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WHOLE LIFE CARBON ASSESSMENT COMPARATIVE STUDY 9.734 – 32-34 AVENUE ROAD, CAMDEN

16/02/2022 *by AJ, reviewed by KM*

EXECUTIVE SUMMARY

An Embodied carbon assessment has been undertaken for two proposed development options at 32-34 Avenue Road in the London Borough of Camden. The two schemes include a new build proposal and a refurbishment and extension proposal.

The Embodied carbon assessment has been aligned with the latest published *GLA Life-Cycle Carbon Assessments guidance. Pre-consultation draft (April 2020).* All lifecycle stages are presented in Figure 1, however as highlighted an embodied carbon assessment only considers lifecycle stages A1 to B5 and C1 to C4. It is important to consider carbon emissions attributable to module B6 - operational energy. Therefore, modelling has been undertaken including module B6 in addition to those covered necessary for an Embodied carbon assessment.

The embodied carbon emissions of the proposed development are shown in the tables below.

When considering embodied carbon & operation energy, the analysis indicated that the refurbished scheme has total carbon emissions higher than that of the new build option over a predicted 60-year lifespan. This is attributed to the lower performance of the building fabric and internal conditions from the refurbished option, compared to that possible from the demolition and erection of a new building.

Therefore, when considering both options, the new-build should be considered the less carbon intensive option in terms of whole life carbon emissions, regardless of the slightly higher total embodied carbon emissions attributable to it.

Table 1 shows the results for *Assessment 1 – New Build Scheme* and the results for *Assessment 2 – Refurbished Scheme.* The results show that modules A1-A5 Product and construction process stages, have the largest impact on the total embodied carbon emissions in both assessments. The second largest source of emissions is derived from the Use stage B1-B5 modules. Of both the assessments the New Build Scheme has the higher total embodied carbon emissions as would be expected, however this does not consider the operational emissions associated with the different schemes.

When considering embodied carbon & operation energy, the analysis indicated that the refurbished scheme has total carbon emissions higher than that of the new build option over a predicted 60-year lifespan. This is attributed to the lower performance of the building fabric and internal conditions from the refurbished option, compared to that possible from the demolition and erection of a new building.

Therefore, when considering both options, the new-build should be considered the less carbon intensive option in terms of whole life carbon emissions, regardless of the slightly higher total embodied carbon emissions attributable to it.

Table 1: Estimated Embodied carbon emissions.

	Module A1-A5	Module B1-B5	Module B6-B7	Module C1-C4	Module D	TOTAL*
Assessment 1 – New Build Scheme (Embodied carbon)						
TOTAL kg CO_2e	1,492,959	402,070	n/a	166,580	-1,580	2,061,608
TOTAL kg CO_2e/m^2 GIA	923	248	n/a	103	-1.0	1274
Assessment 2 – Refurbished Scheme (Embodied carbon)						

TOTAL kg CO_2e	1,478,154	152,833	n/a	81,068	-1,079	1,712,055
TOTAL kg CO_2e/m^2 GIA	1056	109	n/a	58	-0.8	1223
Assessment 1 – New Build Scheme (Including module B6)						
TOTAL kg CO_2e	1,492,959	402,070	730,800	166,580	-1,580	2,790,828
TOTAL kg CO_2e/m^2 GIA	923	248	452	103	-1.0	1725
Assessment 2 – Refurbished Scheme (Including module B6)						
TOTAL kg CO_2e	1,478,154	152,833	1,224,000	81,068	-1,079	2,934,976
TOTAL kg CO_2e/m^2 GIA	1056	109	874	58	-0.8	2096

