CN06

Embodied Carbon Policy Options

Winchester Council

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Winchester City Council

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What is Whole Life Carbon?

Whole life carbon is the sum total of all asset related carbon emissions, both operational and embodied over the life cycle of an asset including its disposal (Modules: A1-A5, B1-B7,C1-C4,) all including biogenic carbon.

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Operational Carbon

The carbon arising from all energy consumed by an asset in-use, over its life cycle (Module B6).

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Embodied Carbon

The carbon emissions associated with materials and construction processes throughout the life cycle of an asset (Modules A1-A5, B1-B5, C1-C4). Embodied carbon is further categorised and explained in the following page.

Factors affecting the building's **embodied carbon emissions** The building lifecycle modules are further explained in the following page.

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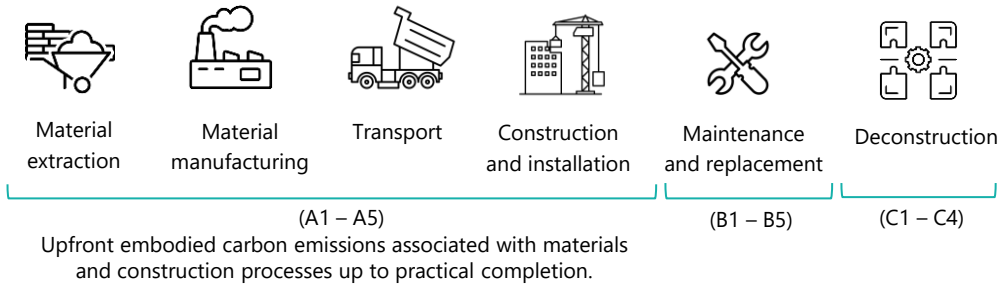
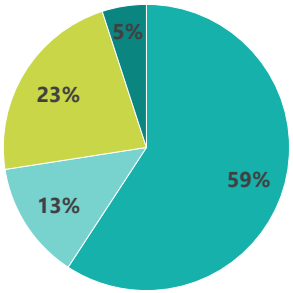




Whole life carbon emissions breakdown for a residential building with an energy use intensity of 35 kWh/m^2

- (A1 – A5) Upfront embodied carbon
- (B1-B5) Maintenance and replacements
- (B6) Operational carbon
- (C1-C4) End of life disposal

