REDUCING EMBODIED CARBON OF NEW BUILDINGS IN GLASGOW

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CONTENTS

1. INTRODUCTION

Climate change is a global challenge that requires urgent action to mitigate its impact on the environment and society. The main driver of climate change is carbon emissions, and the construction sector is a significant contributor to these emissions, both through the operational energy used in buildings and the embodied carbon associated with the construction and demolition of buildings. Embodied carbon refers to the carbon emissions associated with the materials used in the construction of a building, including their extraction, processing, manufacturing, transportation, and disposal. Reducing embodied carbon in the built environment has become critical in the efforts to mitigate the impact of climate change.

The main aim of this report is to provide the information and support necessary for the City of Glasgow to consider the introduction of an embodied carbon policy for new buildings. The report provides an overview of the current state of embodied carbon policies in UK's built environment. The report also explains the details of life cycle assessment of two municipal buildings provided by Glasgow City Council to benchmark the City's new Educational buildings. To further that, the LCA data from the UK region is analysed to define a benchmark value of embodied carbon. This UK benchmark and the case studies are then compared. The report concludes with a suggested roadmap on how embodied carbon could be regulated in the jurisdiction of the City of Glasgow.

This research is undertaken by One Click LCA in appointment by CNCA. It is submitted to Glasgow City Council and the aim is to serve as a roadmap for the introduction of an embodied carbon measurement and reduction policy in the future for buildings in the City of Glasgow.

To facilitate users with no or basic experience in Life Cycle Assessment (LCA) who read this report, the following paragraph explains the concept of LCA in the building sector.

1.1 LIFE CYCLE ASSESSMENT

Life Cycle Assessment (LCA) is a methodology used to evaluate the environmental impacts of a product or service over its entire life cycle, from raw material extraction and manufacturing to distribution, use, and disposal. It assesses environmental impacts such as greenhouse gas emissions, water and energy consumption, land use, and waste generation.

The main goal of an LCA is to identify the environmental hotspots of a product or service, i.e., the stages in its life cycle where the most significant environmental impacts occur. The information obtained from an LCA can be used to make informed decisions about improving the environmental performance of a product or service. For example, the results of an LCA may indicate that changing the raw materials used in a product or reducing the energy consumed during its manufacturing process can significantly reduce its overall environmental impact.

LCA can be used to compare the environmental impact of different products or processes, to identify opportunities for improvement, and to guide decision-making towards more sustainable products and processes. LCA is increasingly used in the construction industry to evaluate the embodied carbon and other environmental impacts of buildings and infrastructure projects. LCA is a valuable tool for design teams and building owners who want to assess the environmental performance of their design and make more sustainable design decisions.

1.2 LCA STANDARDS

There are several guides and standards that provide guidance on how to conduct LCAs. Some of the most common ones are given below:

- **ISO 14040 and ISO 14044:** These are the international standards for conducting LCAs. They provide guidance on the principles and framework for conducting LCAs, as well as the methodology and interpretation of results. They can apply to any sector and product.
- **EN 15978** is based on the principles of ISO 14040 and ISO 14044. The standard sets out the requirements for conducting an LCA of a building, including the scope of the assessment, the data required, and the assumptions and methodology that should be used. EN 15978 also provides guidance on the interpretation of the results and the reporting of the findings. One of the key features of EN 15978 is that it emphasizes the importance of considering the entire life cycle of a building, including the embodied carbon of the materials used in construction and the operational carbon emissions associated with energy use. The standard also includes guidance on the assessment of other environmental impacts, such as water use, land use, and waste generation. It is also used for the case studies applied for this research. Detailed representation of the different life cycle stages and modules as defined in the standard is shown in Figure 1.