*Total *excluding module D*

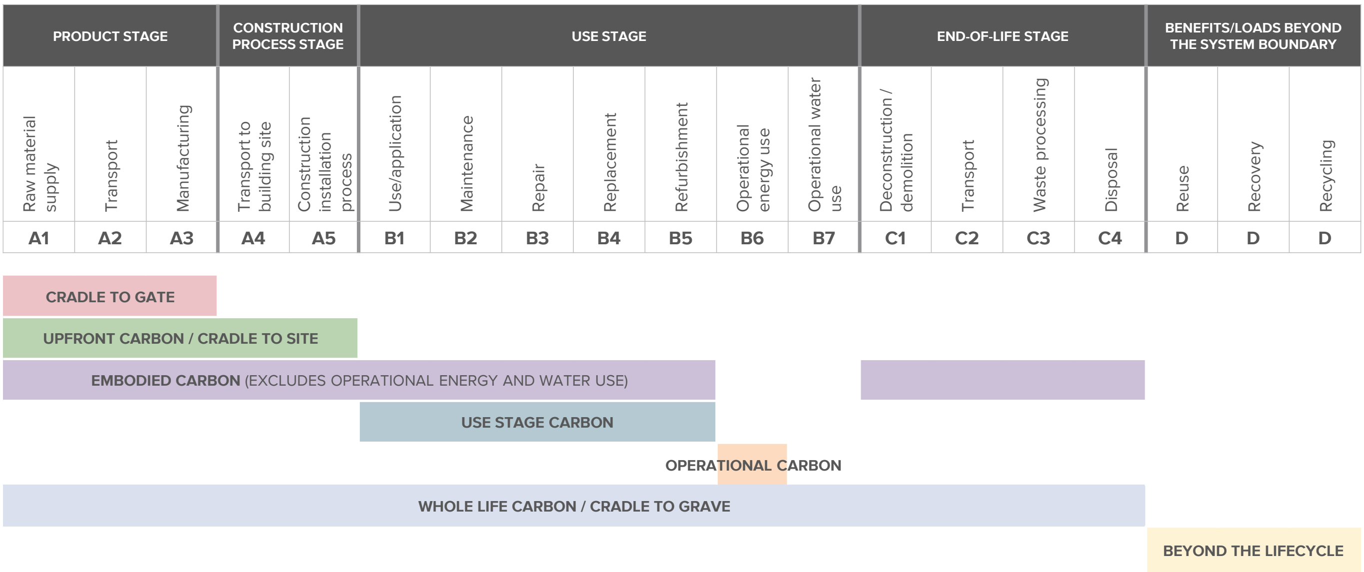

Figure 1: Lifecycle stages (modules) according to EN 15978 and terminology of carbon emissions scopes.

INTRODUCTION

As buildings become more energy efficient, operational carbon emissions will make up a smaller proportion of a development's whole life-cycle carbon emissions. It is therefore becoming increasingly important to calculate and reduce carbon emissions associated with other aspects of a development's life cycle; namely, embodied carbon emissions.

SITE DESCRIPTION

The proposed development is located within a residential area of the London Borough of Camden and currently comprises a 3-storey residential building plus a lower ground floor. There are two proposals for the development at 32-34 Avenue Road. The first includes the retention and extension of the existing building, the second proposal includes demolishing the existing and constructing of a brand-new building.

POLICY FRAMEWORK

The London Plan 2021 has included under Policy SI2 Minimising greenhouse gas emissions, a requirement for a Whole Life-cycle Carbon Assessment for all referable development proposals.

> *F. 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 GLA has also published a draft Whole Life-cycle Carbon Assessments Guidance (April 2020) which explains how to prepare a WLC assessment for planning applications. As outlined in the guidance, applicants are required to take action at the following stages:

- Pre-application
- Stage 1 submission (i.e. RIBA Stage 2/3)
- Post-construction (i.e. upon commencement of RIBA Stage 6 and prior to the building being handed over, if applicable. Generally, it is be expected that the assessment would be received three months post-construction)

METHODOLOGY

The methodology followed in calculating the embodied carbon emissions is aligned with the GLA Life-Cycle Carbon Assessments Guidance and the RICS professional statement (PS) for undertaking detailed carbon assessments. The RICS Whole life carbon assessment for the built environment (2017), follows the European standard EN 15978. For operational carbon emissions estimates for the two development options, the GLA's methodology for energy assessments has been followed. Please refer to Appendix B for more details.

LIFE CYCLE STAGES

The life cycle stages covered by the RICS methodology refer to EN 15978, which includes a modular approach to a built asset's life cycle, breaking it down into different stages. The four main modules are Product stage [A1 – A3], Construction Process stage [A4 – A5], Use stage [B1 – B7] and End of Life stage [C1 – C4]. Module D consists of the potential environmental benefits or burdens of materials beyond the life of the project, this is usually reported separately to the cradle to grave modules [A – C].

Table 2 shows the life-cycle stages that were considered for the assessment and the assumptions made for some stages due to limitations of the software used.

Table 2: Life cycle stages.

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	✓	✓	✓	✓	✓	✓	✓

* B2 has been estimated by extrapolating the results of B3 assuming these correspond to 25% of B2 emissions (RICS PS).
‡ B3: a repair/year% has been added for some building components as indicated in the RICS PS (2.3 Roofs, 2.5 External walls, windows, 2.6 Windows, 3 Finishes and 5 Services).
† B5: B4 figure includes B5 emissions in the GLA WLC template.

BUILDING ELEMENTS

The Embodied Carbon assessment covers all building elements listed in Tables 3 & 4 (where applicable to the Proposed Development). Material quantities have been provided for both the new build and refurbishment scheme options, and are reported in the bill of quantities included in Appendix A. A minimum of at least 95% of the cost allocated to each building element category has been accounted for, where information has been given, in line with GLA policy.

