Refurbishment vs. Demolition & New Build

A PROPOSED POLICY OUTLINE FOR CITIES

CNCA
CARBON NEUTRAL CITIES ALLIANCE

One Click LCA

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1. INTRODUCTION

This report proposes a policy outline for comparing the environmental impacts of the refurbishment of an existing building with those of the demolition and building a new structure instead. It suggests the key characteristics of such a policy as well as technical guidance on how the assessments should be undertaken. Such a policy can be introduced at a city level where cities have the power to enforce it or at a national level in the form of a building regulations amendment. This report focuses on the implementation at a city level.

1.1WHY A NEW CONSTRUCTION VS REFURBISHMENT POLICY

Global warming is an issue that requires urgent action to mitigate its negative effects on the environment and society. The built environment plays a substantial role in global warming, accounting for a significant portion of greenhouse gas emissions worldwide. According to the Intergovernmental Panel on Climate Change (IPCC), buildings are responsible for approximately 39% of global carbon dioxide (CO_2) emissions. This includes emissions from the construction, maintenance, and demolition phases (known as Embodied Carbon), as well as the energy used for heating, cooling, lighting, and appliances within buildings (known as Operational Carbon). Operational Carbon has been at the centre of sustainable building conversations for the last decade but as the grid decarbonises, the focus has been shifting toward Embodied Carbon.

While a lot of guidance already exists on how to reduce the embodied carbon of new buildings, the embodied carbon reduction potential from refurbishing new buildings is often overlooked. With the ageing building stock in Europe, it is necessary to understand the benefits of refurbishing existing buildings instead of deconstruction and building new. Refurbishment of existing buildings will play a vital role in achieving Europe's target for carbon neutrality by 2050 in line with the European Green Deal[1].

Refurbishment is the first measure that can be taken in order to eliminate carbon emissions from new developments. This is done by avoiding carbon emissions related to the demolition of existing buildings, the manufacturing of new materials, the transportation and on-site construction as well as improving operational energy performance.

For the context of this report, by refurbishment it is meant the construction works of any scale that are undertaken to restore and repair a building, upgrade it for improved energy and/or structural performance and any extensions to the existing site either vertically or horizontally.

1.2DRAMATICALLY REDUCING EMBODIED CARBON

This report is a part of Carbon Neutral Cities Alliance (CNCA) three-year project "Dramatically Reducing Embodied Carbon in Europe's Built Environment", launched in 2021, and funded by the Laudes Foundation and Built by Nature. The project aims to analyse, identify opportunities and levers, and to foster widespread adoption of ambitious local, national and regional policies that will reduce embodied carbon and increase the uptake of bio-based materials in the built environment in Europe, and serve as a model for other regions around the world.

[1] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

The main report titled City Policy Framework for Dramatically Reducing Embodied Carbon, is intended for cities and other government bodies to develop a strategy, action plan and policies they can adopt to dramatically reduce embodied carbon, defined as carbon emissions from manufacture, transport, use and end of life of construction materials. This is a manual and a blueprint for cities and government bodies to respond to the climate emergency.

As part of the wider work stream, One Click LCA conducted technical assessments for 12 cities to identify opportunities for embodied carbon reduction via the introduction of new policies. One of the recommendations encouraged cities to conduct a “Demolition versus refurbishment assessments” to assess the benefits of extending the life cycle of buildings that can be repaired instead of being demolished.

This report aims to provide more details on the type of requirements of such policy, propose an outline methodology for the whole life carbon assessment and comparison of the assessed options as well as explore the criteria against under which the demolition and new build will be allowed by the City.

1.3WHY LCA ASSESSMENT

As cities are looking to decrease operational and embodied carbon emissions of their building stock, it is important to ensure best use of resources and to have a reliable, repeatable and comparable methodology for it.

LCA allows to understand the short-term and long-term implication of each option. By including operational and embodied impacts to the assessment, the net benefits of refurbishment vs new build can be understood and the option with lowest overall carbon emissions selected.

The decision can also consider life-cycle costs (LCC) to make sure the approach is financially viable as well as resource use and circularity to ensure the proposed design is in line with the city’s climate goals.

1.4WHAT IS LIFE CYCLE ASSESSMENT

Life Cycle Assessment (LCA) is a methodology used to evaluate the environmental impacts of a building, 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 life cycle stages of a building for an LCA are define by EN15978 and EN15804 and are shown in Figure 1.

