



Embodied carbon in construction

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What is embodied carbon?

Building Life Cycle

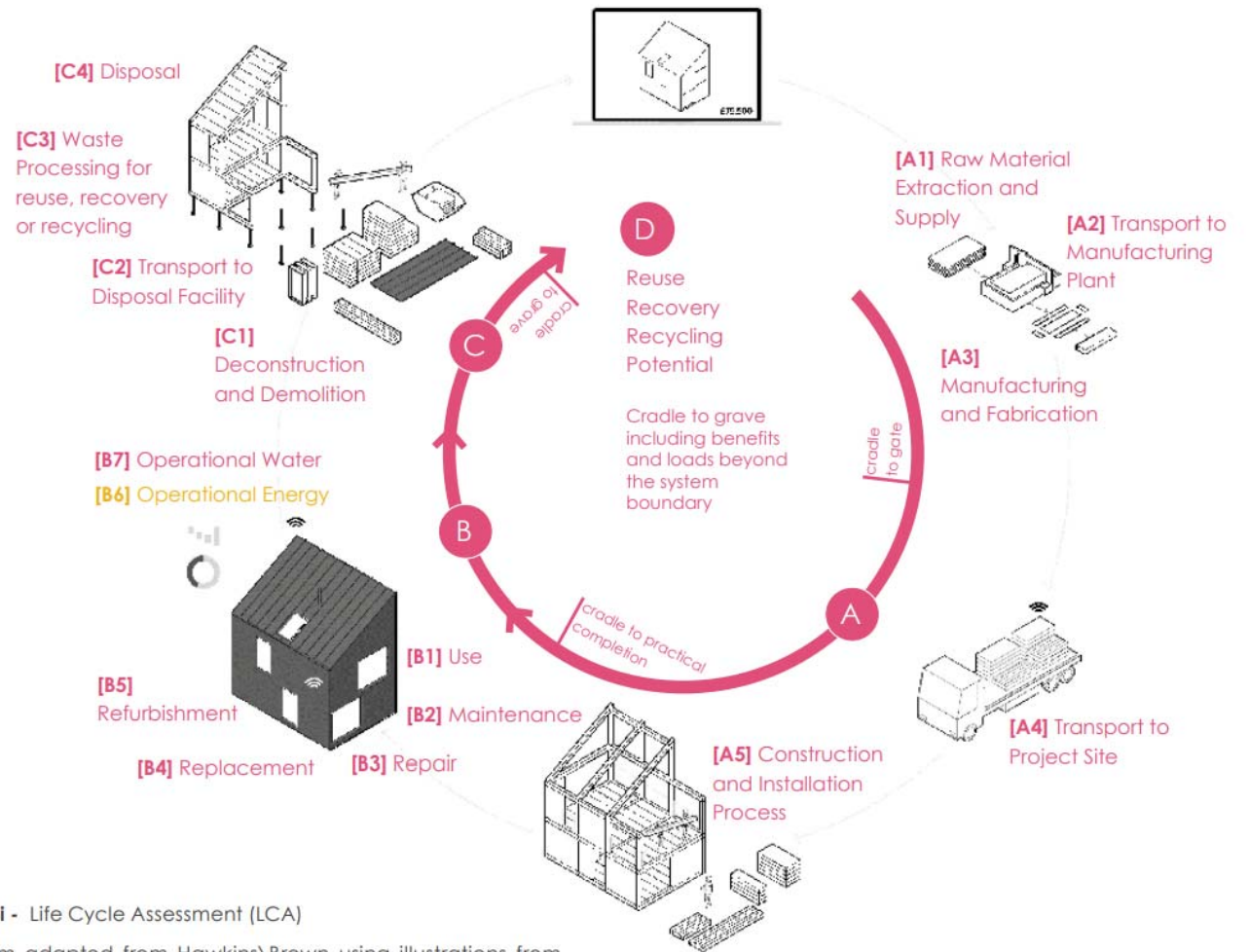
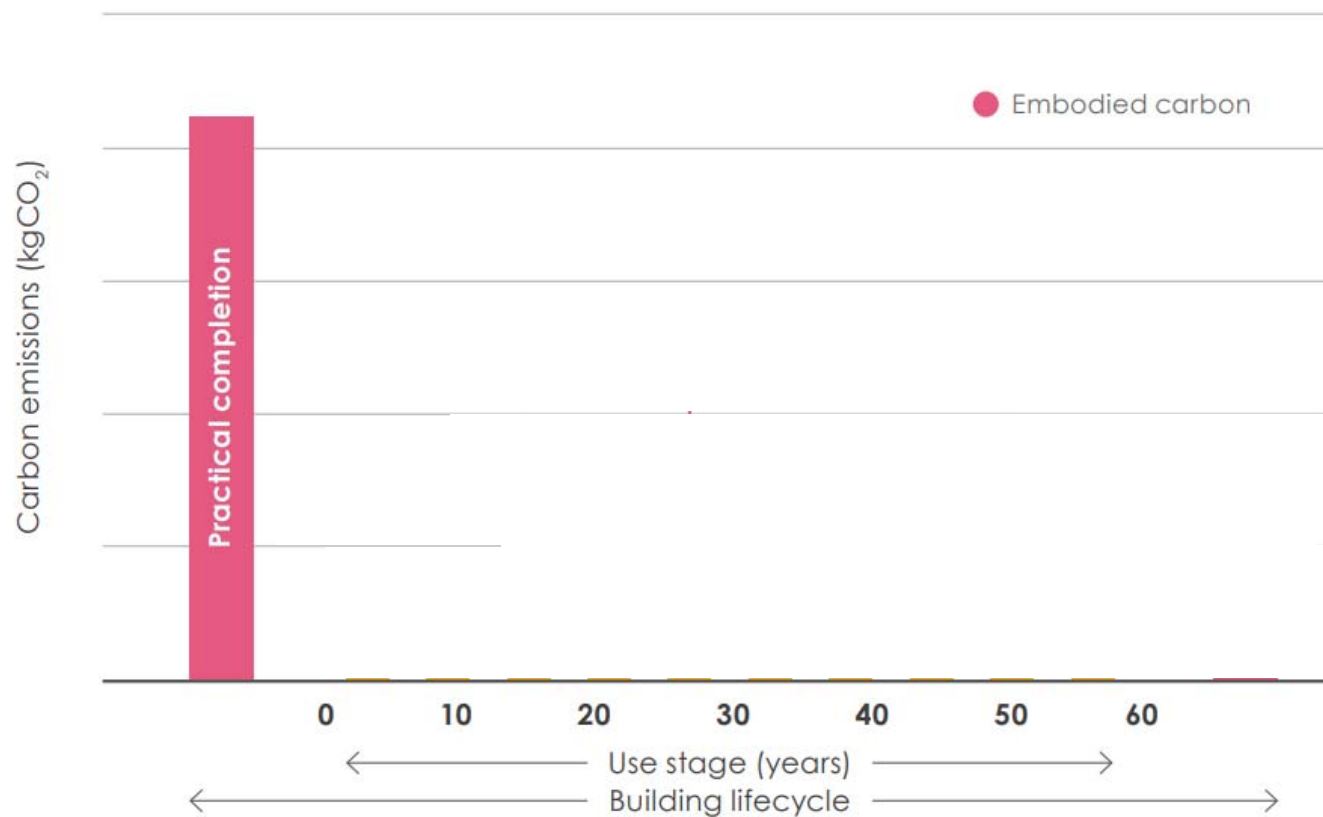