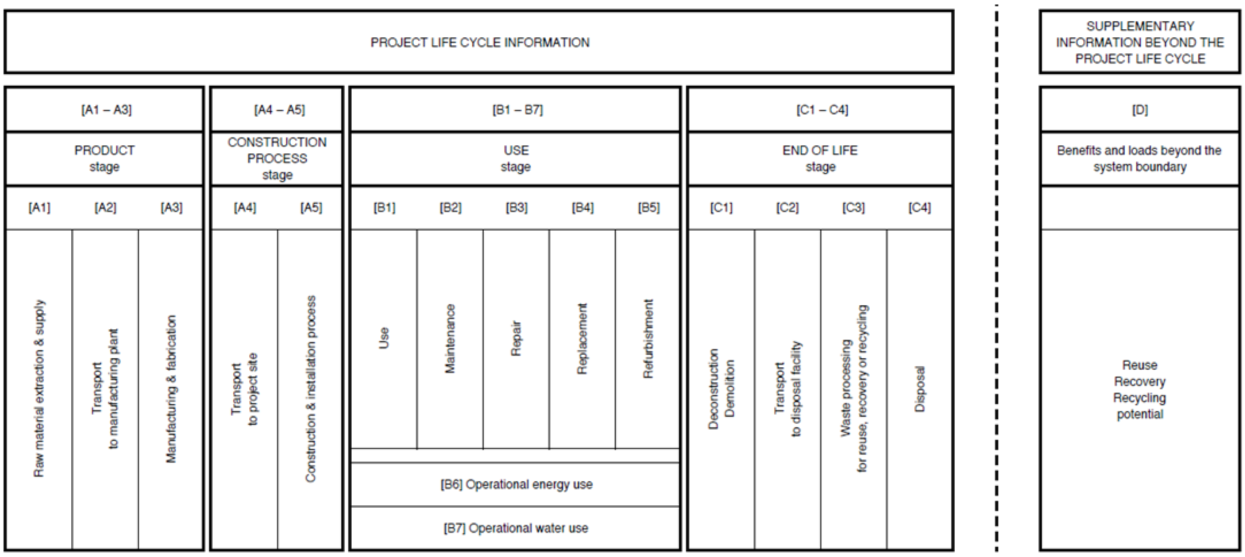

Figure 1: Life cycle stages and modules as per EN15978

Apart from these standards, there are various other LCA methodologies that are based on these standards. Such methodologies are either defined in rating schemes like BREEAM, national regulations, local policies like London Plan or by professional groups like RICS.

These LCA methodologies provide a common framework for conducting LCAs, which is essential for ensuring consistency and comparability of results. They also help to ensure that LCAs are conducted in accordance with best practices and in a transparent and credible way, which builds trust in the results of LCAs.

2. A REVIEW OF LCA METHODOLOGIES AND POLICIES IN THE UK

The focus on embodied carbon and climate change has increased in recent years. Reducing carbon emissions is becoming more and more important for a sustainable built environment. The UK is gradually taking steps towards a more sustainable built environment and is considered among world leaders in the subject as the country seeks to achieve its net-zero carbon emissions target by 2050.

The UK, like most countries has an energy efficiency regulation (Part L) in place that regulates the operational energy consumption and associated carbon emissions of buildings. However the construction industry in the country follows a more holistic approach to sustainable design by looking into all aspects of sustainability during the design, construction and use stage of a building. This is moslty driven by BREEAM which is the dominant building rating scheme and other local and regional policies mandating certain aspects to be considered and levels of performance to be achieved.

In recent years the industry is focusing especially on the whole life cycle impact measuring and optimisation via the formation and work done by various professional groups, initiatives, organisations, and councils like RICS, LETI, ACAN and others. This resulted in the development of various LCA methodologies for Buildings. These are covered below.

2.1 BREEAM

BREEAM (Building Research Establishment Environmental Assessment Methodology) is the dominant green building rating scheme in the UK and one of the most popular ones across the world. BREEAM follows a holistic approach and awards ratings based on performance in many sustainability related factors like environmental impacts, social impacts and governance. Building projects pursuing a BREEAM certification are being awarded credits in different so-called issues that look into different aspects of sustainability like embodied carbon, operation energy carbon, ecology and others. One of the issues addressed in BREEAM is the Mat 01 issue for environmental impacts of materials. This issue in practice requires design teams to undertake a LCA during the design process of the building.

Key points

BREEAM Mat 01 requires design teams to undertake an options appraisal exercise in which they perform an LCA for 4 different superstructure options, 6 substructure and hard landscaping options and 3 core services equipment options during the concept design stage. Three superstructure options must also be assessed during the detailed design stage. More credits are awarded when LCAs are third party verified and when they align with Life Cycle Costing (LCC) assessments. In the case of office, retail and industrial buildings, credits will also be awarded based on a comparison of the LCA results with the BRE’s benchmarks.

System boundary

BREEAM requires separate LCAs for different parts of the building like the superstructure, substructure, hard landscaping and services equipment. All combined, BREEAM requires to include materials of the foundations, basements, frame, upper floor and roof slabs, roofing, envelope and core services equipment like the heating source, ventilation and heating distribution and fuel installation systems. This essentially includes the entire building except for the finishes and part of the MEP equipment.

Scope

The scope required by BREEAM is not fixed and depends on the tool that is being used. As a minimum modules A1-A3 are required. Modules A4, A5, Stage B and Stage C modules are to be reported if the recognised by BREEAM LCA tool supports them. BREEAM approves LCA tools on a case-by-case basis. A list of approved LCA tools may be found in this link.

2.2 RICS WLC ASSESSMENT PROFESSIONAL STATEMENT

RICS (Royal Society of Chartered Surveyors) is a professional organization for property and land experts. Although initially founded in the UK it now has presence and is recognised internationally. RICS conducts market research and analysis and provides insight and advice on a range of property and land related issues. One such issue is the whole life carbon assessment of buildings for which it published a professional statement[1] in 2017.

This statement provides advice to professionals in the construction industry on how to measure, manage, and reduce embodied carbon in building projects in the UK. The statement is based on the EN 15978 standard on Building LCA but goes one step further and defines various details to ensure consistency and facilitate the undertake of an LCA. The statement is currently being updated and a draft version is available for consultation[2] before its final publication.

Key points

The RICS professional statement is a methodology that defines how a whole life carbon assessment should be undertaken. It explains the concept of LCA and provides advice on how certain aspects of a building’s LCA should be modelled e.g. the service life of materials, end of life impacts, transportation distances of materials, biogenic carbon reporting etc.

System boundary

The system boundary includes the entire building including external works, MEP systems and finishes.

Scope

The scope includes the entire life cycle of the building. This includes modules that are typically excluded or are optional in other methods like B1 Use, B2 Maintenance and B3 Repair.

