Embodied Carbon: What You Can Do Right Now

This short article on Embodied Carbon is the first in a series designed to give practitioners pragmatic guidance on immediate steps you can take to reduce the carbon impacts of your projects. Each article will present in brief:

- Background information – What is it? Why is it important? What are the costs? etc.
- Suggested action items
- Tools and resources for those wanting to learn more.

This is the first in a series brought to you each month by AIA California. You can find past articles here.

By Henry Siegel, FAIA and Larry Strain, FAIA

What is embodied carbon?

Embodied carbon is the sum of all the greenhouse gas emissions (mostly carbon dioxide) resulting from the mining, harvesting, processing, manufacturing, transportation and installation of building materials. The global warming emissions associated with these materials, along with emissions associated with construction itself, are the “embodied carbon footprint” of design and construction. Smart choices during design can greatly reduce this footprint.

What are the impacts of embodied carbon?

Embodied carbon emissions are released during the process that begins with sourcing materials and ends with the completion of construction; operating carbon emissions — from heating, cooling, lighting, and plug loads — occur over the life of a building, which can be 50 years or more. For new buildings, embodied carbon emissions typically equal about 20 years of operating emissions. When looking at total greenhouse gas emissions for new buildings built over the next ten years — the critical period for action to address...
the global climate emergency — Architecture 2030 estimates that 80% will come from embodied emissions, so lowering embodied carbon emissions is now even more urgent than lowering operating emissions.

What about existing buildings and materials?

Renovating, remodeling, and repurposing existing buildings almost always generates significantly fewer embodied emissions than new construction. Finding creative ways to reuse existing buildings is an increasingly important strategy for reducing embodied emissions. The urgent need to reduce greenhouse gas emissions in the short term means that the calculus for saving rather than demolishing an existing building has changed and is now weighed much more heavily against demolition. Reusing buildings also offers the opportunity to reduce current operating emissions from existing building through deep energy upgrades, so they can contribute in the long term as well as the short term.

How do you calculate embodied carbon?

There are a number of tools available for calculating embodied carbon. Some of these tools are meant for quick, early estimates while others take a deeper dive. More information on these tools can be found in the resources section at the end of this document. There are also databases that evaluate the life cycles of products and a growing number of environmental product declarations (EPDs) for specific products or product categories that document product global warming potential. Many of these tools are new and not yet widely used. Benchmarks need to be developed; more research is needed. Nevertheless, there are many steps architects can take now.

Where to start?

• Get educated about embodied carbon. Learn more about new tools.
• Consider the time value and impact of different ways to achieve carbon reductions
• Set goals for reducing embodied carbon on each project
• Focus on high volume materials: Between 50% and 75% of embodied emissions typically come from the concrete and steel in the foundation and structure.
• Focus on high emission materials: For example, small amounts of aluminum and certain kinds of foam insulation can have very large emission footprints.

10 things you can do right now

1. Reuse buildings (especially the foundations and structure where most of the embodied carbon is). Always consider reuse and retrofit before designing a new building.
Reuse and renovation with system upgrades typically generates 50% to 75% less embodied carbon emissions than new construction.

2. Concrete, specifically the production of cement for concrete, is responsible for more GHG emissions than any other material. Specify low carbon concrete mixes – replace cement with fly ash, ground blast furnace slag, calcined clays, and other substitute materials, reducing the cement content of concrete as much as possible.

3. Use high recycled content materials – especially metals. Steel is second only to concrete in embodied carbon impact. Virgin steel can have an embodied carbon footprint that is 5 times higher than high recycled content steel. Virgin aluminum can be more than 6 times higher than recycled aluminum.

4. Limit carbon intensive materials – aluminum, plastics, certain foam insulations, etc.
   Use these materials sparingly and only when there are no alternatives.

5. Choose lower carbon alternatives for structure and finishes, such as wood structure over steel and concrete, wood siding over vinyl siding. Compare EPDs.

6. Choose carbon sequestering materials whenever possible. Wood is usually a lower carbon choice than steel or concrete, but it is important to note that the carbon footprint of wood is determined by forestry practices. (One study showed that wood from FSC certified forests sequestered 20% to 60% more carbon than wood from traditionally managed forests.) Consider the use of other agricultural products such as straw, hemp, cork, and cellulose.

7. Reuse materials – brick, metals, broken concrete, wood. Salvaged materials typically have a much lower embodied carbon footprint than newly manufactured materials.

8. Maximize structural efficiency. Use the most efficient structural solutions to save on quantities of materials used. For example, “advanced framing” reduces wood use in wood framed structures.

9. Use structural materials as finishes and use fewer finish materials. Exposed concrete floors and ceilings and exposed wood structure look good and save carbon.

10. Minimize waste. Design in material size modules to minimize waste, taking advantage of standard size sheets for common materials such as 4×8 plywood and gypsum board.

Resources


Athena – Life Cycle Analysis (LCA) and carbon calculator  http://www.athenasmi.org/our-software-data/overview/
About the Authors

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Principal

Since the early 1990s Henry has championed the idea that sustainable design is an essential element of good design. He has put that conviction into practice through projects that combine design for environmental stewardship with thoughtful and site sensitive building design. His projects have won local, regional, and national awards including multiple Top Ten Green Projects of the Year from the AIA’s Committee on the Environment (COTE).

Henry is past chair of the COTE National Advisory Group and current member of AIA California COTE steering committee, where he advocates for laws and codes that address the climate change and the building sector, and for the incorporation of sustainable design values and metrics into architectural awards programs and architecture school curriculums.

Henry has taught sustainable design and design studios at the University of California, Berkeley, and is a past member of the University’s Design Review Committee. He has spoken widely on ecological design and the work of the firm and has served on architectural awards juries across the US.
Larry Strain, FAIA

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Larry has been a leader in sustainable design since the 1980s and brings a deep commitment to environmental stewardship to all projects. His practical experience as a builder prior to becoming an architect and his problem-solving skills are great assets. He has led many of Siegel & Strain Architect’s greenest projects, including many projects on environmentally-sensitive sites and with active community involvement. His industry-leading research on embodied carbon has helped to establish methods and benchmarks for designing lower impact buildings. He shares his expertise, speaking frequently at conferences throughout the country. Larry has served on the boards of the Carbon Leadership Forum, USGBC–Northern California Chapter, and the Ecological Building Network.