Figure ii - Life Cycle Assessment (LCA)

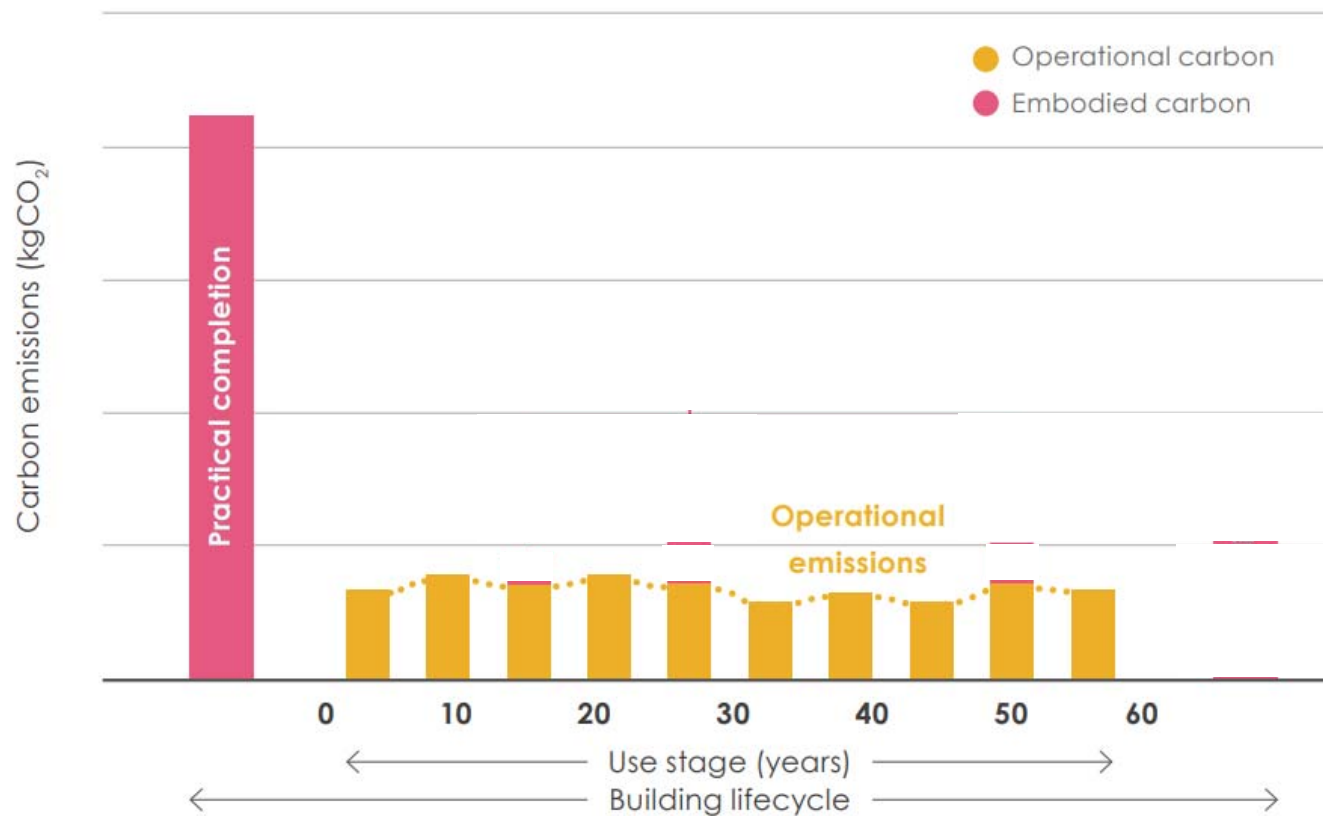
Diagram adapted from Hawkins\Brown using illustrations from Open Systems Lab 2018 licensed under Creative Commons CC-BY-ND