[1] https://www.rics.org/profession-standards/rics-standards-and-guidance/sector-standards/building-surveying-standards/whole-life-carbon-assessment-for-the-built-environment
[2] https://consultations.rics.org/whole_life_carbon_standard/consultationHome

2.3 LONDON PLAN

The London Plan is the spatial development strategy for Greater London Authority (GLA), which sets out a vision and a framework for the city's growth and development over the coming years. The plan covers a wide range of issues, including housing, transport, economic development, and the environment. In terms of sustainability, the London Plan includes a number of policies aimed at reducing the environmental impact of new development and promoting sustainable design and construction practices.

The latest revision of the London Plan introduced new requirements for the whole life carbon emissions[3] and circularity of new referable buildings.

Key points

The technical requirements for the whole life carbon assessment are based on the RICS professional statement. Regarding the timing of the assessment, the guidance requires design teams to undertake three related exercises. The first one is to define emission reduction strategies at an early stage before the outline planning application. The second one is for undertaking an assessment before the planning approval application and the third one for undertaking an As-built assessment after the construction has been completed. Apart from the above requirements, the guidance also suggests some aspirational limit values to be achieved by the developments. Although no reference has been found on whether and when these limit values are planned to become mandatory, there is a general trend across Europe for limit values to be applied in the near future in similar policies/regulations.

System boundary

The system boundary includes the entire building as per the RICS statement. However, the suggested limit values only apply to the superstructure of the building and the operational energy related emissions.

Scope

As per the RICS statement, the scope includes the entire life cycle including Module D which is reported separately.

2.4 PART Z

Part Z[4] is a proposed amendment to the UK building regulations to include requirements for whole life carbon assessment of buildings. Part Z was developed by a group of industry leaders in the UK on the subject of whole life carbon assessments and has received significant support from the construction industry.

This initiative had reached the UK Parliament with the Carbon Emissions (Buildings) Bill that was introduced to the UK Parliament in February 2022 and was mirroring the contents of the

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[3] https://www.london.gov.uk/sites/default/files/lpg_-_wlca_guidance.pdf
[4] https://part-z.uk/

proposed Part Z. However, in November 2022 the government declined to support it on the grounds that such regulation could not be introduced with no prior consultation on the impacts it would have to the industry and the planning authorities. This consultation is already planned for 2023 and 2024 leaving the possibility of a national regulation being introduced most probably not before 2025.

The proposed Part Z is based on the methodology of the RICS professional statement and also suggests the introduction of limit values from 2027 onwards.

2.5 MANCHESTER STANDARD

The Manchester Climate Change Partnership, a partnership that consists of public, private, community, faith, health, culture, and academic organizations from across the city, recently released its roadmap to net zero carbon new buildings in Manchester[5]. The partnership, supported by the Manchester Council, suggests the calculation of whole life carbon emissions in accordance with a nationally recognized methodology and the achievement of A1-A5 carbon emissions lower than set targets. It suggested these targets to be 500kgCO2e/m2 for residential developments, 600kgCO2e/m2 for offices and 550kgCO2e/m2 for retail buildings.

2.6 BRISTOL LOCAL PLAN

The City of Bristol recently published a draft of the updated local plan for consultation[6] which includes provisions for the embodied carbon assessment of new developments. Main points of the new proposed plan are:

- Prioritise renovation over new buildings where technically feasible
- Design of new buildings for material efficiency
- Design for adaptability
- Major developments to undertake embodied carbon assessments and achieve values below certain limits.

A detailed methodology or guidance has not been provided yet on how to conduct such assessments. It is expected that similar to the GLA guidance, this will be defined after the plan is approved and published. Developments will be expected to result in less than 625kgCO2/m2 for residential buildings with less than 5 storeys, less than 800kgCO2e/m2 for residential buildings with 5 storeys or more and 970kgCOe/m2 for non-residential buildings.

2.7 BATH AND NORTH EAST SOMERSET LOCAL PLAN

The Bath and North East Somerset council has recently released plans[7] to include an embodied carbon policy for all new major developments. Applicable developments are all residential buildings with 50 or more dwellings and commercial buildings with a minimum 5000m2 of commercial space. The developments must result in embodied carbon of less than 900kgCO2e/m2 for substructure, superstructure and finishes.

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[5] https://www.manchesterclimate.com/sites/default/files/Roadmap%20to%20Net%20Zero%20Carbon%20-%20Report.pdf
[6] https://www.bristol.gov.uk/files/documents/5446-bristol-local-plan-review-nov-22-further-consultation/file
[7] https://beta.bathnes.gov.uk/sites/default/files/2023-01/Sustainable%20Construction%20Checklist%20SPD%20%28PDF%29.pdf

3. EMBODIED CARBON BENCHMARKS

In this section, benchmark values are being presented for various building types in the UK. These benchmarks are the results of statistical analysis of real building LCAs from projects across the UK undertaken by One Click LCA users. 300 projects of different type such as apartments, cultural buildings, educational buildings, hotels and similar buildings, industrial production buildings, office buildings, retail and wholesale buildings and warehouses were included in the analysis.

One key finding of the UK Carbon Benchmark data is that there is significant variation in embodied carbon across different building types. For example, the embodied carbon of a typical apartment building is approximately 424 kilograms of CO_2 per square meter, while the embodied carbon of a typical house is approximately 235 kilograms of CO_2 per square meter.