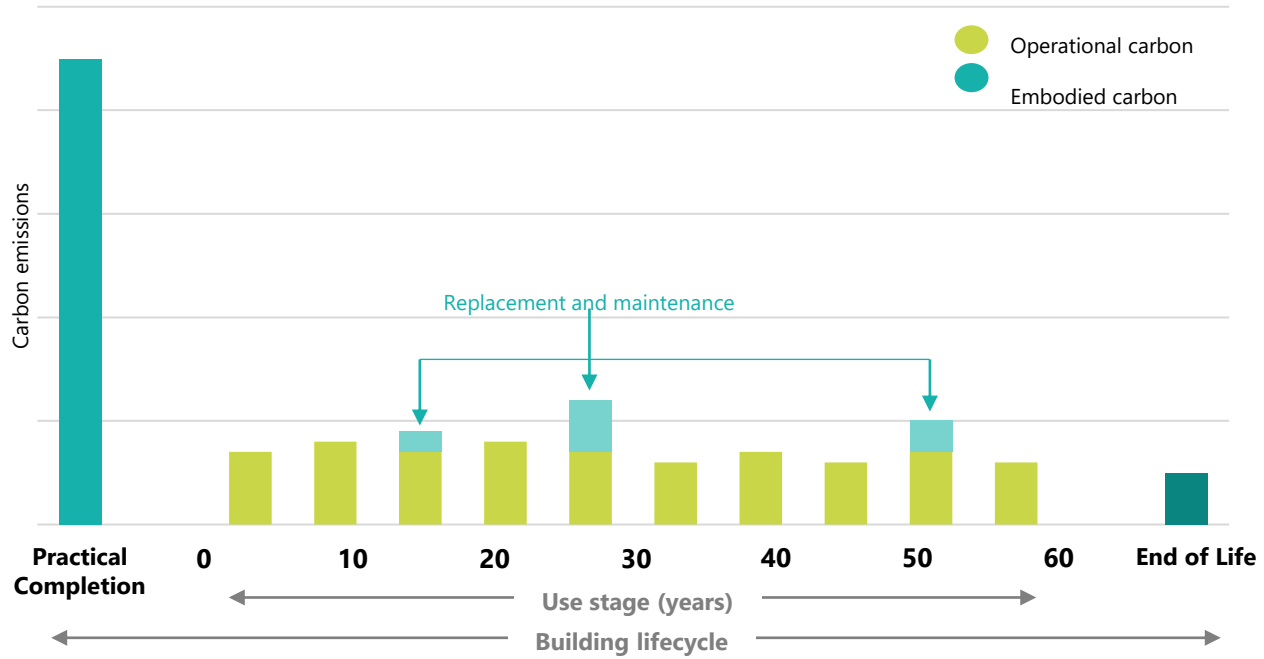


Figure 1: Operational and embodied carbon throughout the lifetime of a building

Lifecycle Stages | Carbon is emitted throughout a building's lifetime

A building emits carbon throughout its whole lifetime. Whole life thinking involves considering all life cycle stages of a project, from raw material extraction, product manufacturing, transport and installation on site through to operation, maintenance and eventual material disposal.

The BS EN 15978 and the RICS Professional Statement set out a modular approach to a built asset's life cycle, breaking it down into different stages, as shown in Figure 2.

- **Product stage (embodied carbon)**: Modules A1 – A3
- **Construction stage (embodied carbon)**: Modules A4 – A5
- **In-use stage (embodied carbon)**: Modules B1 – B5
- **In-use stage (operational carbon)**: Modules B6 – B7
- **End of life stage (embodied carbon)**: Modules C1 – C4

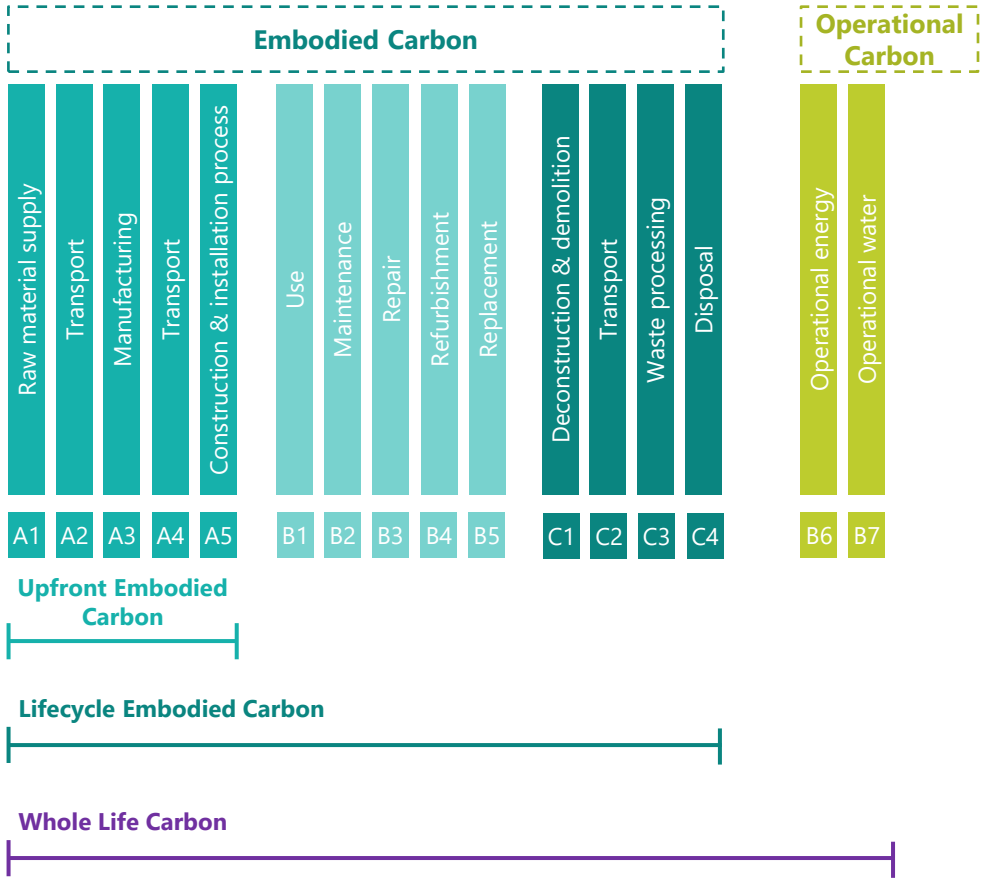


Figure 2: Whole life carbon modules

Upfront Embodied Carbon (Modules A1 – A5):

'Upfront Carbon' emissions are the GHG emissions associated with materials and construction processes up to practical completion (Modules A1-A5). Upfront carbon excludes the biogenic carbon sequestered in the installed products at practical completion.