GHG Emissions during a building's life cycle



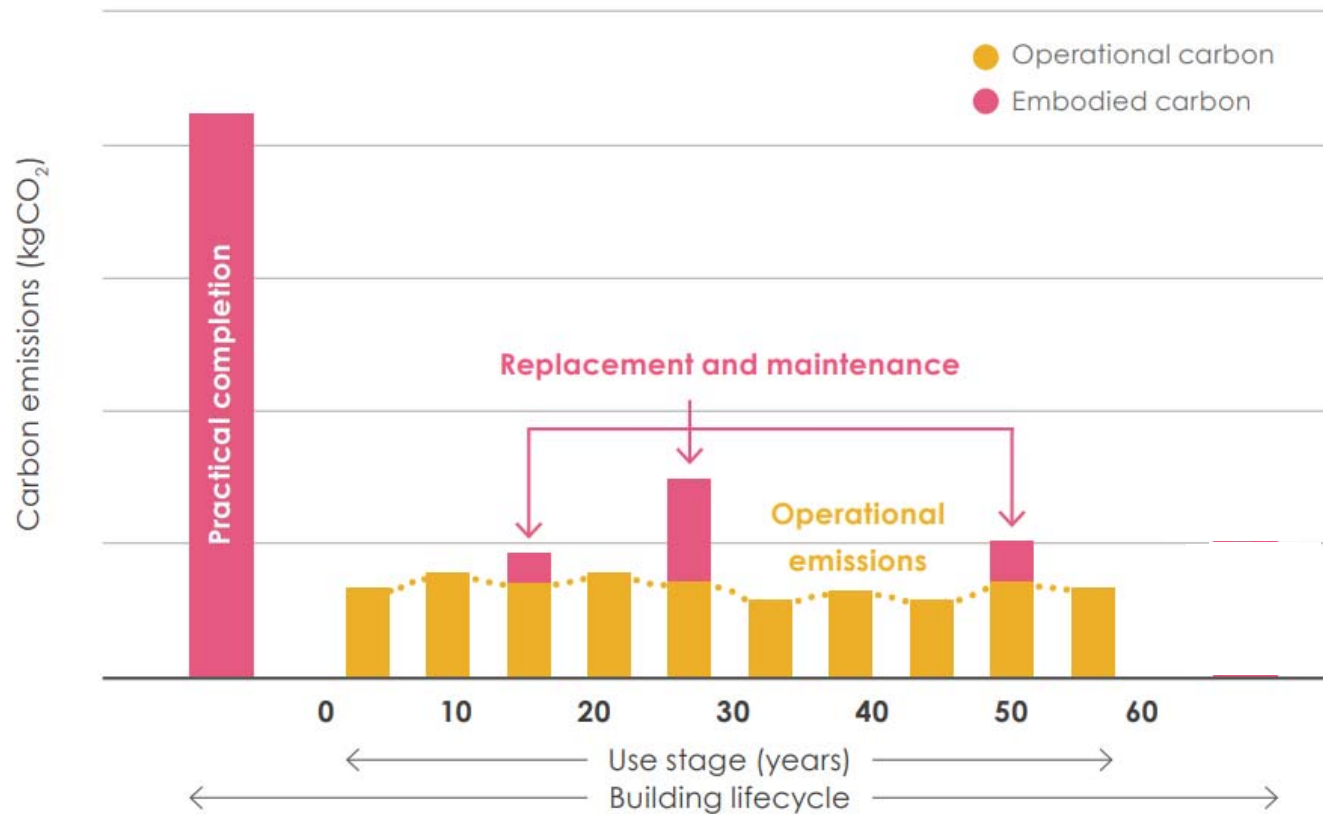
LETI Embodied Carbon Primer, 2020
www.leti.london/ecp

GHG Emissions during a building's life cycle



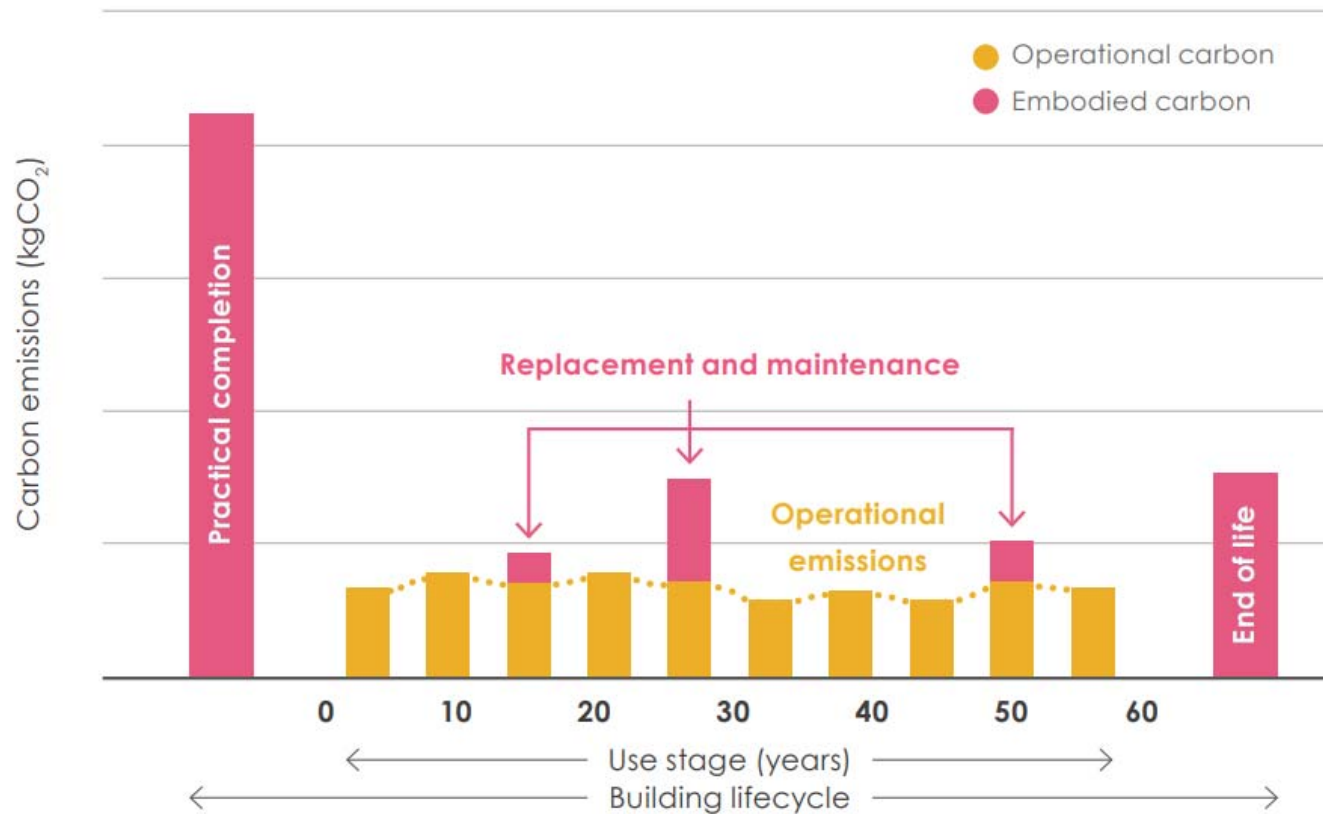
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Whole life carbon (WLC)