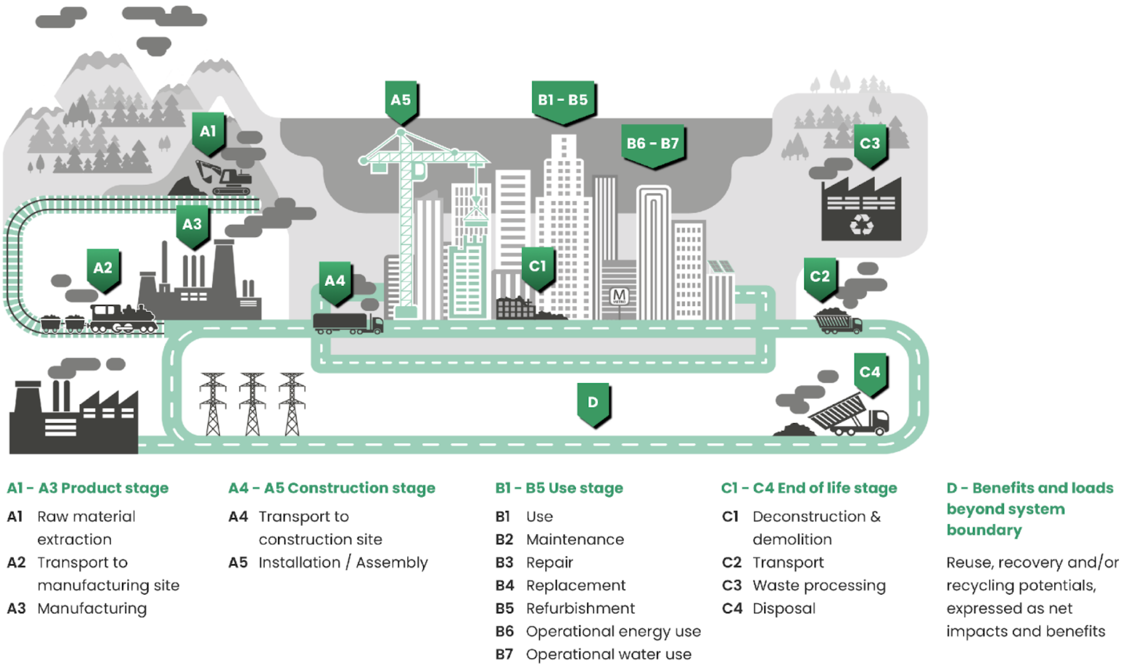

Figure 1: Life Cycle Stages of a building

LCA assesses environmental impacts for various environmental impacts categories such as Global Warming Potential, Acidification Potential, Eutrophication potential etc. Each impact category represents a building's impact to the environment in different ways. For example Global Warming Potential (GWP) represents the contribution of the building to the global warming via the release of Green House Gases to the atmosphere. As GWP is the environmental impact category looking into the Green House Gases like CO_2, it may also be referred as embodied carbon or whole life carbon emissions of a building, depending on the scope of the assessment.

More information about Building LCA can be found in this report by One Click LCA.

Refurbishment can yield carbon savings especially when it comes to upfront embodied carbon (A1 – A5) when compared to new builds. Whilst new builds may in some cases have better operational carbon performance (B6), they have a great upfront embodied carbon impact and higher material consumption comparatively. To identify the best option and quantify the benefit of one against the other, an LCA should be undertaken for each option.

1.5LCA STANDARDS AND METHODS

There are several guides and standards that provide guidance on how to conduct LCAs. The main LCA standards are given below:

- **"ISO 14040 – Environmental management – Life cycle assessment – Principles and framework", and "ISO 14044 – Environmental management – Life cycle assessment – Requirements and guidelines":** 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 Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method."** is based on the principles of ISO 14040 and ISO 14044. The standard sets out the requirements for conducting LCA of buildings, 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 building energy use. This includes guidance on the assessment of environmental impacts, such as energy and water use, land use, and waste generation. Detailed representation of the different life cycle stages and modules as defined in the standard is shown in Figure 2.

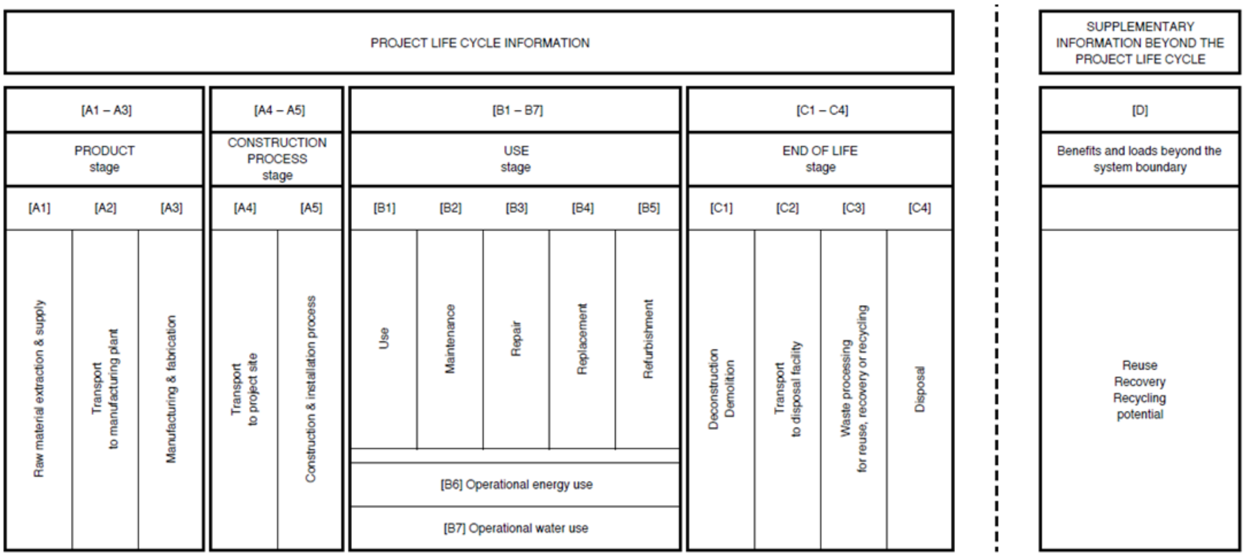

Figure 2: Life cycle stages and modules as per EN15978

Apart from these standards, there are various other LCA methodologies that are based on these standards. Such methodologies are either defined in certification schemes like the Building Research Establishment Environmental Assessment Method (BREEAM), local policies like London Plan or by professional groups like the Royal Institution of Chartered Surveyors (RICS) in the UK.

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.

In addition to building certification schemes and other LCA methodologies, several countries have introduced national LCA or Whole Life Carbon Assessment regulations for buildings. An overview of the existing national LCA regulations in Europe can be found in the "Construction Carbon Regulations in Europe" report published by One Click LCA in 2022.