Table 1: Average A1-A5 GWP impacts for various building types in the UK

Project Type	Average A1-A5 GWP (kgCO2e/m2)
Apartment Buildings	424
Houses	235
Cultural Buildings	336
Educational Buildings	444
Hospitals and Healthcare Centers	430
Hotels and Similar Buildings	302
Industrial Production Buildings	251
Office Buildings	433
One dwelling Buildings	368
Other Buildings	453
Prisons	405
Retail and wholesale buildings	437
Schools	364
Sport Halls	404
Transport Buildings	343
Warehouses	340
Grand Average	**400**

Other benchmarks that are available in the UK include the ones set by the Greater London Authority and those suggested by the London Energy Transformation Initiative(LETI). These are presented below.

Table 2: A1-A5 benchmarks in the UK (kgCO2e/m2 GIA)

Benchmark	Office	Residential	Educational	Retail
LETI 2020 Design Target	600	500(6+ storeys)	500	550
LETI 2030 Design Target	350	300(6+ storeys)	300	3000
GLA	950	850	750	850
GLA Aspirational	600	500	500	550

4. CASE STUDIES

In this section, two buildings owned by the City of Glasgow were assessed. These are:

- Broomhill Nursery and
- North Kelvinside School

The assessments were undertaken in line with the RICS Whole life carbon assessment guidance and EN15978. The scope included the entire buildings but not any external hard landscaping. Operational energy and operational water consumption impacts were excluded so that the results represent material related impacts only.

4.1 BROOMHILL NURSERY

Project Description

Broomhill nursery is a 767m2 GIFA nursery building. The building is one floor high and consists of a concrete ground floor slab, brick walls and standing seam roof.

LCA Results

The LCA results of Broomhill Nursery are summarized at Table 3 and represents the total life cycle GWP impacts during a 60-year service life.

Table 3. Life Cycle Assessment Results of Broomhill Nursery

Result category	Biogenic carbon (kg CO2e)	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations	B1 Use Phase	B2 Maintenance	B3 Repair	B4 Material replacement - materials	B5 Material refurbishment	B6 Operational Energy use - Regulated	B7 Operational Water use	C1 Deconstruction / demolition	C2 Waste transportation	C3 Waste processing	C4 Waste disposal	TOTAL kg CO2e	D External impacts (not included in totals)
0.1 Toxic Mat.																	
0.2 Demolition												2608				2608	
0.3 Supports																	
0.4 Groundworks																	
0.5 Diversion																	
1 Substructure	0	3893	54	279									47	5		4278	-590
2.1 Frame	0	20788	112	903									1016	58		22877	-5936
2.2 Upper Floors	-4807	65565	2976	3351				2131					1583	7711		78511	-45716
2.3 Roof	-21834	38466	164	2662				2230					168	27580	21	49458	-36962
2.4 Stairs & Ramps																	
2.5 Ext. Walls	-12620	19868	130	1394				9883					323	14159	3	33140	-25635
2.6 Windows & Ext. Doors	0	44390	37	0				44718					285	2	4	89436	-156
2.7. Int. Walls & Partitions	-3469	11924	104	1636				14045					864	3526		28629	-4632
2.8 Int. Doors																	
3 Finishes	-5547	11826	45	1314				20474					233	7427		35773	-25304
4 Fittings, furnishings & equipments																	
5 Services (MEP)	0	8445	132	135				14887					147	13	1	23761	-19572
6 Prefabricated																	
7 Existing bldg																	
8 Ext. works																	
Other or overall site construction				23273												23273	
Unclassified / Other	0	2144	2	315				6294					2	999		9756	-2102
TOTAL kg CO2e	**-48276**	**227311**	**3756**	**35263**				**114662**				**2608**	**4669**	**61479**	**29**	**401500**	**-166605**

Results are summarised below:

- The cradle to cradle GWP impact (A1-C4 + D) of the project is 283,172 $kgCO_2e$ or 369 $kgCO_2e/m^2$.
- The cradle to grave GWP impact (A1-C4) of the project is 449,776 $kgCO_2e$ or 586 $kgCO_2e/m^2$.
- Upfront GWP impacts from A1 to A5 of the project is 266,330 $kgCO_2e$ or 347 $kgCO_2e/m^2$.

According to the analysis, most of the impacts are released from A1-A3 Materials emissions as shown in Figure 2 below.