Table 3: Building elements as per RICS NRM. (New build scheme)

Group	Building Element	Applicable	Included
0. Demolition & facilitating works	0.1. Toxic / hazardous / contaminated material treatment	N	N
	0.2. Major demolition works	Y	Y
	0.3. & 0.5. Temporary / enabling works	N	N
	0.4. Specialist groundworks	N	N
1. Substructure	1.1. Substructure	Y	Y
2. Superstructure	2.1. Frame	Y	Y
	2.2. Upper floors incl. balconies	Y	Y
	2.3. Roof	Y	Y
	2.4. Stairs & ramps	Y	Y
	2.5. External walls	Y	Y
	2.6. Windows & external doors	Y	Y
	2.7. Internal walls & partitions	Y	Y
	2.8 Internal doors	Y	Y
3 Finishes	3.1 Wall finishes	Y	Y
	3.2 Floor finishes	Y	Y
	3.3 Ceiling finishes	Y	Y

Group	Building Element	Applicable	Included
4 FFE	4.1 Fittings, furnishings & equipment	Y	Y
5 Building services / MEP	5.1–5.14 Services	Y	Y
6 Prefabricated Buildings and Building Units	6.1 Prefabricated buildings and building unit	N	N
7 Work to existing building	7.1 Minor demolition and alteration works	N	N
8 External works	8.1 Site preparation works	Y	Y
	8.2 Roads, paths, paving's and surfacing's	Y	Y
	8.3 Soft landscaping, planting and irrigation systems	N	N
	8.4 Fencing, railings and walls	Y	Y
	8.5 External fixtures	N	N
	8.6 External drainage	N	N
	8.7 External services	Y	Y
	8.8 Minor building works and ancillary buildings	N	N

Table 4: Building elements as per RICS NRM. (New build scheme)

Group	Building Element	Applicable	Included
0. Demolition & facilitating works	0.1. Toxic / hazardous / contaminated material treatment	N	N
	0.2. Major demolition works	N	N
	0.3. & 0.5. Temporary / enabling works	N	N
	0.4. Specialist groundworks	N	N
1. Substructure	1.1. Substructure	Y	Y
2. Superstructure	2.1. Frame	Y	Y
	2.2. Upper floors incl. balconies	Y	Y
	2.3. Roof	Y	Y
	2.4. Stairs & ramps	Y	Y
	2.5. External walls	Y	Y
	2.6. Windows & external doors	Y	Y
	2.7. Internal walls & partitions	Y	Y
	2.8 Internal doors	Y	Y
3 Finishes	3.1 Wall finishes	Y	Y
	3.2 Floor finishes	Y	Y
	3.3 Ceiling finishes	Y	Y
4 FFE	4.1 Fittings, furnishings & equipment	Y	Y
5 Building services / MEP	5.1–5.14 Services	Y	Y
6 Prefabricated Buildings and Building Units	6.1 Prefabricated buildings and building unit	N	N
7 Work to existing building	7.1 Minor demolition and alteration works	Y	Y
8 External works	8.1 Site preparation works	Y	Y
	8.2 Roads, paths, paving's and surfacing	Y	Y
	8.3 Soft landscaping, planting and irrigation systems	N	N
	8.4 Fencing, railings and walls	Y	Y
	8.5 External fixtures	N	N

Group	Building Element	Applicable	Included
	8.6 External drainage	N	N
	8.7 External services	Y	Y
	8.8 Minor building works and ancillary buildings	N	N

SOFTWARE TOOLS

The tool used for the embodied carbon assessment is the eToolLCA, which follows BS EN 15978, is IMPACT-compliant and BRE certified and listed in the GLA Life-Cycle Carbon Assessments Guidance, Appendix 1 as an acceptable tool.

MATERIALS & PRODUCTS

Embodied carbon calculations have been carried out using:

- Type III environmental declarations (Environmental Product Declarations[1] and equivalent) and datasets in accordance with BS EN 15804; and,
- EPDs and datasets in accordance with ISO 14025 and ISO 14040/44.

Sequestered (biogenic) carbon, in particular from the use of timber products, biogenic carbon is deducted from the GWP emissions in A1-A3, and in C3 the same amount of carbon is added as it is released back to the atmosphere this results in no overall impact on the total carbon emissions.

Embodied carbon is difficult to calculate for many MEP systems due to a lack of available data. Where manufacturer specific data is not available figures for embodied carbon have been taken from the closest matching system within the eToolLCA database. In cases where there are no comparable systems embodied carbon has been calculated based on the key materials used to manufacture the equipment, by weight.

EMBODIED CARBON RESULTS

ASSESSMENT 1 – NEW BUILD SCHEME

Figure 2 overleaf shows the results of Assessment 1, which is the New Build Scheme. The results show that as expected, the highest contribution to the whole life carbon of the project is the *A1-A3 Product stage* which accounts for approximately 1186 tCO_2e (57%). These emissions are derived from the use of concrete and reinforced steel within the building substructure as well as floors within the superstructure.

The second largest contributor is *B4 – Replacement*, which accounts for about 361 tCO_2e (18%) of the total carbon emissions of the building during its lifetime. These emissions can be attributed to the replacement of materials associated with the buildings finishes over its lifetime, particularly the floor finishes such as carpets.

And the third largest contributor is the *A4 - Transport of Equipment and Materials* category with 236 tCO_2e (12%).