2. POLICY OUTLINE

The proposed policy consists of the following key requirements.

1. Refurbishment feasibility study of existing buildings
2. LCA and LCC study of refurbishment scenario and new construction scenario
3. LCA and LCC results comparison
4. Application for demolition and justification

2.1 REFURBISHMENT FEASIBILITY STUDY

For all developments in sites with existing structures, it should be compulsory to consider refurbishment before demolishing the existing structure and building a new one. A site-survey should be commissioned before design commences (RIBA Brief-stage) to assess the structure of the existing building.

The site survey should cover the following as a minimum:

1. An assessment of the existing substructure and superstructure. The assessment should indicate whether the structure has any deficiencies that if not addressed would limit the remaining service life of the building below the typical service life of a new building. It is proposed for the purpose of this methodology that the service life should be set to 50 years in alignment with the Level(s) framework[2].
2. In the case that structural deficiencies are identified, the surveyor should recommend whether the structure can be maintained and/or strengthened to ensure that the service life of the existing structure is extended by at least 50 years. The surveyor must estimate and describe the remediation works that must be undertaken to extend the service life by at least 50 years and whether these works must be done prior to the refurbishment or are expected to take place during the next 50 years of the refurbished building.
3. If structural deficiencies are major and remediation works are technically not possible nor economically viable or if there is a health risk associated to the refurbishment that cannot be mitigated, then the surveyor must describe this in detail within the site survey report. The report should describe the structural deficiencies, health risks, the technical challenges that prohibit remediation and the factors that would drive the remediation costs to unviable levels and give an approximate estimate of the remediation costs in any case unless the works are deemed technically impossible.
4. When the refurbishment of the existing structure is not possible on the grounds of item 3 above, then a pre-demolition audit should be undertaken to identify any building elements that have the potential to be disassembled and reused in the new construction.

The site-survey should be undertaken by a 3rd party surveyor appointed by the developer.

All site survey reports that conclude that refurbishment is not feasible must be reviewed by the city to ensure that any measure has been considered in order to maintain the existing structure.

Below are some example outcomes of the site-survey.

Example #1 – Concrete structure is fit for reuse over 50 years.

[2] https://susproc.jrc.ec.europa.eu/product-bureau/product-groups/412/documents

The site-surveyor has confirmed that the structure can be retained for 50 years with no interventions. After confirming that life of structure can be further extended, the design team should include refurbishment as part of their design process to satisfy client brief.

Example #2 – Steel structure requires some items replaced before reuse over 50 years

The site surveyor has estimated that the structure can be retained for 50 years but requires intervention to enable extended life. The emissions associated with replacing and repairing existing structures must be included in the refurbishment design options and should be compared to the new building LCA. The design team should then include refurbishment as part of their design process to satisfy the client brief.

Example #3 – Structure is not fit for reuse.

The site-surveyor has confirmed that the structure cannot be retained for refurbishment due to ground movement and significant deformation of the building structure. The site survey should in addition identify any building elements that have the potential to be disassembled and/or reused in the new construction to maximise circularity of materials.

Example #4 – Structure cannot support vertical expansion.

The site-surveyor has confirmed that the existing structure cannot be reused as is for supporting additional floors required to satisfy the client brief. The site survey should identify the building elements that need to be strengthened and any additional new elements that needs to be installed that allow the refurbished building to extend to the required size or at its maximum potential. Strengthening of existing elements and the introduction of new elements must be considered in the LCA study of a separate option.

2.2 LCA AND LCC STUDY OF REFURBISHMENT SCENARIOS AND NEW CONTRUCTION SCENARIOS

As refurbishment options (at least one) and new-build options are outlined, an LCA should be carried out for all design proposals to estimate the best solution when it comes to whole life carbon emissions. An LCC may also be undertaken optionally to prove the viability.

Doing whole-life cycle assessment (A to C + D) helps establish the upfront (A1-A5) emissions (associated with extraction, manufacturing, transport to site and construction) as well as the in use and end of life emissions for refurbishment and new build options over a 50 year period.

Once calculations are completed, results should be compared by using one of the following two units.

1. GWP impacts per occupant per year for all residential developments
2. GWP impacts per m2 of NIA[3] per year for all non-residential developments

In the case of LCC, costs should be reported with the following units:

[3] The net internal area (NIA) of a building is the usable area measured to the internal finish of the perimeter or party walls, ignoring skirting boards, at each floor level. Net internal area includes all areas that can be used for a particular purpose.

1. Euros (€) or local currency per occupant per year for all residential developments
2. Euros (€) or local currency per m2 of NIA[3] per year for all non-residential developments

2.3 LCA AND LCC RESULTS COMPARISON

Both refurbishment and new-build options will be assessed over a period of 50 years to guarantee consistency of results as well as comparability. Once the LCA and LCC results are compared, a decision can be made on whether a new-build development can be approved.

LCA comparison

New buildings will in principle result in higher embodied and whole life carbon emissions. Making a decision purely based on the Building LCA results means that the new building option will almost always not be a preferred option. However there are other factors that may influence such a decision as well. The two main factors are:

1. The site densification (additional occupants/users per m2 of site) because of the new building option and
2. Impacts to the local economy.