Lifecyle Embodied Carbon (Modules A1-A5, B1-B5, C1– C4):

'Embodied Carbon' emissions of an asset are the total GHG emissions and removals associated with materials and construction processes throughout the life cycle of an asset (Modules A1-A5, B1-B5, C1-C4). Lifecycle embodied carbon excludes Modules B6-B7 as these are under the in-use stage operational carbon.

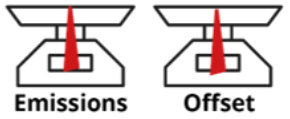
What is Whole Life Net Zero Carbon Buildings

The term ‘net zero’ is often used in the built environment industry, but there is little clarity in what this practically means. Buildings can’t be ‘absolute zero carbon’ as they require the use of non-organic materials to build them. Buildings are carbon neutral if you compensate for the carbon emissions through offsets. However, to meet our climate crisis and limit global warming to 1.5 °C the built environment needs to limit its carbon emissions. There is a finite amount of offsets available, so a different approach needs to be taken.

A 'Net Zero (whole life) Carbon’ Asset is one where the sum total of all asset related GHG emissions, both operational and embodied, over an asset’s life cycle (Modules A1-A5, B1-B8, C1-C4) are minimized, which meets local carbon, energy and water targets or limits, and with residual ‘offsets’, equals zero.

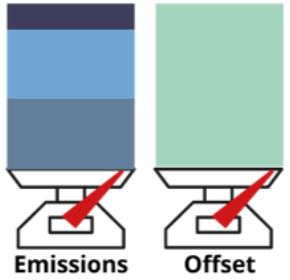
Absolute Zero Carbon

Eliminating all carbon emissions without the use of offsets[1]



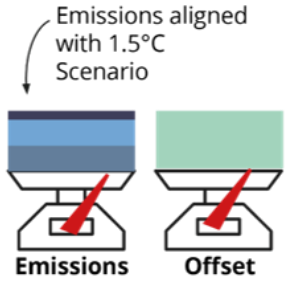
Carbon neutral

All carbon emissions are balanced with offsets based on carbon removals or avoided emissions[1]



Net Zero (whole life) Carbon

A 'Net Zero (whole life) Carbon’ Asset is one where the sum total of all asset related GHG emissions, both operational and embodied, over an asset’s life cycle are minimized, which meets carbon, energy and water targets or limits, and with residual ‘offsets’, equals zero[1]



[1]LETI WLCN Carbon definitions for the built environment document

An increasing importance to embodied carbon

As new buildings become more efficient, operational emissions start to increasingly reduce, thus embodied carbon emissions make up a greater proportion of the total building whole life carbon. Therefore the focus now needs to be on embodied carbon emissions, and the impact should be reduced as far as possible through good design and planning.

Embodied carbon assessments and targets are not yet defined in terms of Building Regulations, however several local authorities have started mandating embodied carbon assessments in their local plans.

Furthermore, several industry organisations have started to shed light on the importance of embodied carbon. The RIBA 2030 Climate Challenge sets targets for 2025 and 2030. LETI have also set design targets for 2020 and 2030, in addition to producing guidance and a reporting tool for embodied carbon assessments.

Furthermore, LETI have worked with RIBA, the GLA, IStructE and the UKGBC to produce guidance on alignment in Embodied Carbon measurement and comparisons, as an interim step towards developing net zero carbon targets that reflect the UK's carbon budget.