[1] An Environmental Product Declaration EPD is an independently verified and registered document that communicates transparent and comparable information about the life-cycle environmental impact of products in a credible way (Environdec)

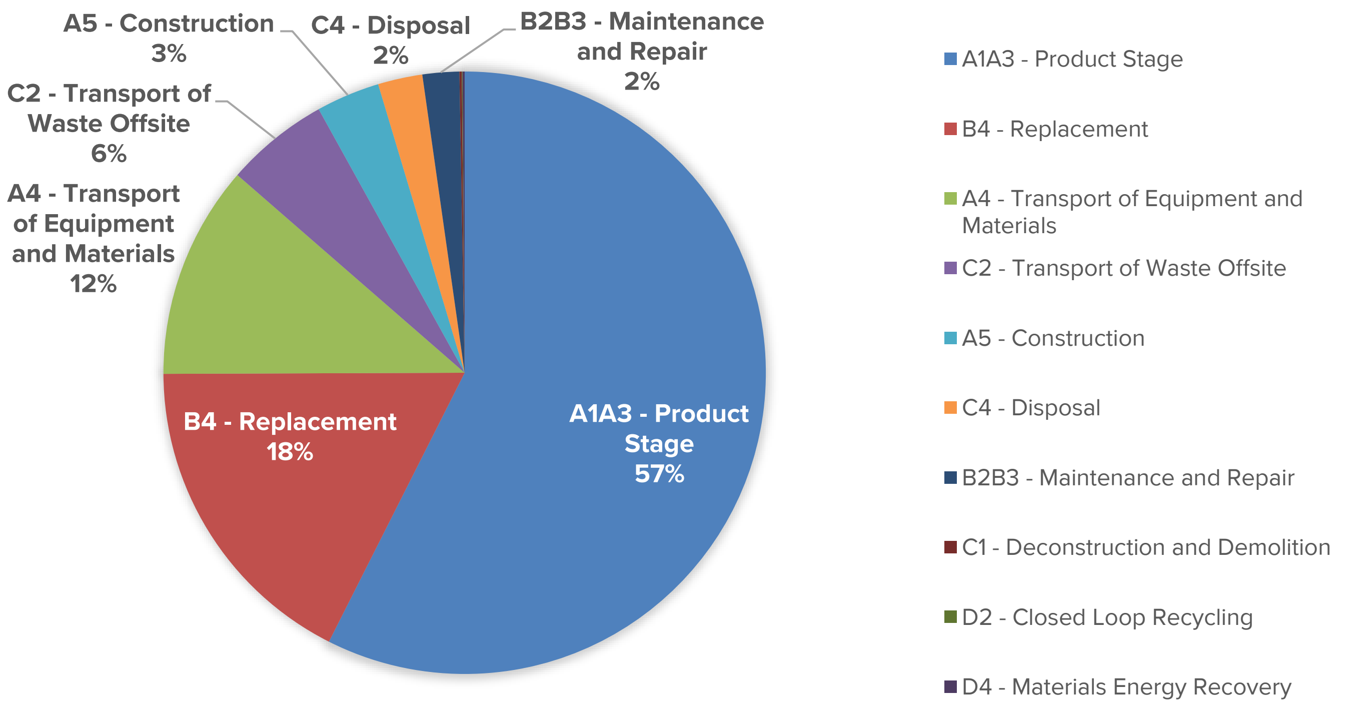

Figure 2: WLC results for Assessment 1 by LCA stage

ASSESSMENT 2 – REFURBISHED SCHEME

Figure 3 shows the results of Assessment 2, which is the Refurbished scheme. The results show that as expected, the highest contribution to the whole life carbon of the project is the *A1-A3 Product stage* which accounts for approximately 973 tCO_2e (57%). Again, as with the new build scheme these emissions are derived from the use of concrete and reinforced steel within the building substructure as well as floors within the superstructure

The second largest contributor is *B4 – Replacement*, which accounts for about 301 tCO_2e (17%) of the total carbon emissions of the building during its lifetime. These emissions can be attributed to the replacement of materials associated with the buildings finishes over its lifetime, particularly the floor finishes such as carpets.

And the third largest contributor is the *A4 - Transport of Equipment and Materials* category with 204 tCO_2e (12%).