Density considerations

It is possible that refurbishing and extending an existing building will not achieve the same final gross floor area as a new building. This may be because of limitations in strengthening the existing structure so that it can support the required number of additional floors. In such cases, the refurbishment scenarios will always be for smaller buildings than the proposed new buildings. To ensure a fair comparison, impacts are compared on a per m2 of NIA basis as explained above. However, in some cases, building a new, larger, and taller building could be a more sustainable option than refurbishing a small existing building even if the direct comparison is in favour of the refurbishment option. This is because of carbon savings that are not captured in a Building LCA, like the building users commuting and the more efficient use of existing infrastructure in redeveloped sites.

To take both into account, the city must allow for a maximum accepted GWP increase of new build developments compared to refurbishment when certain criteria related to public transport and infrastructure are satisfied.

Commuting related carbon savings can be taken into account by calculating a public transportation index similar to the BREEAM International methodology of the Tra 01 issue. New developments that are proposed in a site with a public transport accessibility index higher than the defined benchmark may be allowed for a set increase of the GWP impacts compared to the refurbishment scenario. A simplified rule would be to allow the additional GWP allowance for sites that are within a defined proximity to the City centre and a train station. The Finnish Ministry of Environment classifies the area within 2km from a city centre and within 400m from a public transport station as a public transport zone[4]. In such zones more people will likely use public transport instead of private cars, reducing the carbon emissions related to commuting to and from the new building.

Regarding the public infrastructure (roads, utilities etc.) the GWP increase may be allowed in zones where the infrastructure has capacity to facilitate the additional building occupants/users that will result from the new building.

[4] https://www.motiva.fi/files/1986/Liikennetarpeen_arviointi_maankayton_suunnittelussa.pdf

Impacts to local economy

An assessment may also be undertaken, prior to policy making, on the impacts to the local economy. In principle it is expected that, the local economy will not be affected negatively. This is because the proposed policy will move the construction sector's focus on refurbishment from new build that is now. The available building stock will not be reduced, but the balance between refurbished and newly built buildings will change. However, introducing such a policy will directly affect landowners who in some cases may not be able to reach the maximum potential of built area for their site. To reduce these economic impacts the city may take the following measures[5]:

1. Allow a maximum increase of GWP impacts of e.g., 20%. The percentage allowance must be small to incentivise developers to minimise the embodied carbon of their new developments.
2. Exclude small sites and/or buildings from the policy. For example, sites with a maximum potential-built area of 500 m2 may be excluded.
3. Exclude sites owned by private individuals based on income and overall wealth value.
4. Introduce the new policy progressively, starting with large sites and landowners first and enforcing it widely in a period of 5 years for example.
5. A new build development may be allowed if the construction and/or life cycle costs of the refurbishment option are considerably higher than the ones of a new construction. A new construction that is granted permission on an LCC basis may be subject to embodied carbon limits or lower limits where such already exist.

Life Cycle Costing comparison

The LCC study may be optional. The comparison between new build and refurbishment scenarios will primarily be based on the whole life carbon emissions as calculated in the LCA study. However as proposed above, construction cost and/or life cycle cost may also be used as a criterion for the selection of new build or refurbishment. Cities may choose to allow new build developments in cases where construction or life cycle costs of refurbishment scenarios are higher than those of new build. Similarly, with LCA results it is expected that construction and life cycle costs will rarely be higher in refurbishment projects. However, for cases where the existing structure requires significant retrofit and strengthening works, it may result in higher construction costs due to technically more challenging works. For those occasions, the city may allow a new build if the refurbishment costs are higher than a set benchmark e.g., 20%.

2.4 APPLICATION FOR DEMOLITION AND JUSTIFICATION

Demolition of existing structures should be allowed if:

- The asset has been deemed not-reusable for refurbishment by the site surveyor. It should be noted that reuse/recycling of materials should still occur. Therefore, pre-demolition audit should be carried out to preserve any materials that can be re-used, recycled or upcycled.
- The new build option has lower life cycle GWP impacts than the refurbishment options.

[5] All values mentioned are example values. Each city must define the values based on its socioeconomic state and its carbon emissions reduction goals.

- No refurbishment option can achieve the maximum potential built space and the site is within a public transport zone (Zone and specific criteria to be defined by the City) and the GWP of the new build option is not higher than the limit set by the City.
- No refurbishment option can have a construction cost or life cycle cost below the maximum limit as defined by the City.
- The site or the site owner fulfils the socioeconomic criteria for exclusion from the policy.

Demolition of any existing building should always be approved by the City following a demolition application where the reasons and alignment with the Policy are explained.

2.5 ENFORCABILITY OF POLICY

This policy should cover all new developments in private and public sector. This may change depending on the policy enforceability of the City. Cities that cannot enforce such policies to the private sector can apply it to their own buildings only. Where the policy cannot be enforced, incentives may be given for the voluntary compliance. For example, the city may grant a density bonus to new developments on clear sites where the developer has previously voluntarily opted for a refurbishment of an existing building instead of demolition.

The Policy may be introduced gradually to ensure a smooth adoption by the construction industry. The Policy can initially be enforced to large developments and for certain building types and gradually extended to apply to all buildings within a time span of 5 years for example.

3. ASSESSMENT METHODOLOGY

In this section, the suggested LCA methodology for assessing demolition + new build and refurbishment is outlined.

Life Cycle modules and site boundary.

The assessment of the refurbishment vs. new build should include all product stage modules, material replacement impacts, end of life impact of materials as well as operational energy impacts (B6) and benefits and impacts beyond the system boundary (module D). Due to the early stage of the assessments, modules B1, B2, B3, B5 and B7 may be excluded for simplicity of the assessment. Impacts under these modules should not differentiate between the two assessed options eliminating this way the impact in the comparison of the two options. The physical boundaries of the assessment are defined by the site boundary.