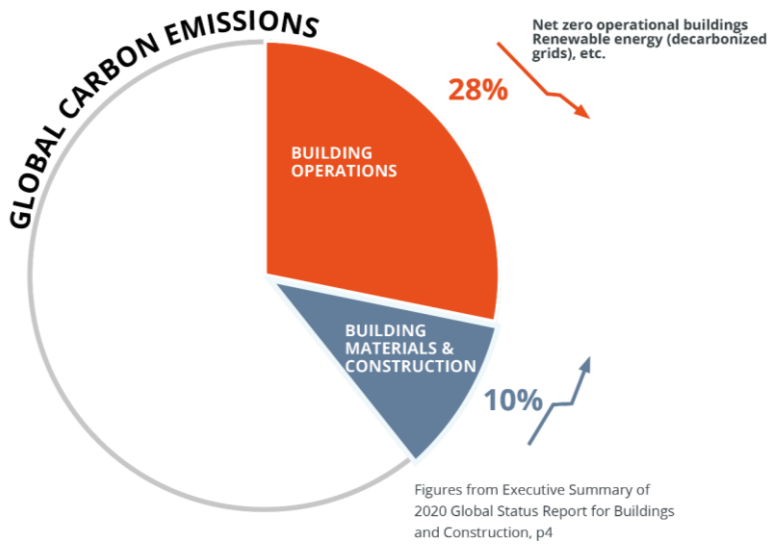


Figure 3: Building's operational and embodied carbon emissions in relation to global carbon emissions.

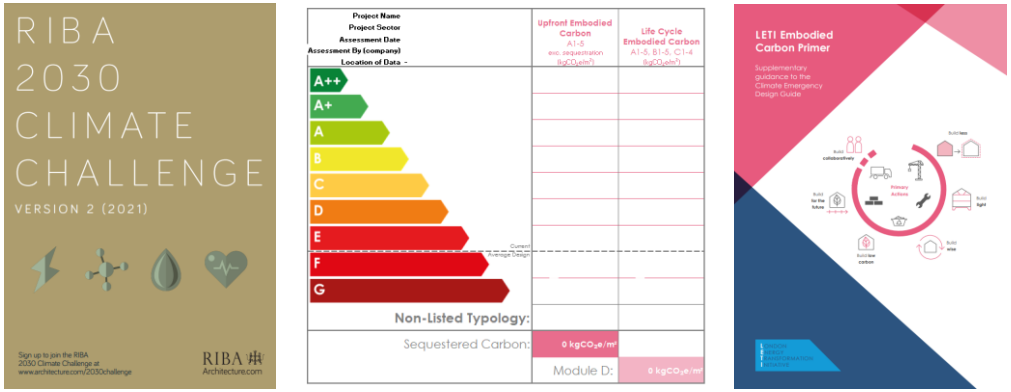


Figure 4: Different industry embodied carbon guidance, RIBA (left) and LETI (right)

Industry Initiatives | NZCBS + Part Z

The UK Net Zero Carbon Buildings Standard

In 2022 various organisations including BBP, BRE, the Carbon Trust, CIBSE, IStructE, LETI, RIBA, RICS, and UKGBC have come together to develop a UK wide Net Zero Carbon Building Standard. It will provide a rule book to robustly prove that built assets are net zero carbon and in line with our nation's climate targets. This project started in May this year, with various task and sector groups beginning work September.

In November/ December the project undertook a 'call for evidence programme' asking for operational energy use and embodied carbon data to be submitted to the project, to support the development of net zero targets and limits. A consultation was carried out in Summer 2023. According to the NZCBS, for the Standard to be adopted in a way that ensures its traction and integrity in the long term, it needs to be both technically robust and have a supporting strategy for implementation and governance. As such, the Standard will be published when the NZCBS committee are confident that these requirements are fully met.

The key metrics for the standard are outlined below:

- Energy Use Intensity (EUI) targets (kWh/m^2/yr)
- Embodied carbon targets kg CO_2/ m^2 upfront embodied carbon (A1-A5) and lifecycle embodied carbon (A1-C4).

Figure 5: UK Net Zero Carbon Building Standard

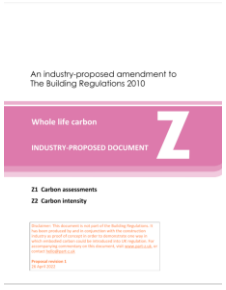
Part Z: Whole Life Carbon – an industry proposed document

This document has been produced by and in conjunction with the construction industry, as a proof of concept in order to demonstrate one way in which embodied carbon could be introduced in UK Building Regulations.

Requirements apply to projects to major developments only - with a gross internal area of [1000]m2 , or that create more than [10no.] dwellings.