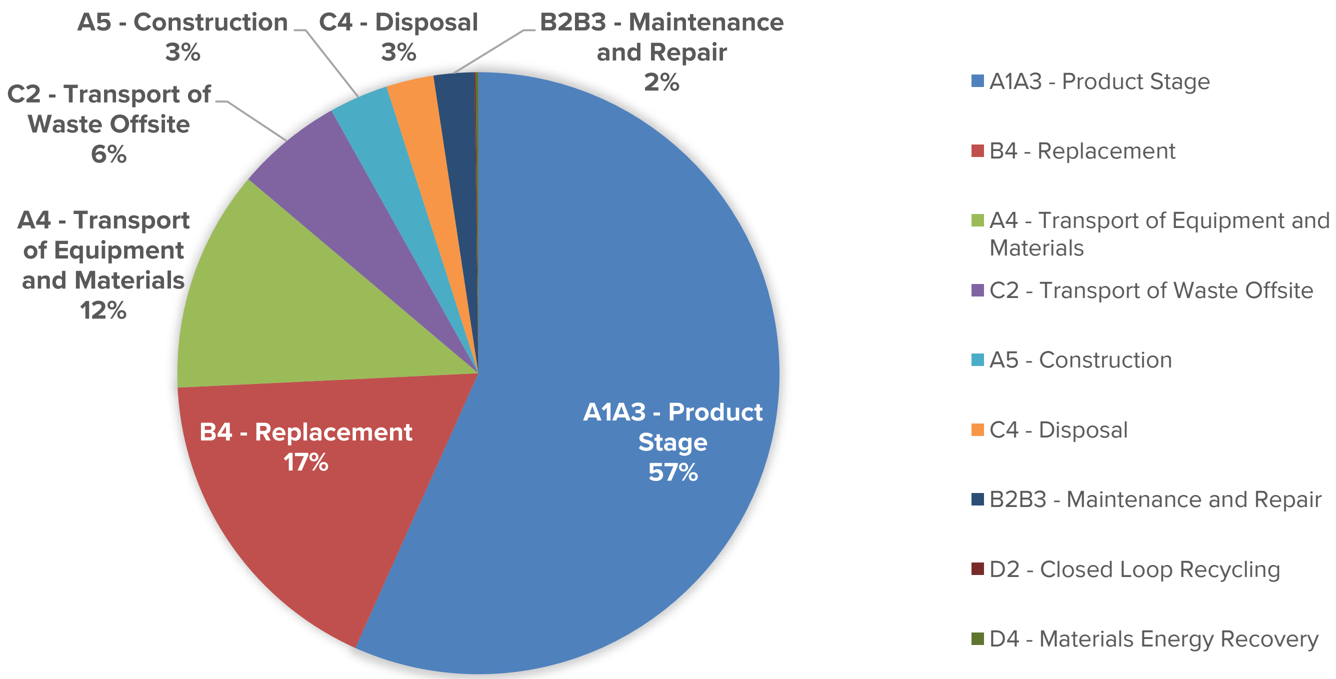

Figure 3: WLC results for Assessment 2. by LCA stage

NEW BUILD SCHEME V REFURBISHED SCHEME

The embodied carbon emissions of the proposed development are shown in Figure 5, for both *Assessment 1 – New Build Scheme* and *Assessment 2 – Refurbished Scheme.* The results show that overall, the new build scheme has a higher total embodied carbon potential than the refurbishment scheme, the difference in total emissions between the new build and refurbishment schemes can mainly be attributed to the increased use of materials and equipment associated with the demolition and construction of the new build option. This can be seen in the increased emissions of modules A1-A3 Products stage, B4 Replacement, A4 Transport of equipment and materials and C2 Transport of waste offsite.

If the two proposals are compared on a m2 basis, as shown in Table 5 the new build scheme still has an overall kg CO2e/m2 GIA higher than that of the refurbished scheme. However, overall, there is a difference in intensity per m2 of 51 kg CO2e, which is a very small margin. The two schemes could be considered to have similar carbon intensities per m2,

Further to this for modules A1-A5 the new build scheme's embodied carbon per m2 is 922.7 kg CO2e, compared to 1055.8 kg CO2e/m2 GIA for the refurbished scheme, as such the refurbished scheme has a higher kg CO2e intensity per m2 than that of the new build. This can be most likely attributed to the overall higher GIA (1,618 GIA) of the new build compared to the refurbishment (1400 GIA).