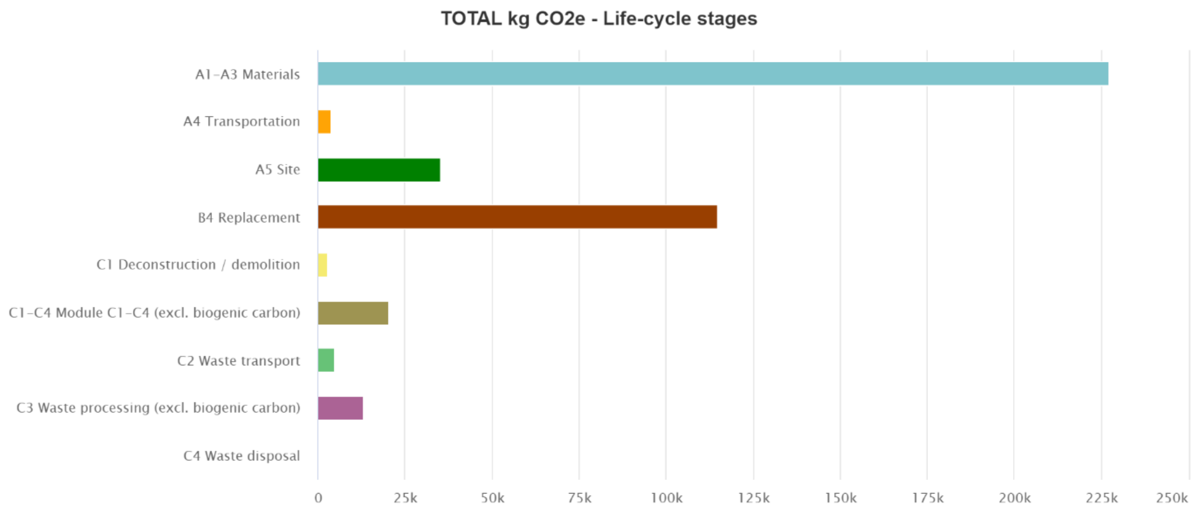

Figure 2. GWP (kgCO2e) - Life Cycle stages

The three largest contributors to the overall embodied carbon of the scheme are the Floors, External Walls, and Roofs as indicated in Figure 3 below.

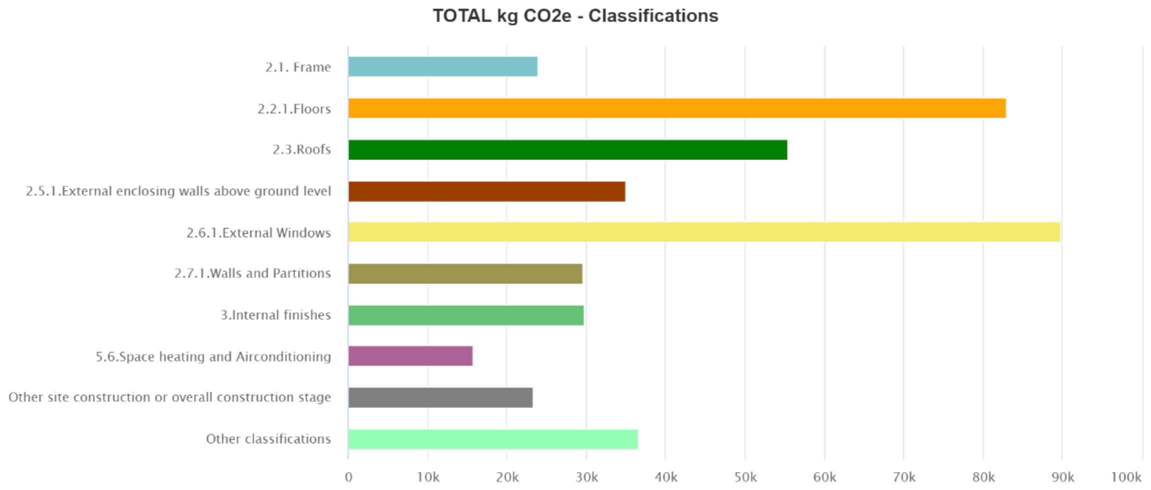

Figure 3. Total kg CO2e – Classification

4.2 NORTH KELVINSIDE SCHOOL

Project Description

North Kelvinside Primary School is a 4,675m2 GIFA school building which started operating on May 2022. It consists of concrete piling foundations, steel framing and composite metal decks.

LCA Results

The LCA results of North Kelvinside School are summarized in the following table and represent the total life cycle GWP impacts during a 60-year service life.

Table 4. Life Cycle Assessment Results of North Kelvinside School

Result category	Biogenic carbon (kg CO2e)	A1-A3 Product Stage	A4 Transportation to site	A5 Site operations	B1 Use Phase	B2 Maintenance	B3 Repair	B4 Material replacement - materials	B5 Material refurbishment	B6 Operational Energy use - Regulated	B7 Operational Water use	C1 Deconstruction / demolition	C2 Waste transportation	C3 Waste processing	C4 Waste disposal	TOTAL kg CO2e	D External impacts (not included in totals)
0.1 Toxic Mat.																	
0.2 Demolition												15895				15895	
0.3 Supports																	
0.4 Groundworks																	
0.5 Diversion																	
1 Substructure	0	577462	19881	27186									13663	1218		639409	-407505
2.1 Frame	0	581825	1373	19651									9005	521		612374	-423124
2.2 Upper Floors	0	119180	6627	6272									4770	418		137266	-151876
2.3 Roof	-4328	27473	52	2233				1919					346	5342		33037	-25351
2.4 Stairs & Ramps	0	4766	200	263									255	30		5513	-1433
2.5 Ext. Walls	-96743	200120	5900	17138				59945					4030	98655	65	289111	-401139
2.6 Windows & Ext. Doors	0	48365	39	0				48713					297	10	4	97427	-9835
2.7. Int. Walls & Partitions	-14051	79223	2004	8310				94209					4092	17394	9	191189	-44438
2.8 Int. Doors																	
3 Finishes	0	90025	1733	6815				92941					1116	96	19	192745	-24066
4 Fittings, furnishings & equipments																	
5 Services (MEP)	0	107957	820	1406				121834					677	59	24	232775	-70959
6 Prefabricated																	
7 Existing bldg																	
8 Ext. works																	
Other or overall site construction				141856												141856	
Unclassified / Other	0	44152	187	7729				301027					1197	27684		381975	-86088
TOTAL kg CO2e	**-115121**	**1880547**	**38815**	**238856**				**720589**				**15895**	**39446**	**151426**	**120**	**2970573**	**-1645815**

Results are summarised below:

- The cradle to cradle GWP impacts (A1-C4 + D) of the project is 1,439,880 $kgCO_2e$ or 308 $kgCO_2e/m^2$.
- The cradle to grave GWP impacts (A1-C4) of the project is 3,085,695 $kgCO_2e$ or 660 $kgCO_2e/m^2$.
- Upfront GWP impacts from A1 to A5 of the project is 2,158,218 $kgCO_2e$ or 462 $kgCO_2e/m^2$.

