



Building-Related Embodied Carbon

A Fact Sheet on Materials & Construction

The Opportunity

We know that the energy required to operate our buildings is a [major driver of greenhouse gas](#) (GHG) emissions in the DC Metropolitan region, but did you know that the materials inside our buildings have a big overall impact on global emissions?

One of the largest contributors to U.S. GHG emissions is the industrial sector, contributing [30% of emissions nationwide](#). Many of those emissions come from the production of major structural materials for our buildings, including steel and concrete. [Globally, steel and concrete production are responsible for 9.6% of all GHG emissions annually](#), representing a larger impact than commercial building energy use each year.

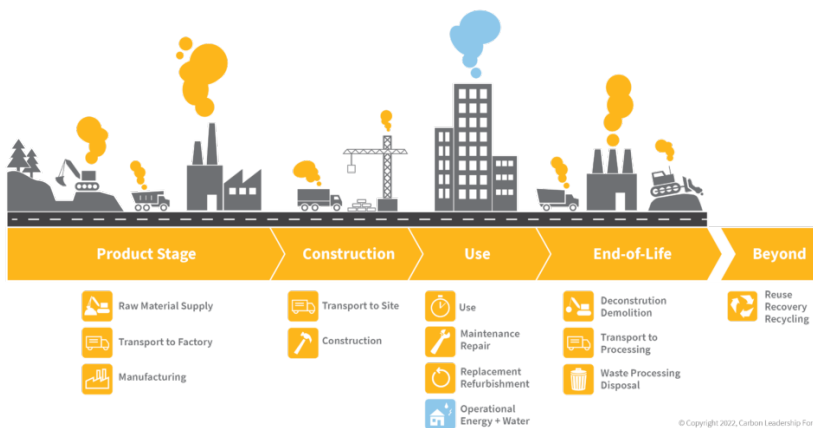


Figure 1: Whole life carbon story of a building. Source: Carbon Leadership Forum.

In addition to their production, the transportation, installation, maintenance, and disposal of these materials also contribute to their overall GHG emissions. These are collectively the embodied carbon of buildings. As buildings become more operationally efficient due to stricter energy codes and building performance standards (BPS), embodied carbon become increasingly important to lowering building-related carbon emission.

Definitions

Embodied Carbon: The carbon emissions generated by manufacturing, transporting, installing, maintaining, and disposing of construction materials.

Life Cycle Assessment (LCA): The method for measuring embodied carbon over its full lifecycle, from raw material extraction through end-of-life and disposal.

Environmental Product Declaration (EPD): A standardized document that reports the results of an LCA for a material or product. EPDs are third party-verified and governed by product category rules (PCRs). These allow comparison of embodied carbon between materials and products, and they are now commonly available.

Global Warming Potential (GWP): The metric used to measure and track embodied carbon. GWP is quantified in kilograms of CO₂ equivalent (kg CO₂e). The “equivalent” or “e” means that other greenhouse gases like methane—which are far more powerful GHG emitters than CO₂—are included and normalized to the impact of CO₂.

The Time Value of Carbon: The idea that in the near term, reducing embodied carbon is as important as—or more important than—operational carbon because upfront embodied carbon emissions are released into the atmosphere before the building is operational.

Whole Life Carbon: The total carbon emissions produced by a building throughout its life cycle from material extraction through construction and operations to demolition and disposal.



Strategies for Reducing Embodied Carbon in Building and Hardscape Materials

Embodied carbon during design and construction phases

1. Planning: Developers can build less and reuse more by extending the life of existing buildings and materials.

- Compare impacts of renovation vs. replacement with the [Carbon Avoided Retrofit Estimator \(CARE\)](#).
- Create an [Embodied Carbon Action Plan](#).
- Consult the [Carbon Leadership Forum](#) for tools and resources.

2. Schematic Design: Collaborate with engineers, owners, and builders to discuss design decisions and conduct a preliminary life cycle assessment to reduce the amount of materials and embodied carbon from materials.

- [AIA-CLF Embodied Carbon Toolkit for Architects](#).
- [Structural Engineer 2050 Resources](#)

3. Design Development: Specify materials that have lower-embodied carbon impacts than industry benchmarks as demonstrated by EPDs.

- Reference [GSA Low Embodied Carbon Material List](#).
- Use Embodied Carbon Calculator ([EC3](#)) to determine low-carbon materials better than “achievable.”
- Use facility-specific EPDs for structural wood products.

4. Construction Documents: Conduct a cradle-to-grave whole building life-cycle assessment (WBLCA)

- Show reduction in GWP using software like [Athena Impact Estimator](#), [OneClick LCA](#), or [TallyLCA](#).
- As a reference, [LEED awards up to 4 points](#) for demonstrating reductions in GWP and other impacts.

5. Construction: Procure Low-Embodied Carbon Construction Materials per specifications.

- Verify materials meet embodied carbon specifications during construction submittal reviews.
- Consult the [Federal Buy-Clean Initiative](#).

Key materials for lowering climate impact

- Lower-carbon concrete technologies and the use of fly ash or recycled glass powder can reduce GHG emissions from major structural elements.
- Sustainably grown wood is considered a lower carbon option for structural use than steel or concrete. Forest Stewardship Council (FSC) certified wood products ensure the wood used in buildings does not contribute to deforestation.
- Some insulation products emit more GHG in manufacturing and installation than saved in energy use over a building’s lifetime. It’s best to use foam and rigid insulation that specify “water-blown” hydrofluoroolefins (HFOs) to avoid methane-producing blowing agents like hydrofluorocarbons (HFCs).

Recommended approach

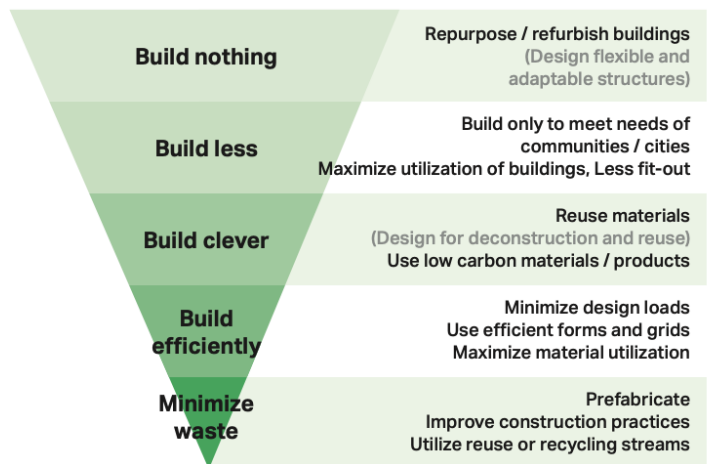


Figure 2: Embodied Carbon Reduction Strategy; Source: Arup and World Building Council for Sustainable Development.