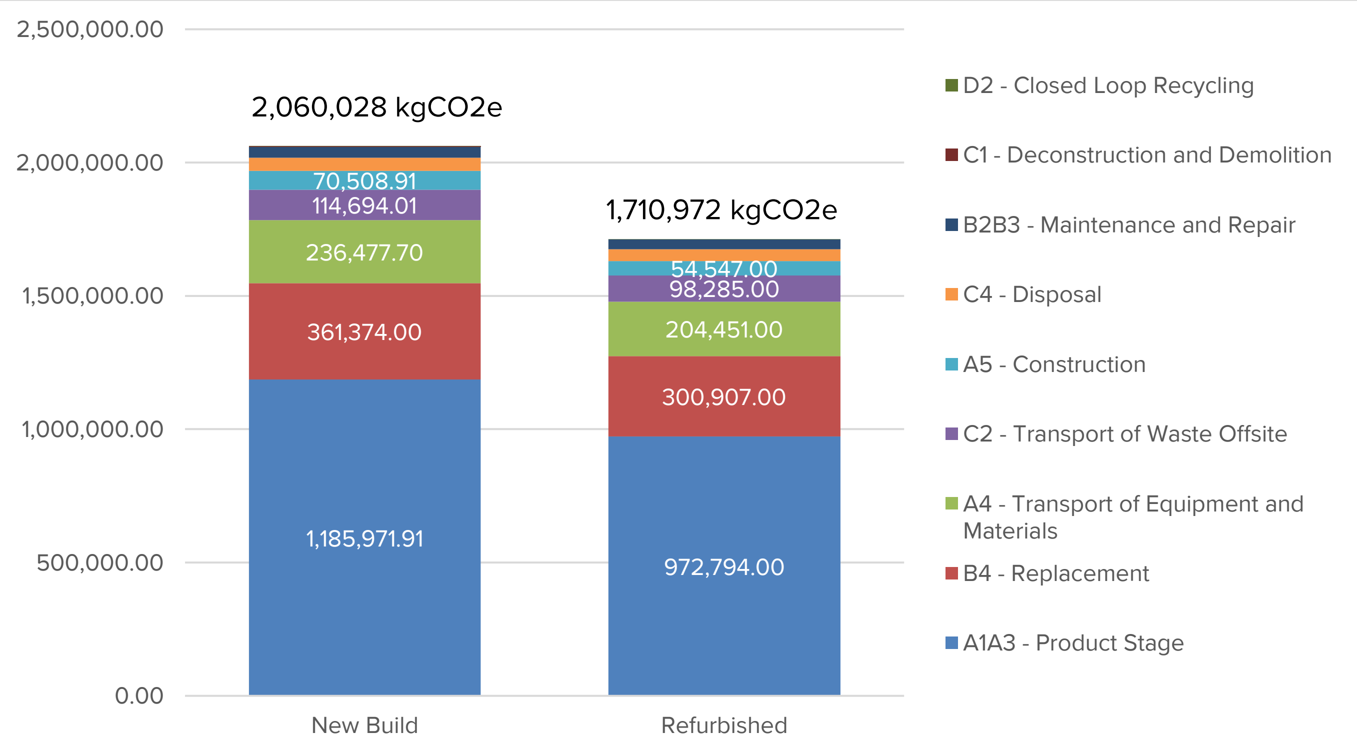

Figure 3: Sum of Global Warming Potential (kgCO2e), Function by Life Cycle Module

Table 5: Embodied carbon emissions by module (kg CO_2e/m^2 GIA)

	New Build Scheme	Refurbished Scheme
Modules A1-A5	922.7 kg CO_2e/m^2 GIA	1055.8 kg CO_2e/m^2 GIA
Modules B-C (excluding B6 & B7)	351.4 kg CO_2e/m^2 GIA	167.1 kg CO_2e/m^2 GIA
Total of Modules A1-A5 B-C	1274 kg CO2e/m2 GIA	1223 kg CO2e/m2 GIA

WHOLE LIFE CARBON RESULTS

B6 - OPERATIONAL ENERGY

Module B6 – Operational energy covers carbon emissions arising from the energy use of the buildings integrated energy systems, projected throughout the lifecycle of the project (in our case 60 years is standard). It on average forms around a 1/3 of all carbon emissions of a built asset over its lifetime, as such it is important to assess its contribution to the overall building performance in addition to just embodied carbon emissions when comparing the new build and refurbished scheme options.

Using the emissions data set out within Table 3 of the accompanying 'Energy technical note' which can also be found in Appendix B of this report, operational energy has been modelled for both the new build and refurbished scheme options to assess the impact on total carbon emissions for both. The analysis has followed GLA's guidance for energy assessments.

ASSESSMENT 1 – NEW BUILD SCHEME (INCLUDING B6)

Figure 6 overleaf shows the results of Assessment 1 but this time including the operational energy figures. The results show that module *A1-A3 Product stage* still accounts for the largest proportion of emissions, however the second largest contributor is B6 – Operational Energy at 26% of the total or 730 tCO2e.

