

Communicating the Importance of

Embodied Carbon and Bio-based Materials

in the Built Environment

Q&A



CNCA
CARBON NEUTRAL CITIES ALLIANCE

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Embodied Carbon

What is embodied carbon?

Embodied carbon is a building’s total carbon footprint – and an overlooked source of emissions generated by the construction sector. Before a building becomes operational, CO₂ from materials and processes used in construction is released. These emissions – as well as the CO₂ produced maintaining the building and eventually demolishing it, transporting the waste, and recycling it – are also known as embodied carbon.

While we have known about carbon emissions from energy, heat, lighting etc. for a long time, the CO₂ emitted from the materials actually used to construct and deconstruct/ demolish a building – and construction itself – are now an increasingly large proportion of its overall environmental impact – especially as energy use switches to lower carbon alternatives.

FACT BOX



According to the International Energy Agency, buildings and construction are responsible for 39% of carbon emissions.



By 2060, cities will accommodate a further 2.7 billion people.



The global new construction projected to accompany that population growth is equal to building one New York City each and every month for the next 40 years.



Embodied carbon emissions currently represent 11% of global emissions.



As energy systems decarbonise, the carbon emitted in the processing of materials, and the construction and demolition of buildings is increasing.

Why should cities take embodied carbon more seriously?

Cities account for more than 70% of global carbon emissions and the construction sector contributes a significant amount. Efforts to reduce the construction sector's carbon footprint have, to date, mostly focused on operational carbon, responsible for 28% of global emissions. These initiatives have already led to improvements e.g., buildings have become more energy-efficient, and the electricity sector is becoming more decarbonised.

However, embodied carbon emissions currently represent 11% of global emissions. This share is rapidly rising – in low-carbon energy regions, it is already likely to be the main share of carbon emissions. To mitigate climate change, decarbonise city buildings and reach net zero by 2050 – it is crucial to consider and reduce embodied carbon in the construction sector.



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GOAL

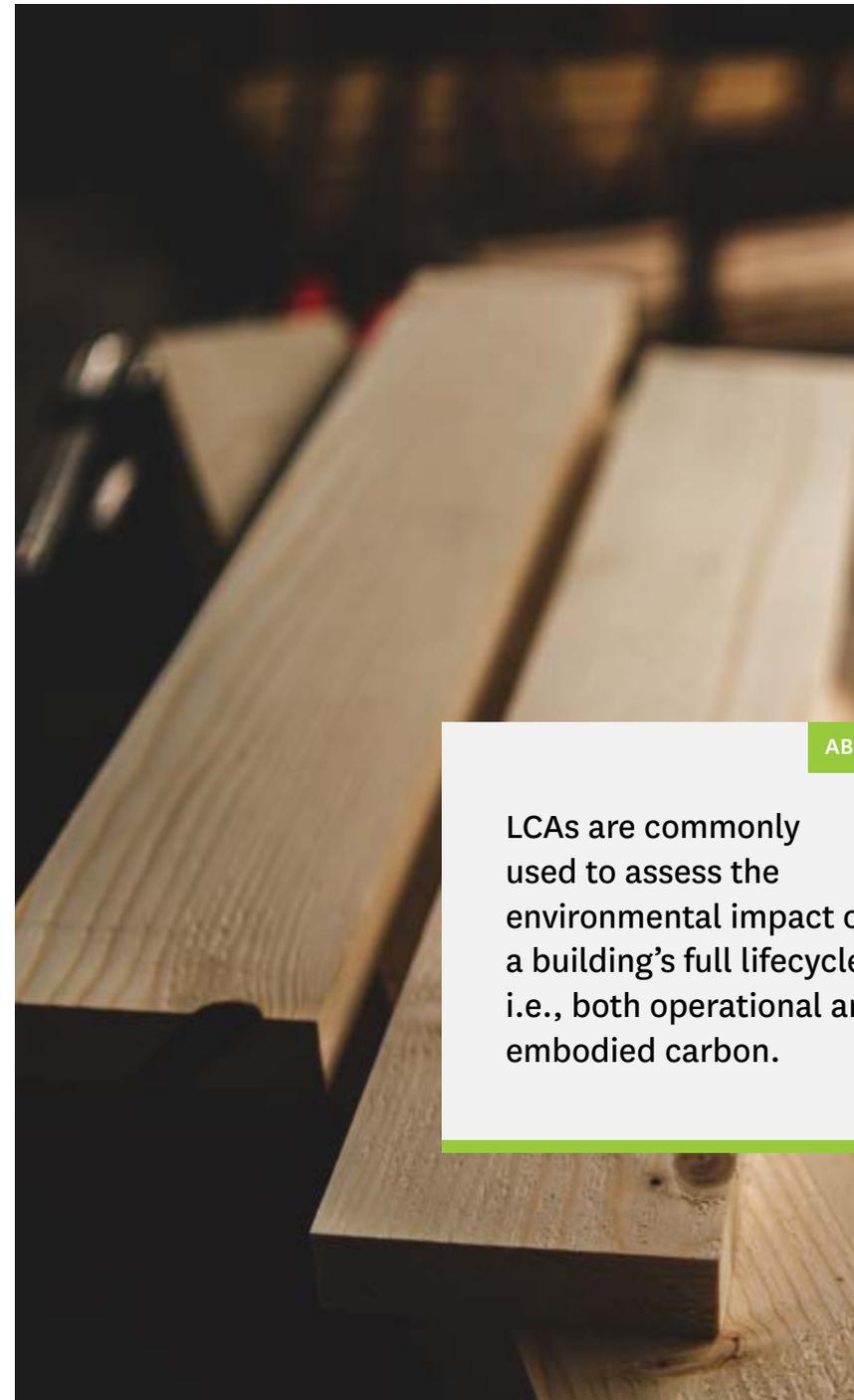
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What is an LCA and how does it relate to embodied carbon?

