164 $tnCO_2e$	1,415 $tnCO_2e$
Improvement achieved	17.7%	

Results show that when calculating the life-cycle carbon footprint of the two options i.e. taking into consideration not only operational use but the embodied carbon of the structure, then the environmental impact of the proposal is by circa 18% lower than the refurbishment scenario. The following table presents the GWP breakdown at each stage of the LCA.

The Firs, Church Grove		**Scenario A:** New build proposal ($tnCO_2e$)	**Scenario B:** Refurbishment and extension of existing property ($tnCO_2e$)
A1-A3	Construction Materials	92	120
A4	Transportation to site	7	3
A5	Construction/ installation process	21	17
B4-B5	Material replacement and refurbishment	23	11
B6	Energy use	1,010	1,260
C1-C4	Deconstruction	12	4
D	External impacts (not included in totals)	-2	-3
TOTAL		1,164	1,415

Based on the results above, the new build proposal performs significantly better at stages A1-A3 and B6 which are the main contributors, by more than 95% to the overall life cycle carbon.

5. CONCLUSION

Mecserve Ltd was appointed to carry out a whole Life Cycle carbon Assessment for the proposed The Firs scheme at Church Grove. The main scope of the assessment is to calculate and compare the global warming potential of the proposal to demolish the existing property and build a new block of flats with the option to retain, refurbish and extend the existing building.

The LCA presented in this report has been carried out in line with the methodology given in the RICS 'Whole life carbon assessment for the built environment' guidance (1st edition, November 2017) that follows the EN 15978 principles. The GWP of each option has been calculated throughout the life cycle stages A to D.

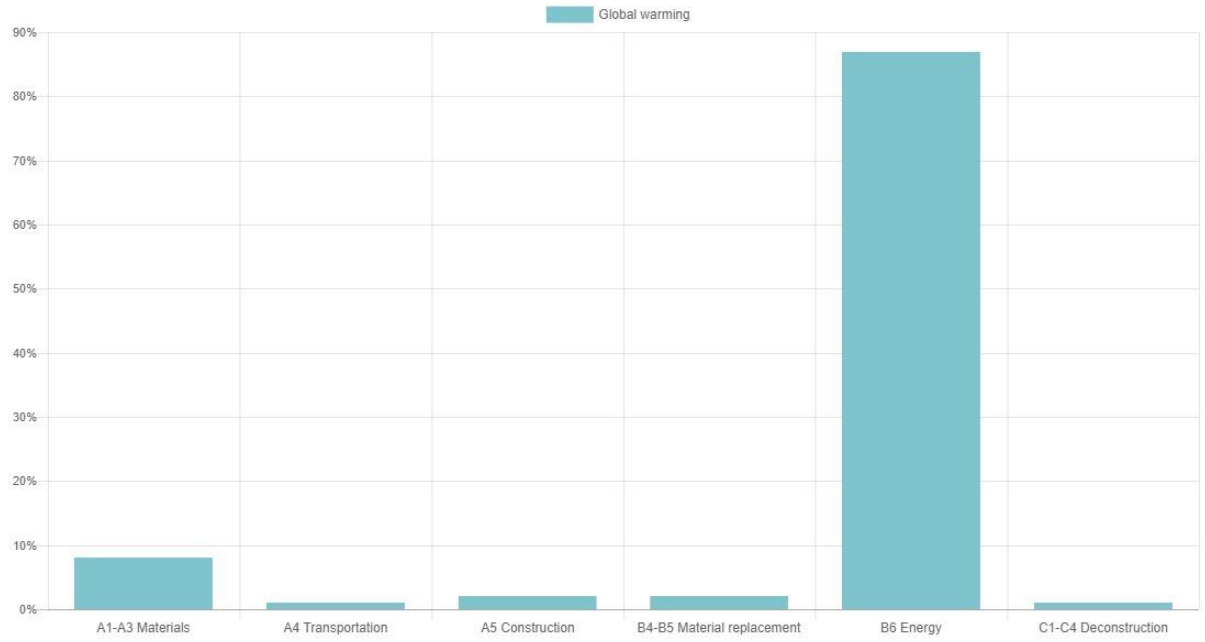
The new building proposal will be built with CLT pre-fabricated panels as opposed to a conventional RC framed building with cavity brick walls. Therefore the embodied carbon of the new building will be much less than conventional buildings.

