Accurately measuring embodied carbon in buildings

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Embodied carbon in the construction industry is a major factor of climate change, but it is rarely measured accurately. A reference text co-edited by an EPFL researcher calls for greater transparency surrounding embodied carbon, along with the introduction of international standards.

Catherine De Wolf, an architect and civil engineer, is a postdoctoral fellow at EPFL, working in the Structural Xploration Lab (SXL) of the school's "smart living lab" in Fribourg. Together with two colleagues she met at the University of Cambridge, she has edited a book containing novel research into grey energy by international experts. The review is both necessary and topical: "After the Paris climate agreement, many countries agreed to take steps to limit the amount of CO2 produced in construction. However, there is still no international consensus about how to measure emissions arising from grey energy in that industry. So we thought it was time to put together a reference text that summarizes recent research in this area."

But what are we talking about exactly? In construction, embodied carbon (or grey carbon) refers to the CO2 footprint related to grey energy in a building. It takes into account greenhouse gas emissions produced during the extraction of materials used to construct a building, the transportation of those materials, the building work itself, renovations, demolition and the potential re-use of materials. It does not include "operational carbon" produced during the in-use phase of a building, including the consumption of electricity, heating and hot water.

Underestimated and poorly assessed

De Wolf stresses the view of the Intergovernmental Panel on Climate Change (IPCC), which is that the construction industry must eliminate its carbon footprint by 2050 to avoid a major crisis. Currently, at least 5% of anthropogenic greenhouse gas emissions come from cement production and 5% from steel production. Although grey carbon is a crucial issue in climate change, it remains underestimated and poorly assessed by the construction industry. Her book is therefore a call for practitioners and researchers to adopt a new mindset and review their practices, while devising practical solutions to create greater transparency in the sector.

The first section of the book shows that the way in which embodied carbon is calculated remains approximate, and that data collection is still a challenge. In theory, the calculation is done by applying a coefficient to the quantity of materials used in producing a building. In practice, however, the elements taken into account by the coefficient vary between regions of the world, because there are no standards and a lack of transparency on the part of certain industry participants. "Often, the coefficient includes only the extraction and production of materials. But we also need to take into account the CO2 produced when constructing the building and transporting the materials to the site, when maintaining and renovating the building, and during its demolition," she explains.

Circular economy

To achieve greater consistency, her book shows how these elements can be factored in at the design stage of a building. The use of digital models – through Building Information Modeling – should help solve the problem, she believes. The book also suggests that circular economy principles should be applied to building materials. That would involve

establishing inventories of used materials that can be re-used in new buildings. Such practices "are still not adopted widely enough in the sector," according to De Wolf. Official documents describing the impact of each material would also bring greater transparency for engineers and architects. They would be similar to country-of-origin labels on food, which tell us where it came from and therefore their CO2 footprint. That solution would logically give rise to another one: the use of local, natural materials.

Finally, the authors encourage engineers to continue inventing more environmentally friendly materials, such as the eco-friendly cements and organic cements developed at EPFL, and to use less carbon-producing materials in buildings. On that latter point, De Wolf has just launched an international initiative aiming to reduce the carbon footprint of construction materials: the Structural Engineers 2050 Commitment Initiative.

Switzerland a promising pioneer

The book also provides a unique global overview of current practices, in Africa, Australia, Europe, China, North America and South America. Europe and the European Commission are leading the way in terms of developing international standards for embodied carbon, but have not yet reached their goal. In North America, in the absence of any governmental lead, the industry is asking the academic community to develop standards. In fact, several major US companies aiming to lead the way in this area directly approached De Wolf when she was writing her thesis at MIT. What is Switzerland's role in all this? "With the research carried out by the Swiss Federal Institutes of Technology, and particularly at the smart living lab in Fribourg, I think that Switzerland is well positioned to be a pioneer in this area. And this research is highly applicable in practice, which facilitates the adoption of these kinds of measures," she noted.

More information: Embodied Carbon in Buildings. www.springer.com/la/book/9783319727950

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