Whole life carbon = Operational carbon + Embodied carbon

(LETI Embodied Carbon Primer, 2020)

Embodied carbon: the greenhouse gases associated with the following stages:

- **Product:** extraction and processing of materials, energy and water consumption used by the factory or in constructing the product or building, and transport of materials and products
- **Construction:** building the development
- **Use:** maintenance and replacement
- **End of life:** demolition, disassembly waste processing and disposal of any parts of product or building and any transportation relating to the above.

Operational carbon: the greenhouse gases associated with the in-use operation of the building.

- heating, hot water, cooling, ventilation, and lighting systems, as well as cooking, by equipment and lifts.

(LETI Embodied Carbon Primer, 2020)

Proportion of WLC that is embodied carbon

Figure 4: Estimated distribution of carbon emissions per life cycle stage

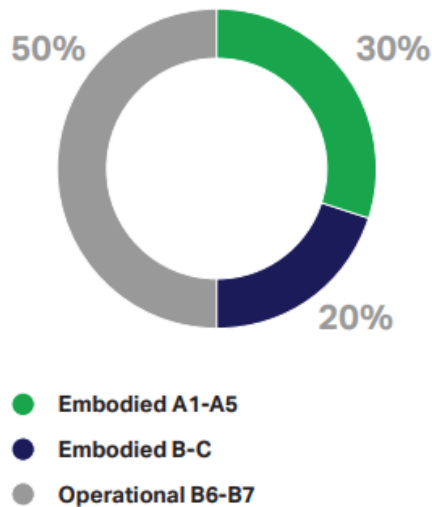
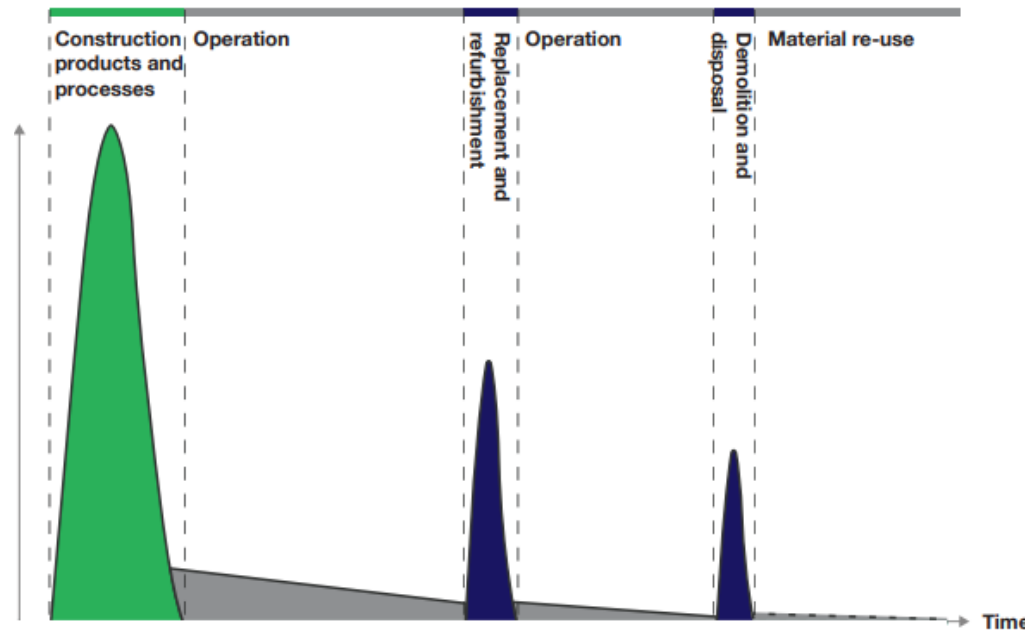


Figure 5: Whole life carbon emissions, Arup (2020)⁷



Currently >50% of WLC emissions from new buildings are anticipated to be from embodied carbon

As building envelopes are improved and heating and electric decarbonises operational carbon is going to decrease.

Therefore embodied carbon will become a greater proportion of a building's emissions.

World Business Council for Sustainable Development (2021) Net-zero buildings Where do we stand?