Compliance with the carbon assessment and carbon intensity requirements of the Building Regulations could be demonstrated by meeting the following criteria:

- Criterion 1: A Whole Life Carbon assessment (modules A1-A5, B1-B7, C1-C4, D) must be undertaken.
- Criterion 2: The upfront embodied carbon (modules A1-A5) of the overall building and its individual elements should not exceed reasonable standards of intensity (which are yet to be developed for different typologies)



Requirement	*Limits on application:*
Part Z Whole life carbon	
Carbon assessment **Z1.** Whole life carbon emissions shall be assessed and reported for the building and any other parts of the project where Building Regulations apply.	Requirements Z1 and Z2 only apply to projects with a gross internal area of more than [1000]m^2, or that create more than [10no.] dwellings.
Carbon intensity **Z2.** Reasonable provision shall be made for the minimisation of carbon emissions;	Requirement Z1 will apply to buildings other than dwellings from [1 January 2023], and dwellings from [1 January 2025]. Requirement Z2 will apply to all buildings from [1 January 2027].

Figure 6: Extracts from Part Z: Whole Life Carbon guidance

What others are doing

1. Bristol Council

- Requiring developments to comply with a target limit

Embodied carbon – general principles

Development will be expected to minimise its embodied carbon. In doing so, development should:

- **Prioritise the renovation or retrofit of existing structures, as part of an efficient use of land, subject to technical feasibility, the other policies and proposals of the local plan and any relevant neighbourhood plans;**
- **Be designed efficiently to minimise the quantity of materials required to meet the building's functional requirements;**
- **Select high quality materials and systems which:**
  - **Have low embodied carbon;**
  - **Minimise the need for replacement over the lifetime of the development;**
  - **Can be reused, recycled and disposed of sustainably at end of life; and**
- **Ensure that new buildings are flexible and adaptable to future uses, reducing the need for future redevelopment.**

Development should set out through the Sustainability Statement how these issues will be addressed.

Embodied carbon – major applications

Major development will be required to undertake an embodied carbon assessment, submitted as part of the Sustainability Statement using a nationally recognised embodied carbon assessment methodology, and demonstrate actions taken to reduce life-cycle carbon emissions. New development will be expected to achieve the following targets as a minimum:

- **Residential (4 storeys or fewer) - <625 $kgCO_2e/m^2$**
- **Residential (5 storeys or greater) - <800 $kgCO_2e/m^2$**
- **Major non-residential schemes - <970 $kgCO_2e/m^2$**

Where these targets for embodied carbon cannot feasibly be met, a full justification will be required as part of the embodied carbon assessment.

Any shortfall against the embodied carbon targets will be offset through a financial contribution towards council approved renewable energy, low-carbon energy and energy efficiency schemes elsewhere in the Bristol area. The value of a tonne of CO_2e is tied to the high scenario in the Valuation of Energy Use and Greenhouse Gas supplementary guidance to the Treasury's Green Book (currently £373).

2. Bath and North East Somerset (BaNES)

- Requiring developments to comply with a target limit

SCR8 Embodied Carbon

Large scale new-build developments (a minimum of 50 dwellings or a minimum of 5000m^2 of commercial floor space) are required to submit an Embodied Carbon Assessment that demonstrates a score of less than 900kg/sqm of carbon can be achieved within the development for the substructure, superstructure and finishes.

3. The London Plan (GLA)

- Requiring developments to report results only

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.

1) https://www.bristol.gov.uk/files/documents/5446-bristol-local-plan-review-nov-22-further-consultation/file
2) https://beta.bathnes.gov.uk/sites/default/files/2021-08/1.%20Districtwide%20Post%20Council_formatted.pdf
3) https://www.london.gov.uk/sites/default/files/the_london_plan_2021.pdf

Embodied carbon policy options

The following are potential embodied carbon policy options for Winchester Council:

Recommended policy option 1 : Embodied carbon assessment

Major residential and non-residential developments are required to undertake an embodied carbon assessment, following the RICS Whole Life Carbon Assessment for the Built Environment methodology, and **should report it.**

Recommended policy option 2 : Meeting an upfront embodied carbon limit

Major residential and non-residential developments are required to undertake an embodied carbon assessment, following the RICS Whole Life Carbon Assessment for the Built Environment methodology, and should comply with an **upfront embodied carbon limit** by 2025*

Recommended policy option 3 : Meeting a lifecycle embodied carbon limit

Major residential and non-residential developments are required to undertake an embodied carbon assessment, following the RICS Whole Life Carbon Assessment for the Built Environment methodology, and should comply with a **lifecycle embodied carbon limit** by 2025*

Pros and cons of a policy without embodied carbon limits (Policy Option 1)