A life-cycle carbon assessment (LCA) is a methodology for assessing environmental impacts at all stages of a product's life – from raw material extraction through materials processing, manufacture, distribution, and use. In the construction sector, LCAs are commonly used to assess the environmental impact of a building's full lifecycle – i.e., both operational and embodied carbon.

As initiatives tackling operational carbon grow in impact, embodied carbon becomes a greater share over the overall carbon footprint of the construction sector. Embodied carbon emissions are also part of Scope 3 greenhouse gas emissions – (indirect emissions occurring in an organisation's value chain from assets not owned or controlled by them). Measuring Scope 3 emissions is an important first step for the construction sector on the pathway to full decarbonisation.



ABOUT LCAs

LCAs are commonly used to assess the environmental impact of a building's full lifecycle – i.e., both operational and embodied carbon.

What are the latest technological developments relating to embodied carbon? Is there a more sustainable alternative to concrete?

Just three materials – concrete, steel, and aluminium – are responsible for a very large share of global emissions and come, mostly from the built environment. While alternatives do exist, their development of greener alternatives remains in its infancy.

Carbon-intensive industries will increasingly be affected by climate regulation and concrete will become increasingly expensive. By encouraging investment in sustainable innovation and public procurement procedures which take into account the full carbon life cycle and set fixed maximum carbon limits for key construction materials. Bio-based materials are also another option [see section below].

In the meantime, cement production needs to be decarbonised. Several options exist, with lower carbon fuels such as hydrogen potentially being substituted for fossil fuels in heating the limestone and clay. Scientists are also examining whether electricity — instead of combustion — could be used for heating; increasing the use of electric arc furnaces.

Why are cities choosing to focus on embodied carbon in construction?

Dramatic embodied carbon reduction action is required to tackle climate change. Cities need to scale up the development of zero carbon buildings to neutralise embodied carbon.

While embodied carbon is an overlooked – and increasing – source of emissions in the construction sector, there are many other benefits to reducing them. These include lower air pollution, less congested landfills, reduction of heavy transport and the creation of better, greener jobs.



Bio-based materials

What are bio-based materials and how are they used in construction?