The energy performance of both options has been assessed using SAP 2012. A reduction of 35% over the Baseline Emission Rate set by GLA i.e. Part L1A Target Emission Rate for the new build option and Emission Rate of the existing building plus Part L1A TER for the new extension has been considered. The new proposal will be much more energy efficient and will have lower level of carbon emission as a result of complying with all relevant factors and no restrictions in achieving high energy standards.

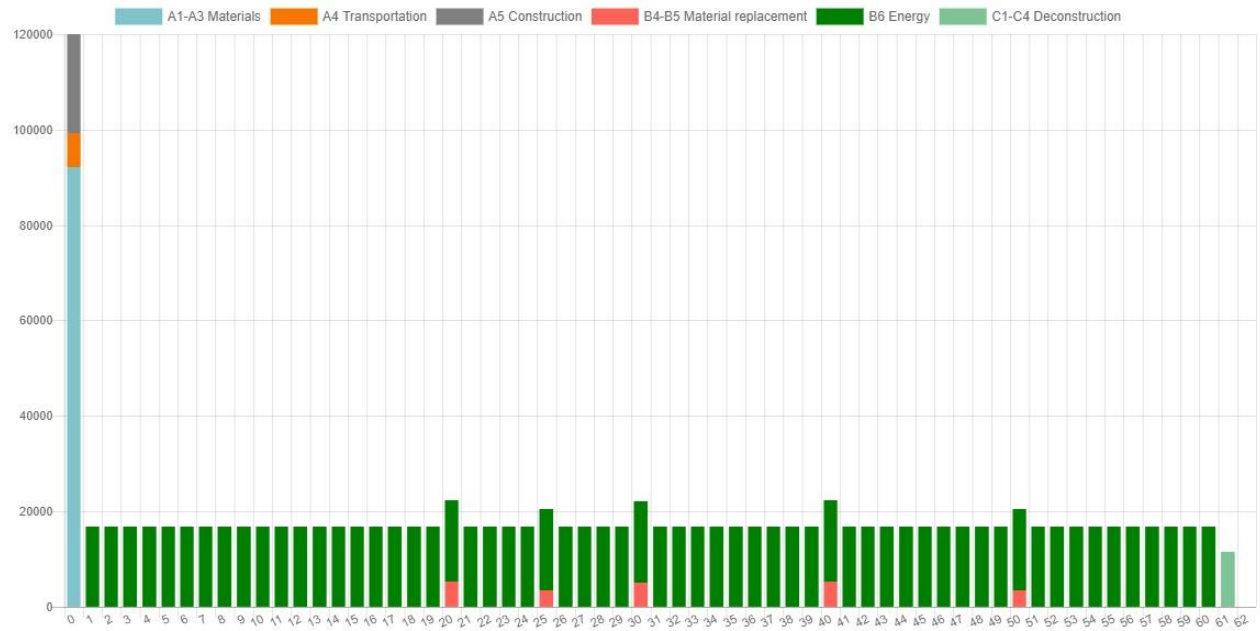
Results show that the overall GWP of the proposal is by circa 18% lower than that of the refurbishment scenario. This is mainly due to the lower environmental impact of the timber used in the CLT panels as opposed to concrete and brick (Stage A) and the better energy performance of the proposal built to improve upon current Part L1A standards, which are stricter compared to the minimum energy efficiency requirements set by Part L1B for works on existing buildings.