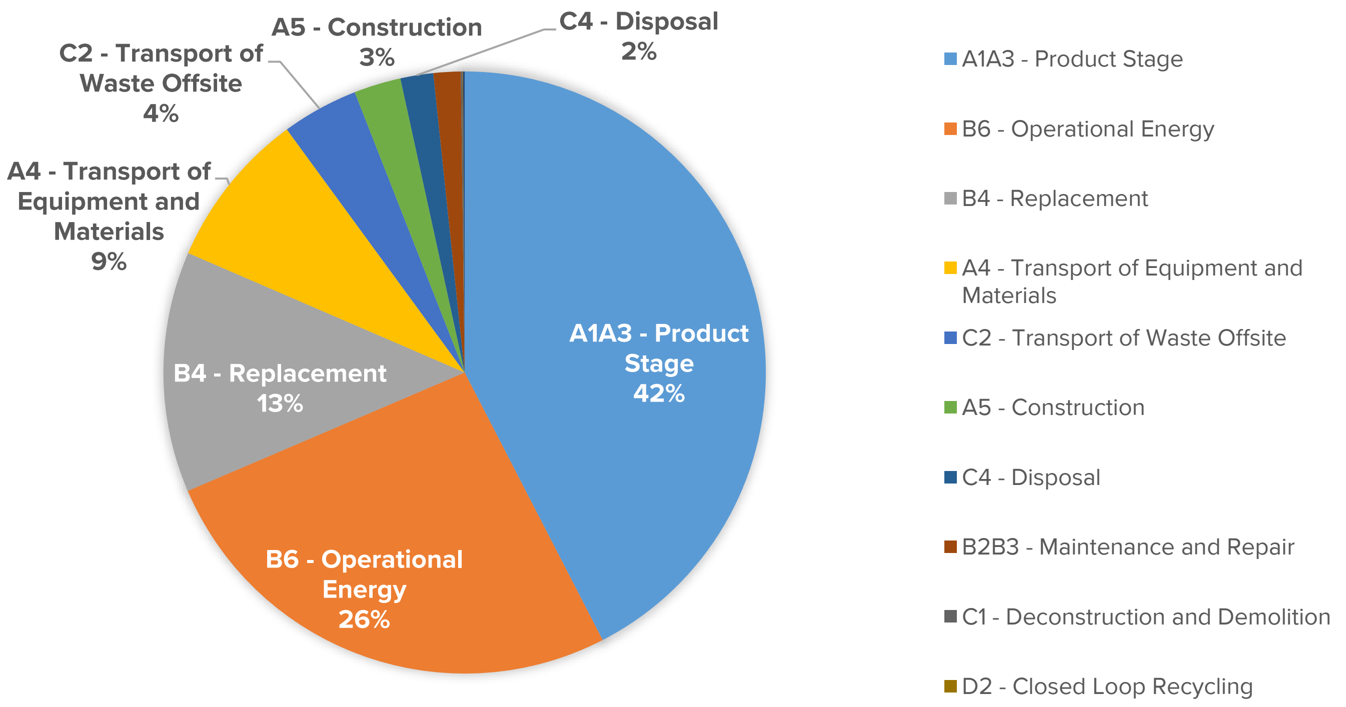

Figure 6: WLC results for Assessment 1. by LCA stage (including B6 – Operational Energy)

ASSESSMENT 2 – REFURBISHED SCHEME (INCLUDING B6)

Figure 7 shows the results of Assessment 2, the results indicate that module *B6 – Operational Energy* now accounts for the largest proportion of emissions, at 42% of the total or 1224 tCO2e. This demonstrates that the refurbished scheme has a significantly higher proportion of emissions attributed to operational energy, than the new build scheme.

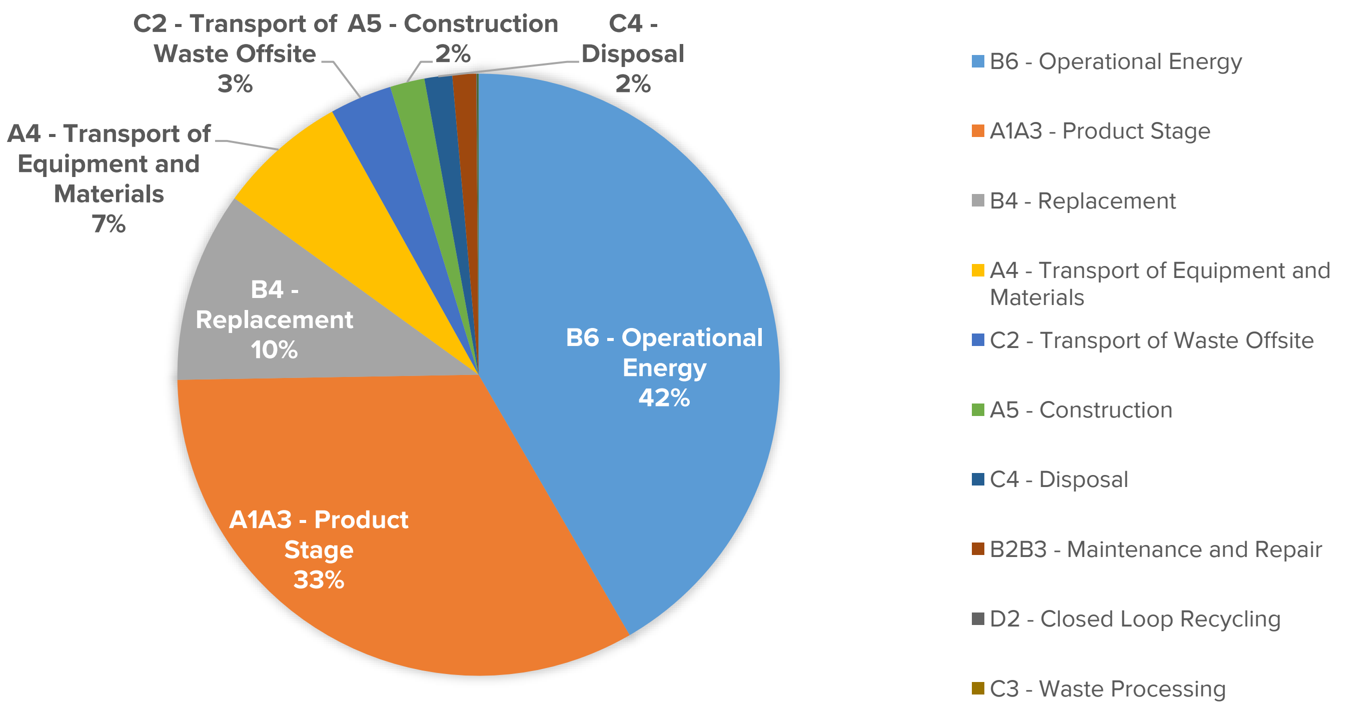

Figure 6: WLC results for Assessment 2. by LCA stage (including B6 – Operational Energy)

NEW BUILD SCHEME V REFURBISHED SCHEME (INCLUDING B6)

The embodied carbon emissions of the proposed development with the addition of B6 – Operational energy emissions, is shown in Figure 7, for both *Assessment 1 – New Build Scheme* and *Assessment 2 – Refurbished Scheme.*

The results show that overall, the refurbished scheme has a higher total whole life carbon potential than the new build scheme, the difference in total emissions between the new build and refurbishment schemes can mainly be attributed to the increased proportion of emissions from the operational energy of the refurbished option.