- ✓ Mandates that assessments are carried out, supports the industry in developing in this specialism
- ✓ Increased embodied carbon assessments and results, leading to more evidence, which can promote stronger targets in the near future.
- ✓ Data gathered can be used for benchmarking embodied carbon targets in the next local plan review
- ✗ Applicants are not restricted by a maximum embodied carbon limit, so might not be encouraged to reduce embodied carbon

Pros and cons of a policy with embodied carbon limits (Policy Option 2&3)

- ✓ Mandates that assessments are carried out, supports the industry in developing in this specialism
- ✓ Applicants will have to comply with an embodied carbon limit, which will encourage embodied carbon to be factored into design decisions.
- ✗ A bespoke evidence base will need to be developed to provide limits. Its important that a limit is set that is stretching but achievable.
- ✗ Industry is currently developing information on benchmarking of embodied carbon, it will be simpler to set limits once this has been developed. Once these have been set, the policy could be updated.
- ✗ Setting a target that is too large a number, is unhelpful, as it might lead to applications that show higher embodied carbon than in reality, which will skew benchmarking.

Additional cons of a policy with embodied carbon limits (Policy Option 3)

- ✗ The use and the end-of-life stages are not typically in the 'control' of the developer, and thus the outcomes of the assessment are less likely to be implemented
- ✗ Carrying out upfront embodied carbon assessments is gaining much more traction but still not common place. Lifecyle embodied carbon, that includes the embodied carbon of the use and end-of-life stages, is additional work, and this has a much higher level of uncertainty.

*Compliance with an upfront/lifecycle embodied carbon limit is only required starting 2025 as it is anticipated that the industry will have better defined limits by this year.

Policy recommendation | Embodied Carbon

Recommended Policy

Embodied carbon emissions are the emissions emitted producing a building's materials, their transport and installation on site, as well as their disposal at end of life.

As new buildings become more efficient, operational emissions start to increasingly reduce, thus embodied carbon emissions make up a greater proportion of the total building whole life carbon.

Therefore it is important that the focus is directed towards embodied carbon emissions, and the impact is reduced as far as possible through good design and planning.

Policy Wording:

Major residential and non-residential developments are required to undertake an embodied carbon assessment, following the 'RICS Whole Life Carbon Assessment for the Built Environment' methodology, and should report it as part of the Embodied Carbon Assessment chapter in the Energy and Carbon Statement submitted with planning.

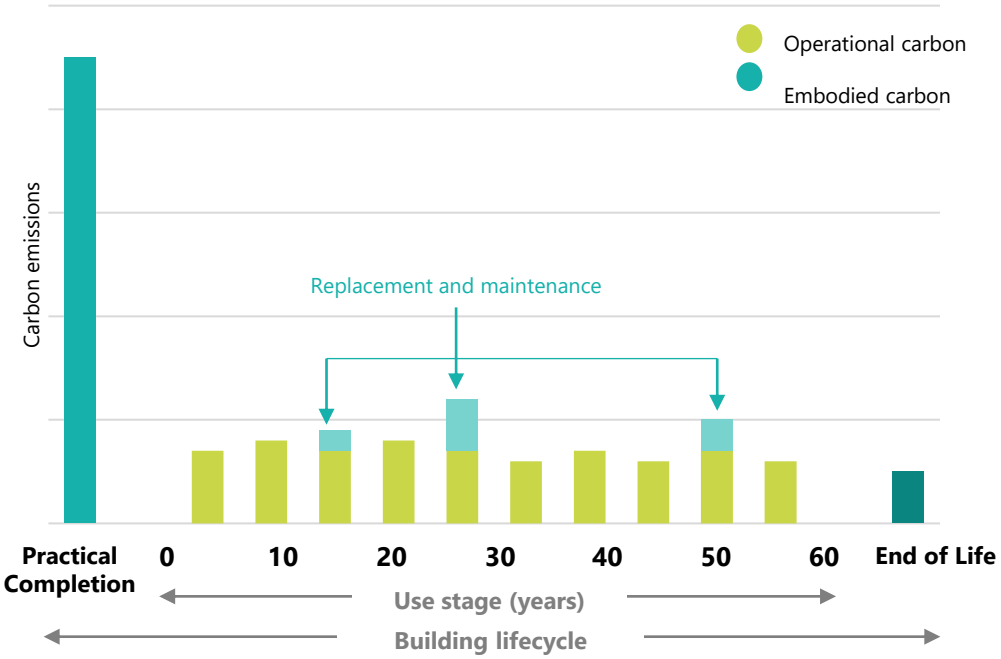


Figure 7: Operational and embodied carbon throughout the lifetime of a building

Embodied carbon design principles

This section covers embodied carbon reduction strategies for various building elements.