APPENDIX 1. LIFE CYCLE CARBON – PROPOSAL

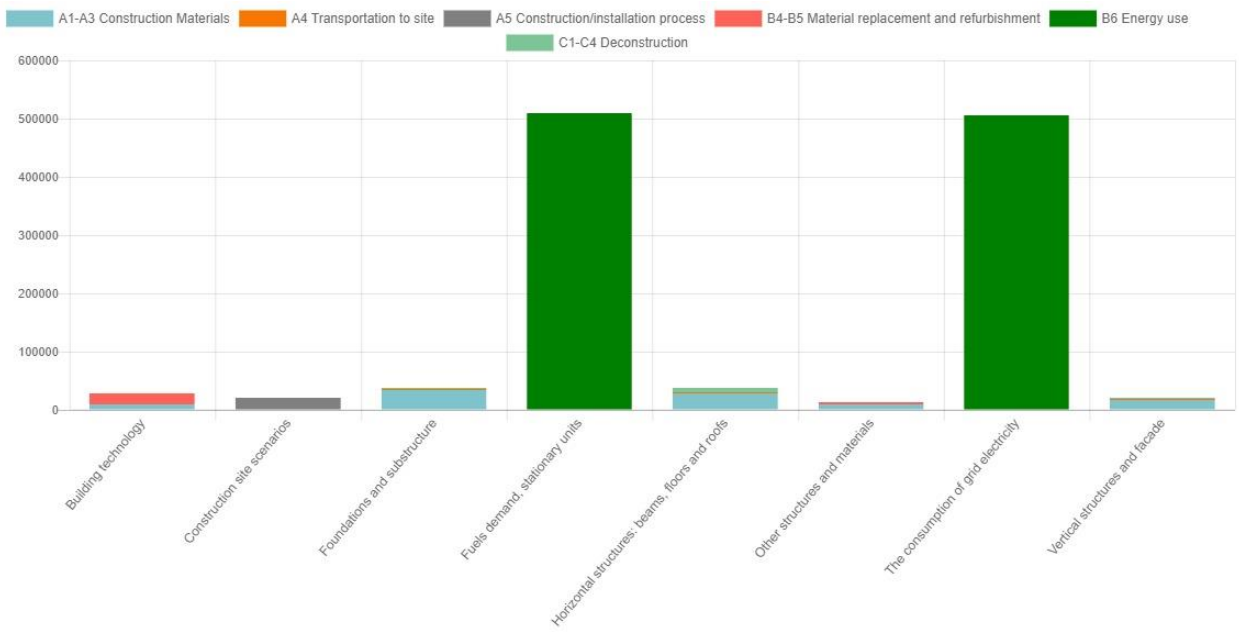
Results distribution by life-cycle stage