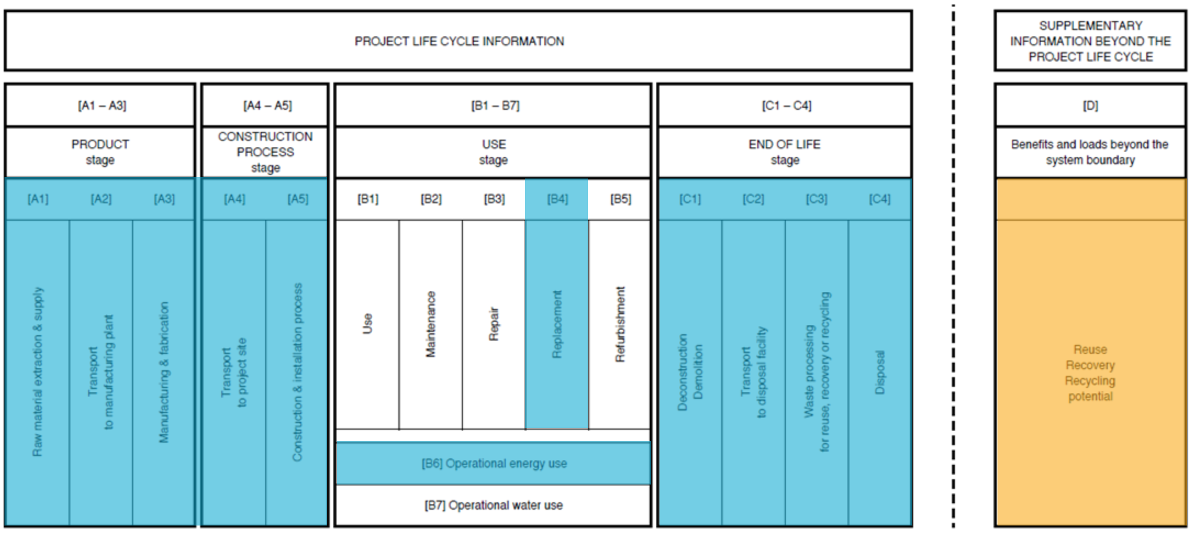

Figure 3: LCA scope (Modules highlighted in green are mandatory. Module D is mandatory and reported separately.)

Scope of building elements

The scope of assessed building elements should be in line with EN 15978. This assumes most building elements to be included in the assessment (where applicable) even at an early start. Assumptions should be made for building elements that are not defined yet, both in new build as well as refurbished designs.

In the case of a refurbishment/retrofit, works related to retrofitting a built asset should also be included.

Demolition impacts

For comparison purposes, the demolition of existing assets (for new builds) and any demolition/deconstruction or alterations to facilitate the retrofit/refurbishment works (for refurbishment) should be included in the assessment. This deviates from the EN 15978 standard according to which demolition impacts belong to the existing building's life cycle, but it ensures a fair comparison as demolition impacts of existing assets are saved when the refurbishment option is selected instead of building new.

Any deconstruction/demolition of existing structures should be accounted for in module A5.

To calculate the carbon emissions associated with pre-construction demolition and retrofit enabling work (deconstruction and/or partial demolition), appropriate emissions factors must be made available to the applicants either in the form of suggested values for standard demolition works or in the form of approved LCA tools and databases.

Note: To facilitate the assessments and ensure consistency among assessed projects, benchmark cost and carbon emission values may be provided in the policy for the following processes unless these are already covered in existing LCA tools:

1. the demolition of an existing building per m^2 GFA, for different structural frame types.
2. the deconstruction of facades per m^2
3. the stripping out of floor finishes
4. the stripping out of ceilings
5. the stripping out of wall finishes
6. the deconstruction of internal walls
7. Complete refurbishment (Removal of all building elements except for the foundations, structural frame and structural slabs and installation of new elements)
8. Removal of damaged structural elements (per kg or m^3 for steel, concrete and timber elements)
9. New façade installation impacts
10. New floor finishes installation impacts
11. New ceilings installation impacts
12. New internal wall installation impacts
13. Construction of new buildings (per m^2) for different structural frame types

Reference study period

The reference study period for the refurbishment should be 50 years, in line with the reference study period of new buildings according to Level(s). Where the extended life expectancy of 50 years cannot be ensured in a refurbishment option, the reference study period for this option may be adjusted as per the site surveyor's recommendation. In this case, the impacts of the refurbishment option must be adjusted to take into account the construction of a new building at the end of the refurbished building service life using the formula below:

L_R: Service life of refurbishment options e.g. 25 years. Cannot be more than 50 years.

L_N: Service life of new build is 50 years

GWP_R: GWP of refurbishment option in $kgCO_2e/m^2/year$

GWP_N: GWP of new build option in $kgCO_2e/m^2/year$

GWP_A: Adjusted GWP of refurbishment option in $kgCO_2e/m^2/year$

$$GWP_A = \frac{GWP_R \times L_R + GWP_N \times (L_N - L_R)}{L_N}$$

Operational energy impacts

The estimations of B6 impacts, also known as operational energy impacts, should follow the local recommended energy modelling standards/policy. At the stage that this comparative assessment is undertaken it is unlikely that any energy study will have been undertaken, since this is typically done at concept and planning design stage. Assessors may model B6 impacts based on the maximum operational energy consumption allowed by the national energy efficiency regulation or based on the client's target if lower.

HVAC systems may be considered the same across the two options for simplicity. Assumptions on primary energy sources must be the same for both options.(e.g. natural gas for heating and electricity for the rest of the consumption or electricity for all energy uses)

Operational energy should only include the regulated (building systems) loads. Unregulated loads (plug loads) must be left out of the assessment scope.