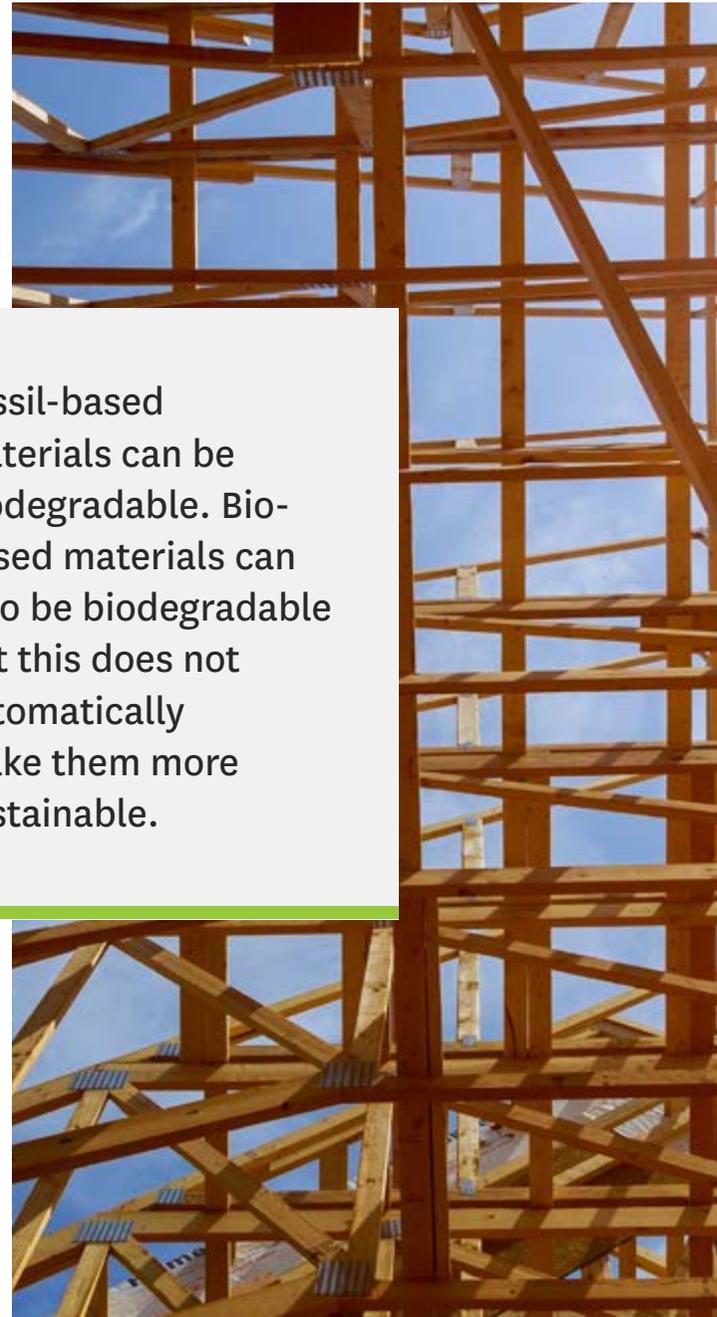
Simply put, bio-based materials are made from biological matter. They are renewable materials whose main constituents are originally derived from living organisms – which may be natural or synthesised – and exist in nature.

Bio-based materials can potentially be used in a range of building materials, such as bricks, wool insulation and plaster. Sustainably-sourced wood is increasingly touted as a lighter, easier-to-handle, more environmentally-friendly and safer alternative to concrete and steel, which is also durable. While metal and concrete absorb, emit and reflect heat, warming cities, wood does not.

Does bio-based also mean biodegradable?

No. Biodegradability occurs when organic matter is given the right conditions – in presence of microorganisms, fungi, or bacteria – to break back down to its basic components. Fossil-based materials can be biodegradable.

Bio-based materials can also be biodegradable but this does not automatically make them more sustainable. Biodegradable materials of all types can lead to unsustainable processes like releasing damaging chemicals, taking many years to break down.



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Are bio-based materials always more sustainable?

As bio-based materials use renewable feedstock, it is likely that overall carbon emissions will be reduced against fossil fuel alternatives. Waste can be minimised, and handling expenses will decrease compared to traditional chemicals.

Bio-based materials are also a way to boost business opportunities in cities looking for a green, post-pandemic recovery – and create a global business model with a local value chain. The EU bioeconomy sector employs around 22 million people and its annual turnover is €2 trillion.

However, bio-based materials are not automatically more sustainable or circular. For example, despite higher carbon emissions emitted during production, the recycling and upcycling value chain needs to be considered in the round when considering the overall carbon footprint of bio-based materials against polymers. – so may have an overall lower carbon footprint. Therefore, it is important to consider and address issues such as resources, feedstock, energy use and recycling when discussing bio-based materials. Encouraging more LCAs is likely to make bio-based materials a more attractive solution for the construction sector.

How does industry view bio-based materials?

While brands are increasingly setting targets for bio-based procurement and products – and cite consumer demand and public image as driving uptake – many require more information on barriers to adoption, such as pricing, availability and performance.

Again, it is important to openly consider and address these issues when discussing bio-based materials. It is also important to keep in mind that all carbon-intensive industries will increasingly be affected by climate regulation and fossil-based materials will become increasingly expensive.

Why are cities choosing to focus on bio-based materials in construction?

Under the right conditions, bio-based materials are the most sustainable option, helping the construction sector reduce embodied carbon and helping cities to reach Net Zero by 2050.

As urban planning changes to accommodate new ways of life and post-pandemic realities, bio-based construction materials are an opportunity to stimulate more sustainable procurement and create greener, local jobs using renewable feedstock.

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This document was elaborated by the Carbon Neutral Cities Alliance (CNCA) and Culmer Raphael under the project "Dramatically Reducing Embodied Carbon in Europe's Built Environment", which CNCA launched in 2021 with the support of the Laudes Foundation. The purpose of this document is to serve as a communications material that city staff can resort to when raising the awareness of the importance of addressing embodied carbon and increasing the uptake of bio-based materials among their city-department peers.

About Carbon Neutral Cities Alliance

Carbon Neutral Cities Alliance is a collaboration of leading global cities working to achieve carbon neutrality by 2050 or sooner — the most aggressive GHG reduction targets undertaken anywhere by any city.

For more information: www.carbonneutralcities.org.

For any questions, reach out to:

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