<https://www.wbcsd.org/contentwbc/download/12446/185553/1>

The scale of the issue

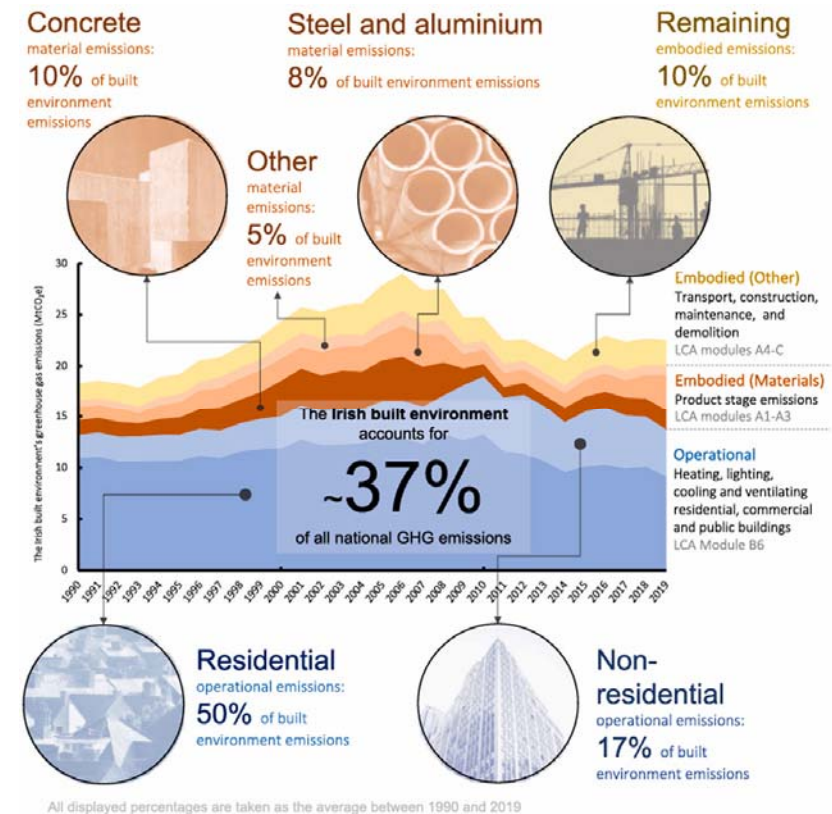
Embodied carbon ... contributes around 11% of all global carbon emissions.

Carbon emissions released before the building or infrastructure begins to be used, sometimes called upfront carbon, will be responsible for **half of the entire carbon footprint of new construction between now and 2050**, threatening to consume a large part of our remaining carbon budget.

WGBC (2019) Bringing embodied carbon upfront
https://www.worldgbc.org/sites/default/files/WorldGBC_Bringing_Embodied_Carbon_Upfront.pdf

Embodied carbon accounts for ~12% of national GHG emissions in RoI

O'Hegarty, R., Wall, S. and Kinnane, O. (2022) 'Whole Life Carbon in Construction and the Built Environment in Ireland', Building and Environment. 226(October), p. 109730. DOI: 10.1016/j.buildenv.2022.109730.



Public bodies reporting duties: Reflections from QUB

Travel 37%

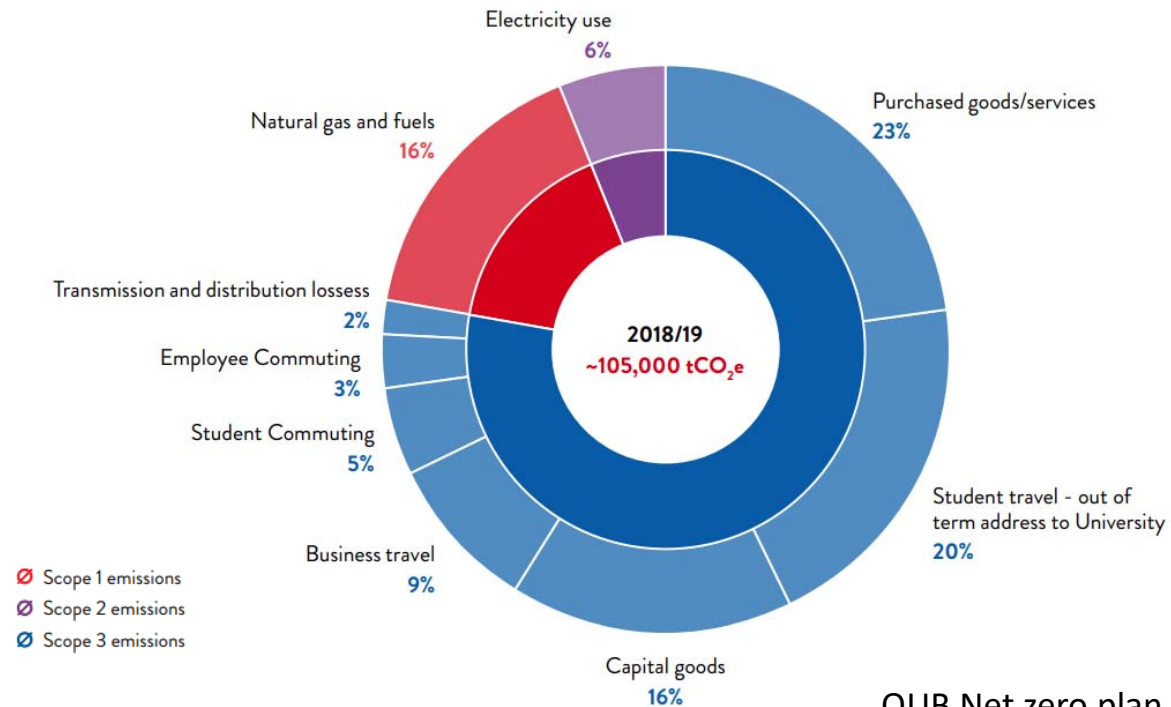
- Student travel to home
- Business travel
- Student and employee commuting