Regulated energy refers to building energy consumption resulting from the specification of controlled, fixed building services and fittings, including space heating and cooling, hot water, ventilation, fans, pumps, and lighting. Such energy uses are inherent in the operation of a building.

Unregulated energy is the energy consumption resulting from a system or process that is not 'controlled', ie energy consumption from systems in the building on which the Building Regulations do not impose a requirement. For example, IT equipment, lifts, escalators, refrigeration systems, external lighting, ducted-fume cupboards, servers, printers, photocopiers, laptops, cooking, audio-visual equipment, and other appliances.

As the electricity grid is being decarbonised steadily in most countries and in order to account the future energy related emissions more accurately it is proposed that the carbon emission factors used to estimate B6 impacts consider the future decarbonisation of the electricity grid. Where no decarbonisation projection for the national electricity grid is available, assessors may use the most recent carbon emission factors that are available for their region.

LCA data selection

As the assessment is carried out at strategic/concept design phases, no specific products will have been selected and sometimes no materials (and their technology) have been specified. Generic data should therefore be used for the purpose of the comparative assessment.

Generic data can be any of the following two types:

Generic material type	**Example**	**Description**
Generic EPD	BRMCA Generic Ready Mixed Concrete EPD, European Flexible Bitumen Sheet EPD, Swedish Sawn Timber EPD	Industry average EDP. Verified data to a consistent methodology (EN15804). Relevant to a specific group of manufacturers but may cover products with a wide range of impact. Industry average EPD are also available for other regions.

Generic LCA databases for construction (can be conservative)	BRE IMPACT database, generic datasets from Oekobau.dat, default datasets from INIES, One Click LCA generic materials	Data produced to a consistent methodology (EN15804), but usually without direct data from manufacturers. May not have been peer reviewed. Will be specific to a region and may be production or consumption based.

When available, always select generic EPD data. If generic EPD is not available, prioritise generic LCA data which follows the EN15804 calculation methodology. Where generic data are not available, average performing EPDs from local manufacturers can also be used.

3.1 MODELLING CONSISTENCY AND FUNCTIONAL EQUIVALENCE

To fairly assess new building and refurbishment options, modelling consistency and functional equivalence between the two options assessed (refurbishment and new build) is key.

Modelling consistency refers to the selection of underlying assumptions, data, and methodologies used in different stages of an LCA study being aligned and coherent.

The assessor must ensure to:

- Include the same life cycle modules.
- Use the same system boundary (building parts).
- Use the same assumptions and scenarios where needed.
- Use the same data source and data type. Select same EPDs for same products in both options, use the same LCI data source (example: If a generic concrete C32/40 datapoint was used in one of the assessments, retain the same datapoint. For different materials, retain the same data source/type).

Functional equivalence refers to the concept of comparing products, processes, or services based on their ability to fulfil the same function by the same means.

Ensuring to:

- Specify the same material (example: don't use carpet in one option and polished concrete in the other)
- Specify same technology and specifications (examples: don't compare a concrete extension to the existing building with timber new structure. Maintain the same GGBS or fly-ash replacement in concrete mixes across both options for example).

Any deviation on specifications between the assessed options should be clearly justified.

3.2 THIRD PARTY VERIFICATION AND APPLICATION REVIEW

All assessments that show that a demolition and new build option can be pursued must be verified by an independent, competent, third party. Special focus will be given on the consistency of the assumptions and material selection of the assessments.

The City may undertake a detailed review of the assessments as well, when these result in the preference of a demolition and new build option. The city may decide to review all such assessments for large existing buildings. The definition of a large building varies in different countries and regions, and it depends on the current building stock of the city. All other assessments will be subject to spot check reviews with the aim to review a minimum of 20% of all assessments for example.

3.3 LCA RESULTS REPORTING

Results of the LCA for refurbishment and new build designs should be reported using the functional units outlined in Paragraph 2.3. The results may be reported in accordance with any existing local policy or national LCA methodology. In lack of any such policy or methodology, the results may be submitted to the City in the following form.

	A1-A3	A4	A5	B4	B6	C1	C2	C3	C4	**Total**	D
Substructure					N/A						
Superstructure					N/A						
Finishes					N/A						
Roofing					N/A						
Building Services											
External Works					N/A						
Total											

4. EXAMPLE POLICY

In this Chapter, a simplified example is provided of a policy for assessing refurbishment and demolition and new build options. It is assumed that the city has legislative power to enforce the policy to all developments including municipal and private ones. The city is assumed to be in the UK, hence reference to the RICS guidance on whole life carbon assessment is made.

Note: None of the numbers used in the example policy is based on a scientific or other analysis. Cities should undertake socioeconomic studies to define the most appropriate figures for their regions.