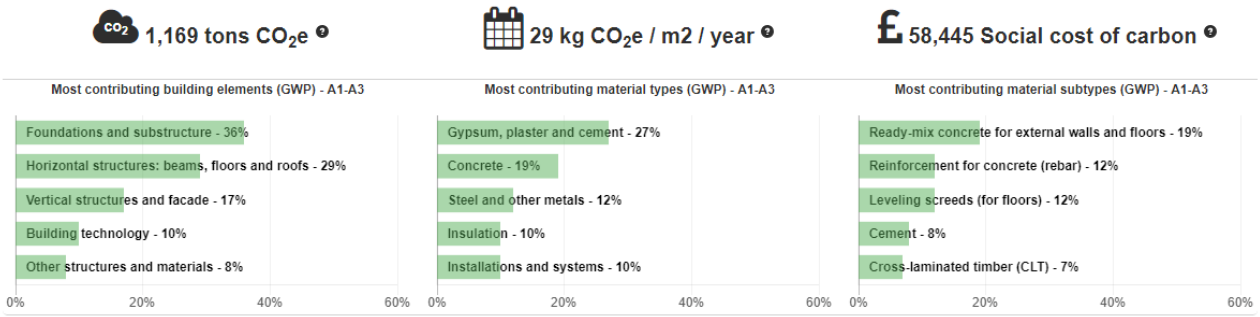
Annual GWP impact



Global warming (GWP) breakdown

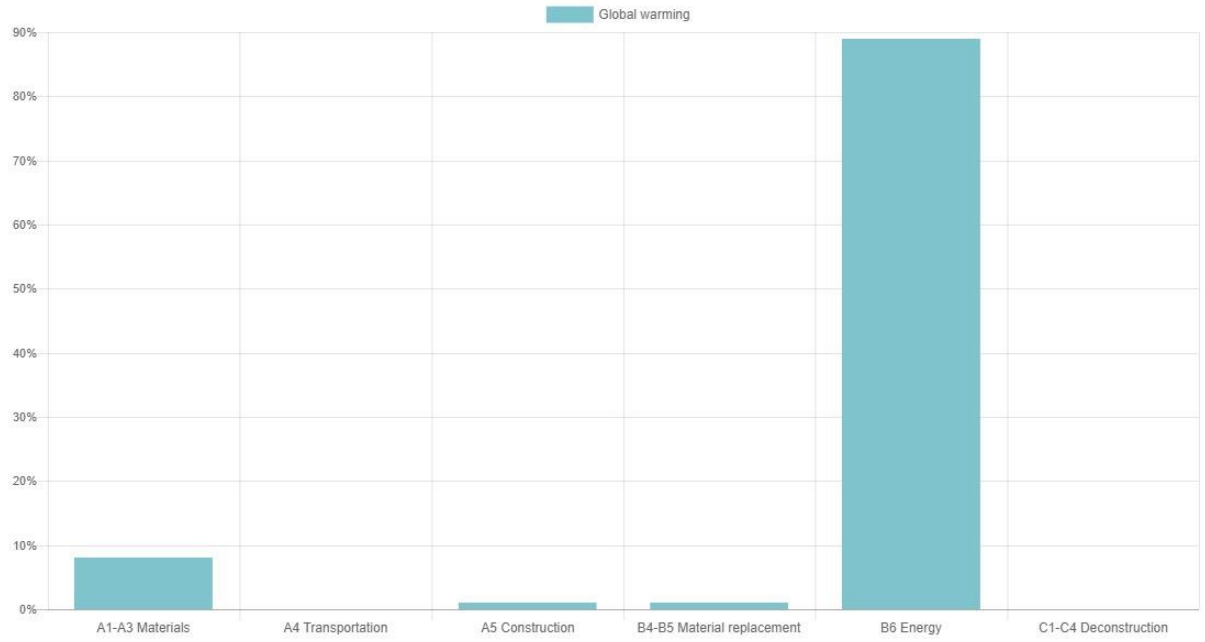


Global warming results

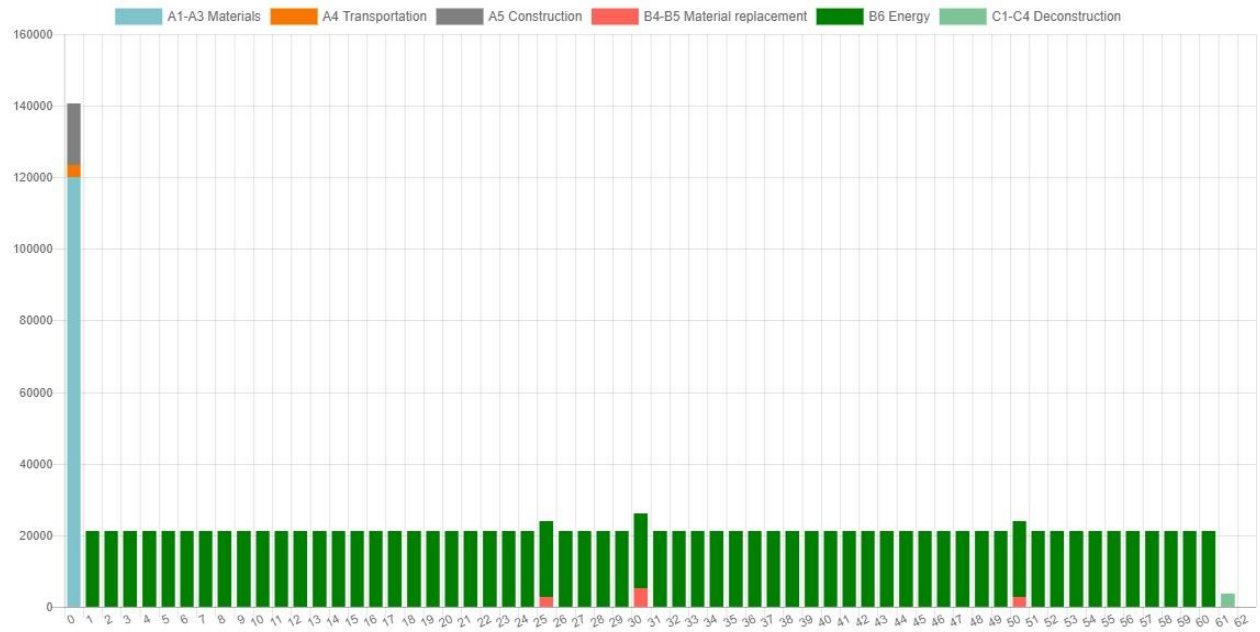