Substructure

Cement replacement - Use cement replacement (e.g., GGBS, Fly ash) to reduce the content of Portland cement in concrete. When using replacements, allow for longer setting times which will ensure higher strength grade**.**

Aggregates - Specify recycled aggregates and specify local procurement whenever possible. Understand the impact of aggregates choice on the mix percentages to minimise water use.

Concrete strength - Specify lower strength concrete whenever possible and use GGBS or fly-ash replaced concrete that has longer curing time but has higher strength compared to the same non-replaced concrete. C32/40 is the most efficient grade.

Use precast before poured on site – Consider using precast floor slabs and rib decks as they have lower embodied carbon impacts than the poured-on site equivalent.

Superstructure

Steel specifications and quantities - Reduce material use through lean geometry and dematerialisation through voids where possible. For example, use castellated beams.

Envelope design - Use natural materials for insulation whenever possible.

Adaptability - Consider loads, structural grids and spans that allow for change in use in the future. Incorporate soft spots in the structure.

Façade design - Design a simple geometry with limited shelf angles.
Specify high quality windows with long service life use and timber frames or alu-hybrid. Use materials with multiple benefits. Use lime mortar for brick façades to enable bricks to be reclaimed.

Interiors - Standardise sizes of internal partitions and make them as modular as possible (e.g., standardised spacing between the stud walls).

Using fewer materials – reduce loading requirements where possible. Reduce spans which reduces sizes of columns. Design lighter façade larger deflection at slab edges.

Internal Finishes and FF&E

Extend service life - Specify longer-lasting fittings and furniture (when and where possible) to reduce replacements.

Reduce/eliminate finishes - Select materials of high quality which do not require additional surface finishes.

Disassembly - Avoid composite materials that are hard to dissemble.

Cleaning and maintenance – Consider the cleaning and maintenance regium of the finishes, as this can have a large effect on embodied carbon.

MEP

Passive design - Embrace passive design principles in the project, for example robust fabric, good form factor, sensible glazing ratios, optimising orientation which reduces the load of the MEP systems.

Lean design - Reduce the amount and size of equipment as much as possible. For example reduce the lengths of ducts and pipes.

Material and product choice - Building services equipment often use materials with high embodied carbon, they are also replaced frequently thus impacting the embodied carbon across the whole life cycle.

Refrigerant leakage – Select refrigerants with a low GWP potential where applicable. Products such as heat pumps contain refrigerants. Refrigerants can have high GWP, and high leak rates. For Air source heat pumps, they type of refrigerant uses can increase the embodied carbon of the heating and hot water system by 30%.

Long lifetime - Specify products and systems with long lifetimes, that do not need to be replaced frequently.

Glossary

Whole Life Carbon - Whole Life Carbon emissions are the sum total of all asset related GHG emissions and removals, both operational and embodied over the life cycle of an asset including its disposal (Modules: A1-A5; B1-B7; C1-C4, all including biogenic carbon).

Net Zero Whole Life Carbon - A 'Net Zero Whole Life Carbon' Asset is one where the sum total of all asset related GHG emissions, both operational and embodied, over an asset's life cycle (Modules A1-A5, B1-B7, C1-C4) are minimized, which meets local carbon, energy and water targets or limits, and with residual 'offsets', equals zero.

Operational Carbon - Energy - (Module B6) are the GHG emissions arising from all energy consumed by an asset in-use, over its life cycle.

Operational Carbon – Water - (Module B7) are those GHG emissions arising from water supply and wastewater treatment for an asset in-use, over its life cycle.

Embodied Carbon or Lifecycle Embodied Carbon - Embodied Carbon emissions of an asset are the total GHG emissions and removals associated with materials and construction processes throughout the whole life cycle of an asset (Modules A1-A5, B1-B5, C1-C4).

Upfront Embodied Carbon - Upfront Carbon emissions are the GHG emissions associated with materials and construction processes up to practical completion (Modules A1-A5). Upfront carbon excludes the biogenic carbon sequestered in the installed products at practical completion.

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