According to the analysis, most of the impacts are released from A1-A3 Materials production, followed by B4 Material replacement as shown in Figure 4 below.

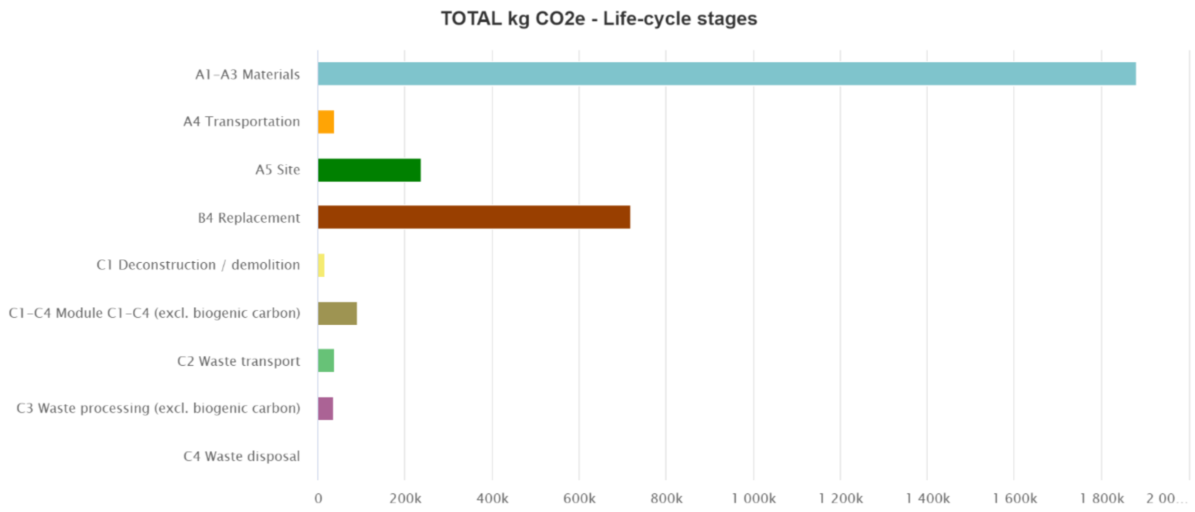

Figure 4. Global Warming kg CO2e - Life cycle stages

The three largest contributors to the overall embodied carbon of the building are the External Walls, Foundations and Frame as indicated in Figure below.

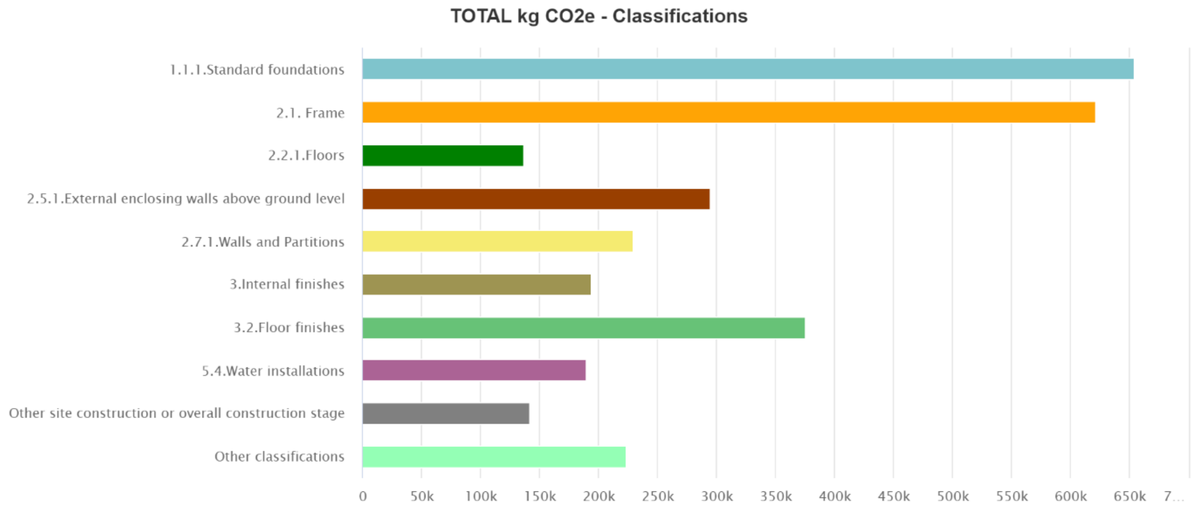

Figure 5. Total kg CO2e - Classifications

4.3 COMPARISON OF UK BENCHMARK AND CASE STUDIES

The two studied buildings are resulting in embodied carbon close to the calculated UK average for educational buildings. Broomhill Nursery results in 347kgCO2e and North Kelvinside School, 462 kgCO2e while the UK average for educational buildings for modules A1-A5 is 444kgCO2e.