APPENDIX 2. LIFE CYCLE CARBON – REFURBISHMENT SCENARIO

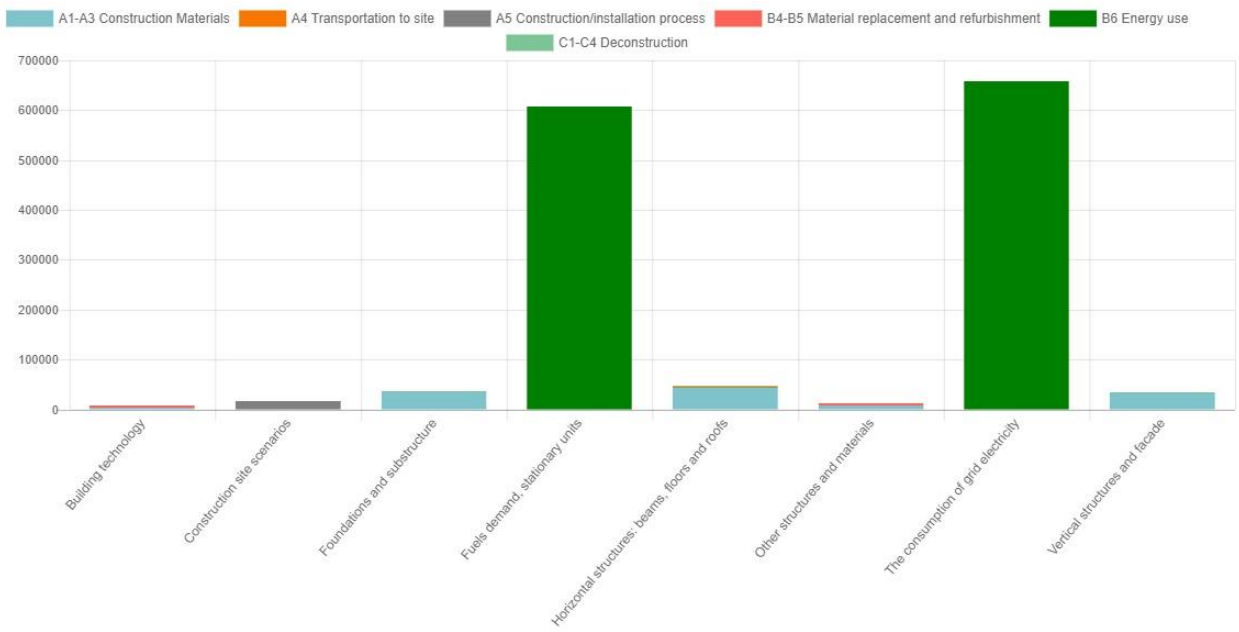
Results distribution by life-cycle stage



Annual GWP impact



Global warming (GWP) breakdown



Global warming results