Operational energy 24%

- Electricity
- Natural gas and fuels
- Transmission and distribution losses

Purchased goods and services: 23%

New builds and refurbishments 16%



QUB Net zero plan

<https://www.qub.ac.uk/about/sustainability/files/Fileupload,1870172,en.pdf>

Carbon reduction targets and construction

Climate Change Act (Northern Ireland) 2022

- at least 48% reduction in net GHG emissions by 2030
- At least 100% reduction in net GHG emissions by 2050.

for Northern Ireland compared to baseline (1990)

Belfast City Council targets

- 66 per cent reduction by 2025
- 80 per cent reduction by 2030
- 100 per cent reduction by 2050

on the 2000 level of GHG emissions

By 2030, new buildings, infrastructure and renovations will have at least 40% less embodied carbon with significant upfront carbon reduction, and all new buildings must be net-zero operational carbon.¹⁸

Whole life carbon vision (WorldGBC)

World Green Building Council (2021), Whole Life Carbon Vision
<https://www.worldgbc.org/advancing-net-zero/whole-life-carbon-vision>

Measuring whole life carbon

Whole life carbon measurement

“It’s not about calculating – it’s about **reducing**. Calculating carbon lets you see where carbon is hiding so you can reduce it.”

Penny Gowler

RICS methodology

- Sets out how to do a whole life carbon assessment for a building.
- Varying levels of detail expected at different stages of projects.
- Minimum reporting requirements with increasing detail are mandated at
 - early design
 - technical design
 - post project completion.
- It is always best practice to report the highest level of detail possible.



RICS Whole life carbon assessment for the built environment (2023)

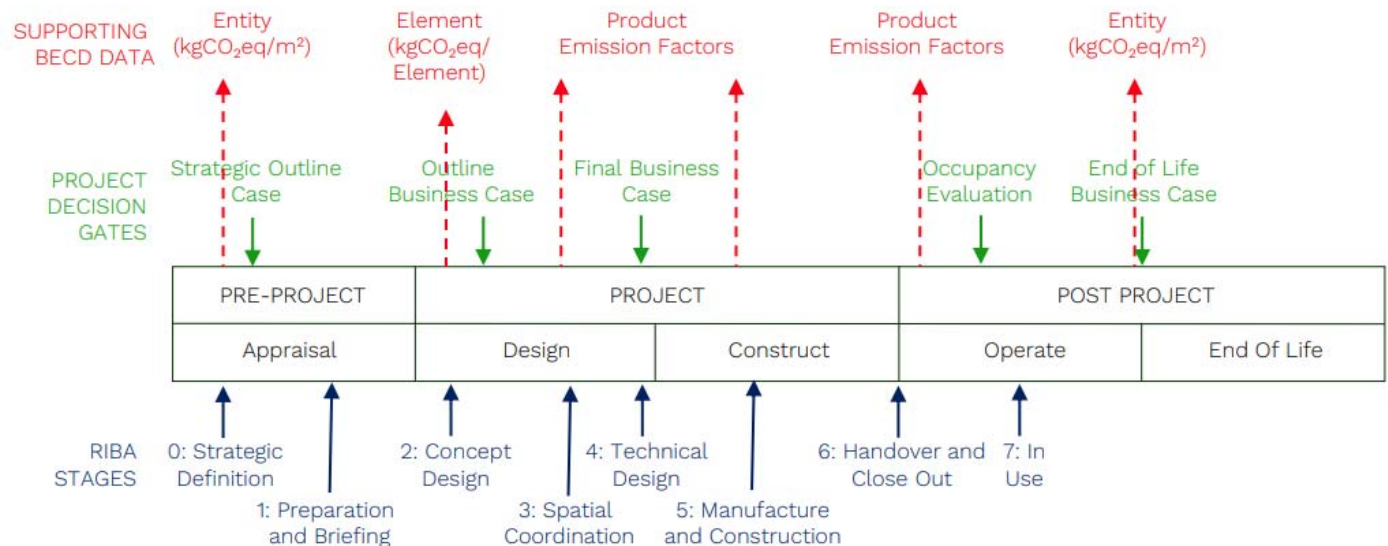
Built Environment Carbon Database (BECD)

Database of embodied carbon from all parts of a project, launched Oct 2023.

Professional bodies are asking their members to use the BECD on every project they work on, both to estimate carbon due to the project and share data from the project with other professionals

Register to be kept informed of developments with the database at:

<https://www.becd.co.uk/>



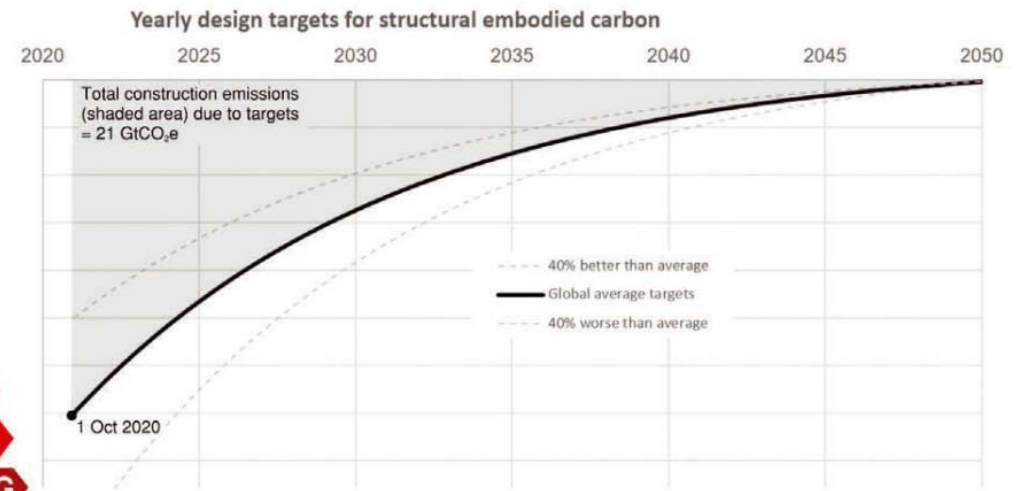
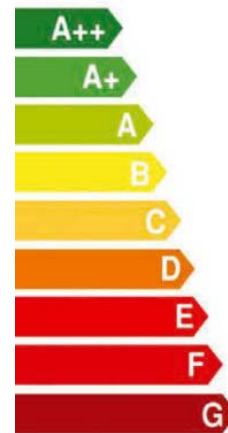
Embodied carbon standards

“Standards are about helping people understand what good looks like.”