Policy – Minimising greenhouse gas emissions via refurbishment of existing buildings

1. Refurbishment or refurbishment and extension of existing buildings should be prioritised over demolition and new construction to reduce whole life carbon emissions of the building.
2. When the option of demolition and new construction is proposed for applicable developments, it must be supported by a whole life cycle carbon assessment that compares the refurbishment and new construction options. Developments that are subject to the above assessment must undertake the following:
    a. Refurbishment feasibility study of existing buildings (Paragraph 4)
    b. LCA and LCC assessment of refurbishment scenario and new construction scenario (Paragraph 5)
    c. LCA and LCC results comparison (Paragraph 5)
    d. Application for demolition and justification if relevant (Paragraph 6)
3. Any development for which, one of the following applies, is subject to this policy:
    a. Developments built on sites with maximum potential-built area larger than 1000 m^2.
    b. Developments built on sites with existing buildings larger than 500 m^2.
    c. The site is owned by individuals or companies with annual net income lower than GBP 100000.
4. Refurbishment feasibility study: For all developments that are applicable to the policy, it is compulsory to consider refurbishment before demolishing the existing structure and building a new one. A site-survey should be commissioned before design commences (RIBA Brief-stage) to assess the structure of the existing building. The survey must cover the following as a minimum:
    a. An assessment of the existing substructure and superstructure. The assessment must indicate whether the structure has any deficiencies that if not addressed would limit the remaining service life of the building below 60 years.
    b. In the case that structural deficiencies are identified, the surveyor must recommend whether the structure can be maintained and/or strengthened to ensure that the service life of the existing structure is extended by at least 60 years. The surveyor must estimate and describe the remediation works that must be undertaken to extend the service life by at least 60 years and whether these works must be done prior to the refurbishment or are expected to take place during the next 60 years of the refurbished building.

c. If structural deficiencies are major and remediation works are technically not possible or economically viable or if there is a health risk associated to the refurbishment that cannot be mitigated, then the surveyor must describe this in detail within the site survey report. The report must describe the structural deficiencies, health risks, the technical challenges that prohibit remediation and the factors that would drive the remediation costs to unviable levels and give an approximate estimate of the remediation costs in any case unless the works are deemed technically impossible.
d. When the refurbishment of the existing structure is not possible on the grounds of item c, then a pre-demolition audit must be undertaken to identify any building elements that have the potential to be disassembled and reused in the new construction.

The site-survey must be undertaken by a 3rd party surveyor appointed by the developer.

5. LCA and LCC assessment of refurbishment scenario and new construction scenario: The assessments must be undertaken in line with the "Refurbishment vs Demolition and New Build whole life cycle carbon assessment" guidance. Results must be reported and compared in line with the guidance.
6. Application for demolition and justification: Demolition of existing building for redevelopment can only be allowed via a formal application for demolition. Demolition of existing buildings that are subject to this policy can be granted if:
    a. The asset has been deemed not-reusable for refurbishment by the site surveyor.
    b. The new build option has lower life cycle GWP impacts than the refurbishment options as per the LCA analysis.
    c. No refurbishment option can achieve the maximum potential built space and the site is within a "public transport" zone and the GWP of the new build option is not higher than the respective limit values in the "Refurbishment vs Demolition and New Build whole life cycle carbon assessment" guidance.
    d. The construction cost or whole life cost of the refurbishment options is more that 20% higher compared to the new build option.

Refurbishment vs Demolition and New Build whole life cycle carbon assessment guidance

Life Cycle modules and site boundary

Figure 4 shows the modules that should be included in the LCA of both the refurbishment and new build options.

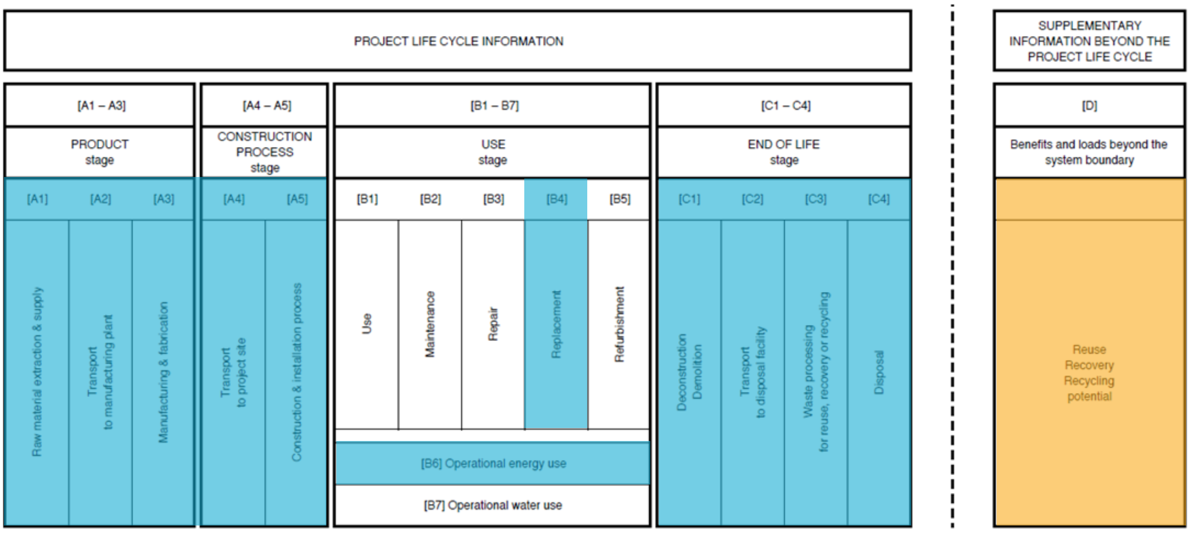

Figure 4: LCA scope (Modules highlighted in green are mandatory. Module D is mandatory and reported separately.)

Scope of building elements

The building elements included in the assessment must be in line with the RICS "Whole life carbon assessment (WLCA) for the built environment" standard.

Assumptions should be made for building elements that are not defined yet at the stage of the assessment, both in new build as well as refurbished designs.

In the case of a refurbishment/retrofit, works related to retrofitting a built asset should also be included.

Demolition impacts

The demolition of existing assets (for new builds) and any demolition/deconstruction or alterations to facilitate the retrofit/refurbishment works (for refurbishment) should be included in the assessment.