This increase in B6 carbon emissions attributed to the refurbished option, is most likely due to the inability to make similar levels of improvements to the building fabric and internal conditions as would be possible with the demolition of the existing building and erecting of a new-build alternative. Therefore, the refurbished option underperforms when compared to the new build option, over the course of its predicted 60-year life span.

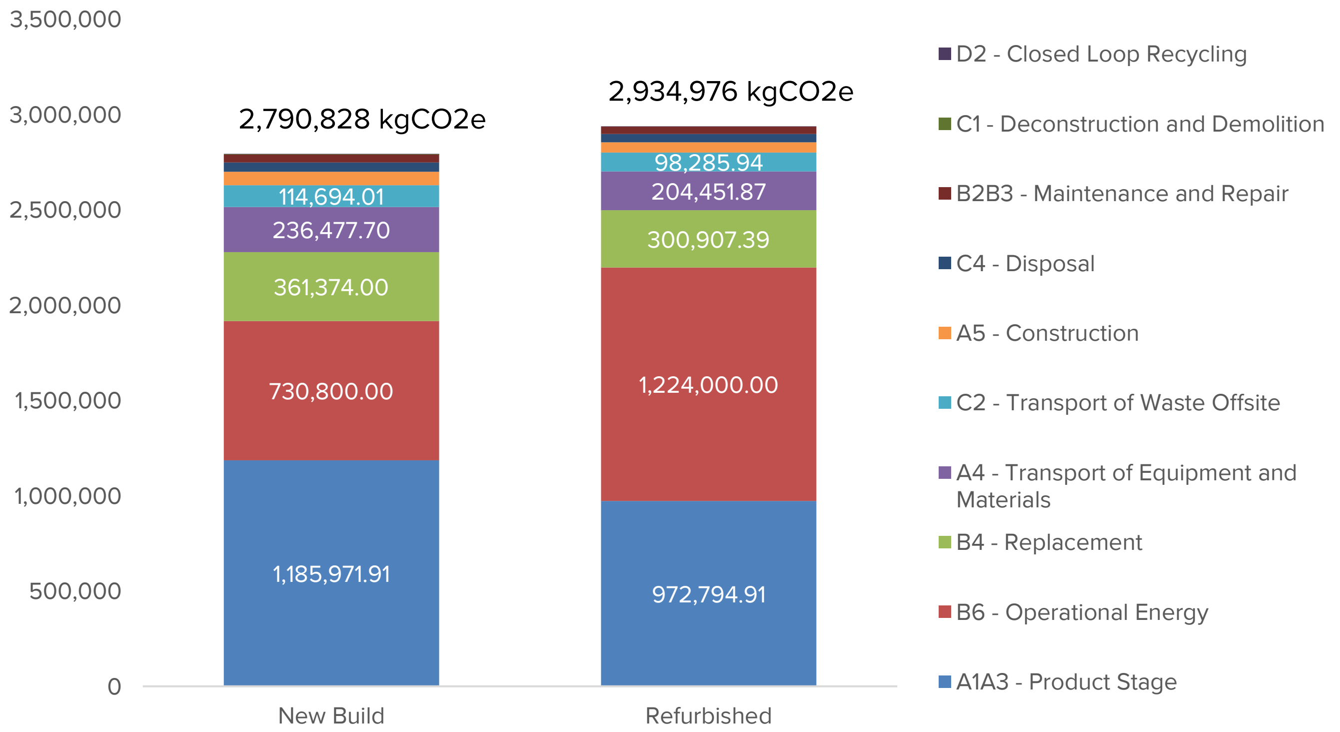

Figure 7: Sum of Global Warming Potential (kgCO2e), Function by Life Cycle Module (including B6 – Operational Energy)

CONCLUSION

In conclusion the proposed new build scheme has higher overall associated embodied carbon emissions than the refurbished scheme, which is attributed to the complete demolition of the currently existing building, along with associated emissions from materials and equipment used during construction of the new building.

However, when operational energy emissions are included within the modelling, in addition to the embodied carbon emissions it is demonstrated that the refurbished scheme has total carbon emissions higher than that of the new build option over a predicted 60-year lifespan. This is attributed to the lower performance of the building fabric and internal conditions from the refurbished option, compared to that possible from the demolition and erection of a new build.

Therefore, when considering both options the new build should be considered the less carbon intensive option, regardless of the slightly higher total embodied carbon emissions attributable to it.

APPENDIX A – NEW BUILD AND REFURBISHMENT RFI

APPENDIX B – OPERATIONAL EMISSIONS TECHNICAL NOTE