Dr Scott Steedman, Director of Standards, British Standards Institution

Embodied carbon standards:

- RIBA Whole building Whole life cycle
- LETI Whole building Upfront only
- SCORS Structure Upfront only

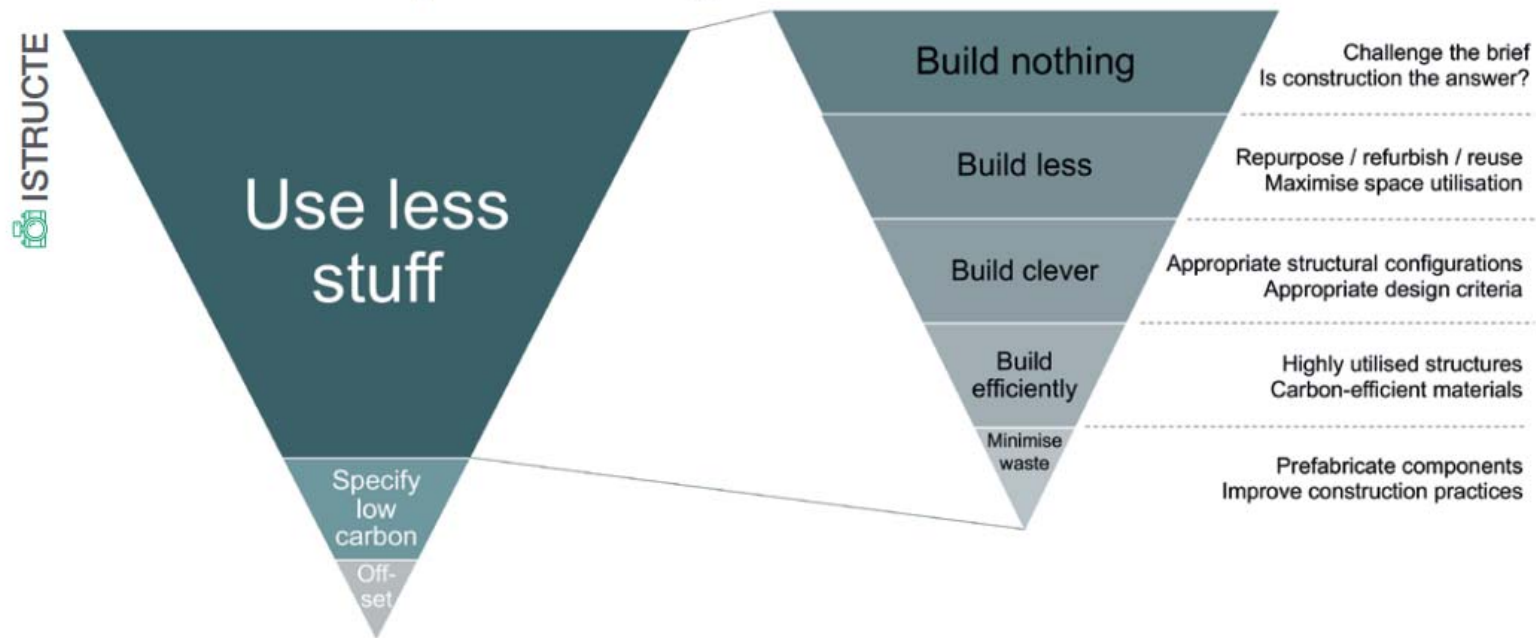


Structural embodied carbon (kgCO₂e/m²)

Reducing embodied carbon

Hierarchy for net-zero design

↓ FIGURE 5: Hierarchy of net-zero design



White (2022) Engineering in the climate emergency: doing less, better [Available at

[https://www.istructe.org/journal/volumes/volume-100-\(2022\)/issue-10/engineering-in-climate-emergency-less-better/](https://www.istructe.org/journal/volumes/volume-100-(2022)/issue-10/engineering-in-climate-emergency-less-better/)]

Repurpose existing buildings



Reuse building elements

- Reused steel causes only 5% of the GHG emissions of replacing with new steel



Design for low carbon

When new build cannot be avoided:

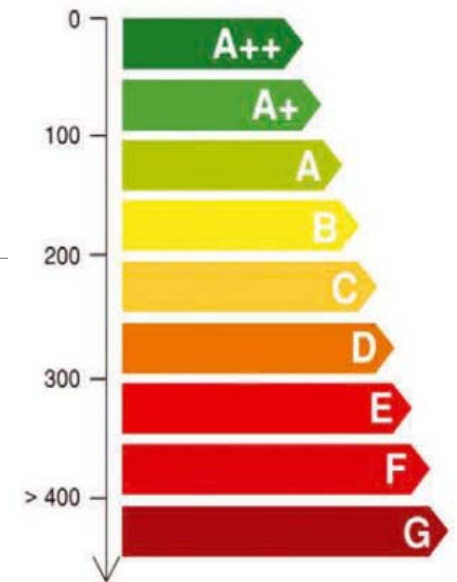
Design for low carbon

- Consider carbon reduction from project conception

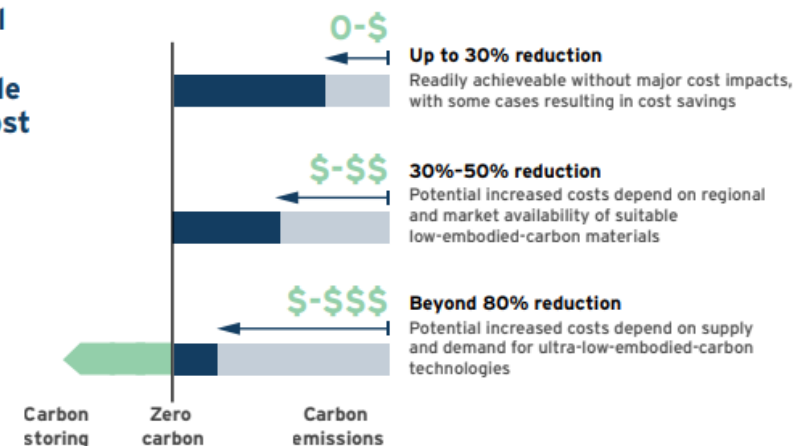
When the structure is fully optimised, consider using green materials

- Make appropriate use of timber and other biobased materials
- Use recycled materials (circular economy)

The first 30% of embodied carbon reductions are likely to be cost neutral or even save money



Substantial reductions are available today at cost parity



Opportunities for Belfast City Council

BCC capital works portfolio

£300M of projects currently in the portfolio
(from design phase to construction on site)

Opportunity to undertake whole life carbon assessments for all new builds.

- BCC would be a civic leader
- Potential to move early and identify a pilot study – Belfast Stories?
- Introduce targets for embodied carbon reduction after baseline established

Potential to work with undergraduate students at our universities



Measurement of WLC and phased implementation of EC targets more widely

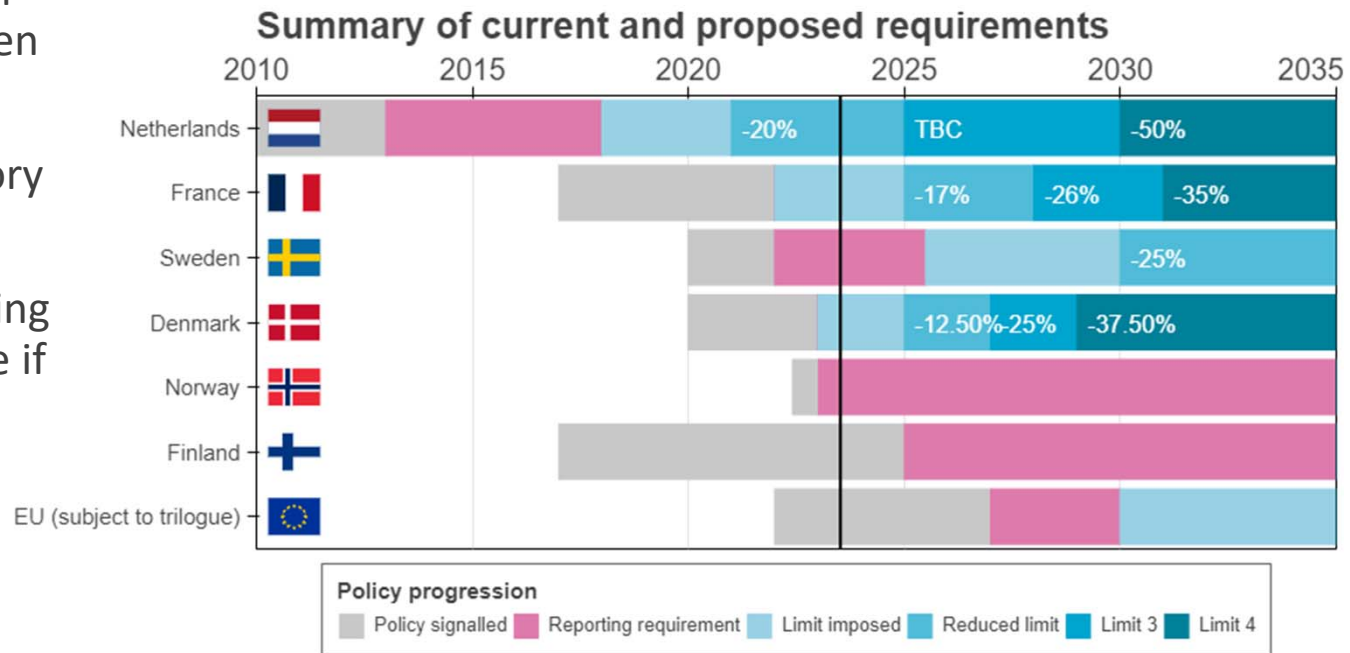
Mandatory reporting introduced in the Netherlands in 2012. Since then targets imposed and reduced.

EU Directive to introduce mandatory reporting and targets proposed.

Rol proposes to implement reporting and targets before the EU directive if possible*

England and Wales considering Part Z for the building regulations which would introduce mandatory reporting and targets

* https://data.oireachtas.ie/ie/oireachtas/committee/dail/33/joint_committee_on_housing_local_government_and_heritage/reports/2022/2022-10-14_report-on-embodied-carbon-in-the-built-environment_en.pdf



<https://www.jannikgiesekam.co.uk/embodiedcarbon/>

Planning policy

“Development proposals should, where feasible, seek to avoid demolition and should consider how existing buildings or their main structures could be reused. Development proposals that include the demolition of existing buildings should demonstrate that reuse is not appropriate or feasible. Where demolition is proposed, measures should be included to minimise any waste through the reuse of as much building material as possible.”

Belfast City Council, Local Development Plan

This could be strengthened in supplementary guidance to require

- Whole life carbon assessment
- Demonstrate actions to reduce whole life carbon
- Justification of demolition on the basis of whole life carbon

(see approach adopted by Leeds City Council:
<https://www.leeds.gov.uk/planning/planning-policy/local-plan-update/proposed-policy>)



Any questions?