Any deconstruction/demolition of existing structures should be accounted for in module A5.

To facilitate the assessments and ensure consistency among assessed projects, benchmark cost and carbon emission values may be provided in the policy for the following processes unless these are already covered in existing LCA tools:

1. Demolition of an existing building per m^2 GFA (Steel frame): *(emission factor provided)*
2. Demolition of an existing building per m^2 GFA (Concrete frame): *(emission factor provided)*
3. Demolition of an existing building per m^2 GFA (Timber frame): *(emission factor provided)*
4. Demolition of an existing building per m^2 GFA (Load bearing walls): *(emission factor provided)*
5. Deconstruction of facades per m^2: *(emission factor provided)*
6. Stripping out of floor finishes: *(emission factor provided)*
7. Stripping out of ceilings: *(emission factor provided)*
8. Stripping out of wall finishes: *(emission factor provided)*
9. Deconstruction of internal walls: *(emission factor provided)*

10. Complete refurbishment (Removal of all building elements except for the foundations, structural frame and structural slabs and installation of new elements): *(emission factor provided)*
11. Removal of damaged structural elements (per kg or m^3 for steel, concrete, and timber elements): *(emission factor provided)*
12. New façade installation impacts: *(emission factor provided)*
13. New floor finishes installation impacts: *(emission factor provided)*
14. New ceilings installation impacts: *(emission factor provided)*
15. New internal wall installation impacts: *(emission factor provided)*
16. Construction of new buildings (per m^2) for different structural frame types: *(emission factor provided)*

Reference study period

The reference study period for the refurbishment should be 60 years, in line with the reference study period of new buildings according to the RICS Whole life carbon assessment (WLCA) for the built environment standard. Where the extended life expectancy of 60 years cannot be ensured in a refurbishment option, the reference study period for this option may be adjusted as per the site surveyor's recommendation. In this case, the impacts of the refurbishment option must be adjusted to consider the construction of a new building at the end of the refurbished building service life using the formula below:

L_R: Service life of refurbishment options e.g. 25 years. Cannot be more than 60 years.

L_N: Service life of new build is 60 years

GWP_R: GWP of refurbishment option in $kgCO_2e/m^2/year$

GWP_N: GWP of new build option in $kgCO_2e/m^2/year$

GWP_A: Adjusted GWP of refurbishment option in $kgCO_2e/m^2/year$

$$GWP_A = \frac{GWP_R \times L_R + GWP_N \times (L_N - L_R)}{L_N}$$

Operational energy impacts

The estimation of B6 impacts should be based on the maximum energy consumption allowed by the Approved Document L.

HVAC systems may be considered the same across the two options for simplicity unless the refurbishment option does not allow for the same systems to be installed. Assumptions on primary energy sources must be the same for both options (e.g. natural gas for heating and electricity for the rest of the consumption or electricity for all energy uses)

Operational energy should only include the regulated (building systems) loads. Unregulated loads (plug loads) must be left out of the assessment scope.

The carbon emission factors used to estimate B6 impacts must consider the future decarbonisation of the electricity grid based on the latest Future Energy Scenarios of the National Grid.

LCA data selection

When available, generic EPD data should be used. If generic EPD is not available, generic LCA data which follow the EN 15804 calculation methodology should be prioritised. Where generic data are not available, average performing EPDs from local manufacturers can also be used.

Modelling consistency

The assessor must ensure modelling consistency between the two compared options by

- Including the same life cycle modules.
- Using the same system boundary (building parts).
- Using the same assumptions and scenarios where needed.
- Using the same data sources and data types. The same EPDs for same products should be used in both options. The same LCI data source should be used in both options.

Functional equivalence

The assessor must ensure functional equivalence across the two compared options by:

- Specifying the same materials for the same functions in both options (example: don't use carpet in one option and polished concrete in the other if both finishes can be applied to both options)
- Specifying the same technology and specifications (example: don't compare a concrete extension to the existing building with a timber new structure or maintain the same GGBS or fly-ash replacement in concrete mixes across both options).

Any deviation on specifications between the assessed options should be clearly justified.

Third party verification

All assessments showing that a demolition and new build option can be pursued must be verified by an independent, competent, third party. Special focus must be given on the consistency of the assumptions and material selection of the assessments.

Results Reporting

Results of both options must be reported using the reporting template of the RICS Whole life carbon assessment (WLCA) for the built environment standard.

5. REFURBISHMENT CASE STUDIES

In this section, two buildings in London (UK) are reviewed to appreciate the practical implication of refurbishment. Both projects have occurred in the Greater London area where a whole life carbon assessment and circular economy assessment policy is already in place.

The two projects showcased were both awarded for the utilisation of the existing structure in the Structural Awards 2022 organised by the Institution of Structural Engineers in the UK. The two projects are:

- London South Bank University – London Road Building
- HYLO – London, Islington

London South Bank University – London Road Building

New student hub building reusing an outdated reinforced concrete frame building. No new NIA was created in this development. By refurbishing and saving as much of the existing materials as possible, the embodied carbon component related to substructure and superstructure for the project is just 49 $kgCO_2e/m^2$. Design and construction works have been extensive including existing structure verification, carbon-fibre strengthening, further modifications and new structural additions of various scale.

Structural works have further extended its design life by 50 years.

HYLO – London, Islington

Office building developed by retrofitting an existing 1960s, 16 storeys building to which 16 new floors were added on top, and effectively doubling the leasable area by simply reusing its existing frame and foundations.

Reuse of structures was achieved through redirecting load paths and allowed the designers to exploit the inherent robustness in the original structure.