It is noted that for Broomhill Nursery it was expected to fall below the average given its simple structural system and foundation. On the other hand, the design of North Kelvinside school is closer to a typical new school of this size with piling foundations, steel framing and composite metal deck slabs.

5. POLICY ROADMAP FOR REDUCING EMBODIED CARBON OF BUILDINGS IN GLASGOW

An action proposal for reducing embodied carbon and increasing the use of biobased materials was issued to the City of Glasgow in October 2021. One of the proposed actions was for the City to require embodied carbon calculations and reporting for new municipal and private buildings. In this chapter a roadmap of how such a policy could be developed is presented.

5.1 POLICY DEVELOPMENT ROADMAP

The following steps are identified as distinct steps to be followed during the policy development process.

1. Definition of policy outline. This will include answers to questions like what developments this policy will apply to and how to comply with it.
2. Definition of the calculation methodology
3. Definition of performance targets or limit values

All the above items are being discussed in more detail in the following paragraphs.

5.2 POLICY OUTLINE

The policy will need to define the following:

- The intent i.e. why is such policy needed.
- The building types that are subject to this policy.
- The size over which buildings become subject to this policy.
- A reference to the methodology that must be followed when assessing the embodied carbon.
- Targets or limit values that may need to be achieved by developments.
- The timing of the required assessment
- Any potential requirement for 3rd party verification of assessments

The intent of the policy must align with climate change mitigation targets set by the council. In most cases these are targets for achieving a Net Zero status by a certain year e.g. 2040.

The type and size of the buildings that will be subject to the new policy will depend on the real estate industry's ability in the region to quickly adapt this policy. New policies like this may be more challenging to comply with for smaller developers so a smooth transition must be considered of course bearing in mind the emergency of climate change. Eventually all new buildings must be built sustainably and with the aim to reach net zero carbon emissions.

A technical guidance on the methodology to be used for complying with this policy must be made available. The calculation aspects can be covered by referring to an existing and recognised methodology like the RICS methodology for Whole Life Carbon Assessment. Other details like the assessment scope and limit values must be defined in addition.

5.3 ASSESSMENT METHODOLOGY

Most similar policies and regulations across Europe usually dictate the use of an existing calculation methodology. This can be a national standard on Building LCA for example in the case of the Norwegian national regulation or a nationally recognised LCA methodology like in the case of the London Plan. For the cases where no such method already exists, one is being defined such as in the case of the Finnish national regulation.

In the UK, the RICS Professional Statement on Whole Life Carbon Assessments is recognised as a best practice guidance for such assessments across the country. The Greater London Authority is requiring all assessments to be made in compliance with this guidance. It is suggested that the City of Glasgow refers to the same guidance and only specify the potential deviations from the standard. These deviations can be limited to the scope and system boundary of the required assessments.

A whole life cycle assessment includes all modules from A1 to C4 plus module D as described in Section 1. This includes module B6 which is the operational energy related impacts which however can remain out of scope for this policy since these are addressed by the national regulation for energy efficiency of buildings (Part L). It is noted however that the council could introduce an additional policy for going beyond the national regulations or requiring the carbon offset of the expected operational energy emissions. Module B7 calculates the carbon emissions from water consumption during the operation of the buildings. This module can also remain outside the scope of the assessment in this case. Figure 6 below, highlights the remaining life cycle modules that could be required in an embodied carbon regulation policy in Glasgow.

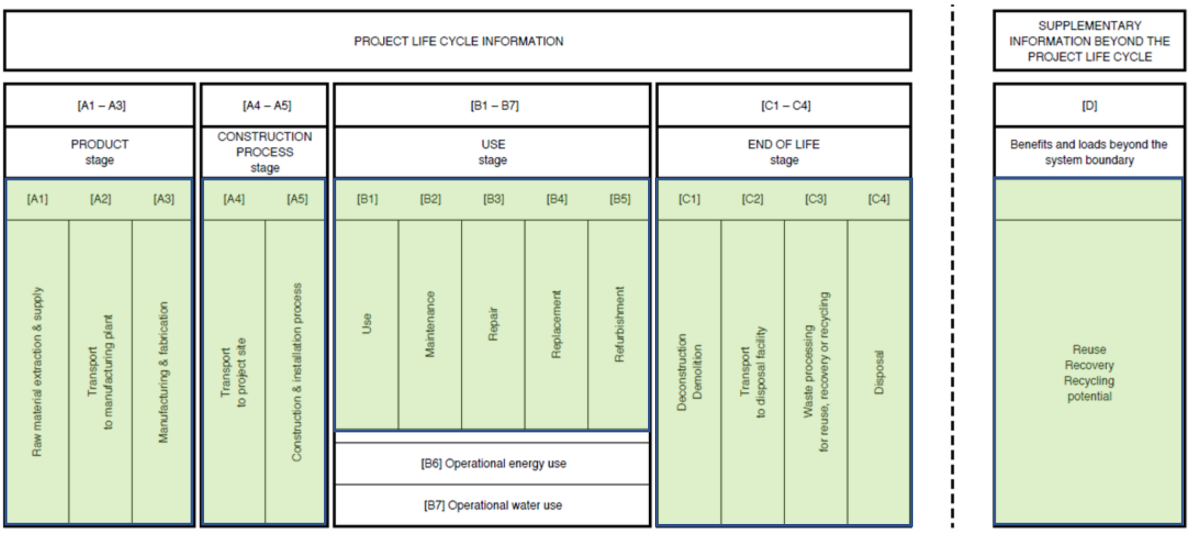

Figure 6: Suggested scope for embodied carbon assessments

Regarding the building parts to be included in the assessment it is suggested for the policy to align with the RICS guidance and require the inclusion of the entire building and external works. This is because parts of the building that are often excluded in embodied carbon assessments is some methodologies, can have a significant impact depending on the materials specification, the expected service life of the building and the type of the building.

For example, floor finishes, ceilings and building systems could have a major impact compared to other building parts in a building that is expected to be used for several decades as communicated in Figure 7.

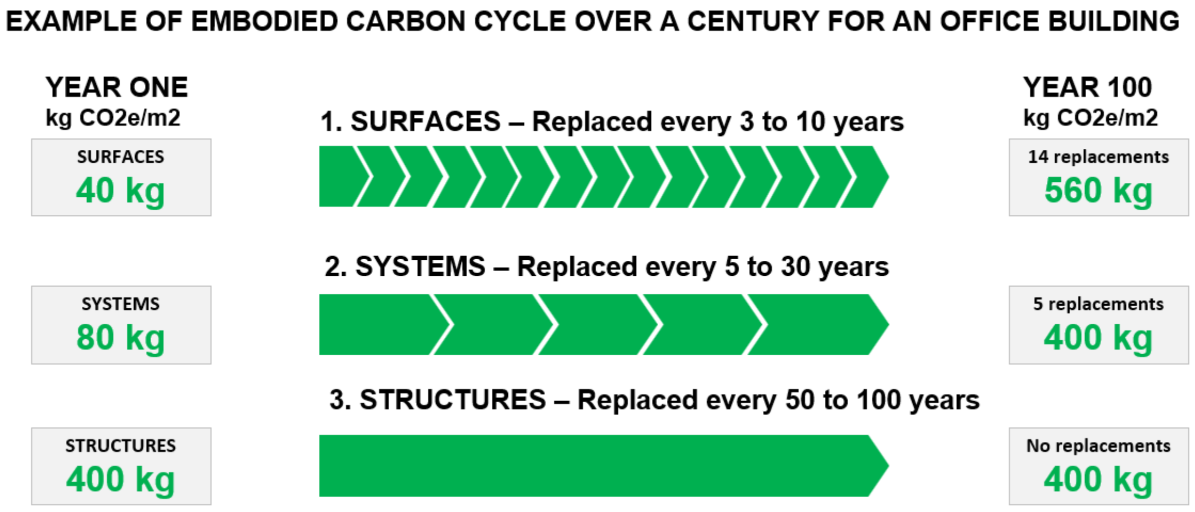

Figure 7: Impact of material replacements in long lasting buildings

5.4 LIMIT VALUES

An embodied carbon policy can be either a declaration-type policy which only requires the calculation and reporting of impacts or a limit value-type policy that apart from calculating and reporting the impacts it also requires developments to achieve certain performance levels similarly with national energy efficiency regulations.

Such policy will typically be introduced with no limit values initially until the construction sector in the region adapts to the changes required by the new policy. Limit values can be introduced later in the future for example in two years after the policy has been introduced. This period will allow the receipt and analysis of embodied carbon data from new developments which would help the policy makers make an informed decision on appropriate values for each building type.

It is also suggested for limit values to be set separately for different years in the future. These limit values must align with the council's sustainability and future carbon reduction goals and they must be set such so that they ensure a smooth transition to a net zero carbon building sector in the region.

5.5 IMPLEMENTATION TIMELINE

The implementation of the embodied carbon policy is suggested to follow the steps below:

1. Definition of an outline policy for assessing the embodied carbon of all new developments owned by the City of Glasgow.
2. Definition of the calculation methodology and reporting requirements.
3. Adjustment and publication of the policy to be applicable to private developments as well.
4. Publication of aspirational and optional limit values.
5. Definition of updated limit values based on data received and current climate change related targets and commitments. Limit values to be reduced gradually.

5.6 SUMMARY OF THE PROPOSED POLICY

The intent of the policy is to decarbonise the construction sector in the wider region and push the construction material manufacturing sector to decarbonise their manufacturing processes. It will allow the council to meet any decarbonisation targets already set or targets that may be set in the future.

All new office, retail, residential and educational buildings must undertake a whole life carbon assessment before planning application and upon completion of construction. More building types may be added by the council if needed. The calculation method to be followed must be in accordance with the latest version of the RICS Whole Life Carbon Assessment professional statement. Results must be reported in accordance with the RICS template by life cycle module and RICS category. A 3rd party verification of assessments submitted could become mandatory for developments of certain size. All assessments could undergo a spot quality check and verification by a 3rd party defined by the council.

The assessment must include all life cycle modules except for B6 and B7. The assessment must include all parts of the building including the MEP services, finishes and external works.

It is proposed that no limit values are enforced initially until a detailed study is undertaken to advise on appropriate values for each building type. The study must take into account the average performance of the previous developments and developments that have submitted whole life carbon results in accordance with the new policy. The study should also include a sensitivity analysis to advise on the impact different design solutions or site restrictions might have in the building's embodied carbon. Following the study, the council may define limit values for stage A1-A5 or the entire life cycle in accordance with its sustainability targets and any commitments related to reducing carbon emissions in the city.