I. Embodied Carbon 101: Housing

Embodied carbon refers to the greenhouse gas (GHG) emissions generated by the manufacturing, transportation, installation, maintenance, and disposal of construction materials used in buildings, roads, and other infrastructure. Embodied carbon is a significant share of global emissions and requires urgent action to address it.

This factsheet provides a high-level overview of embodied carbon – how it is defined, its significance, and why it is an important consideration for building housing.

Measuring embodied carbon

In order to quantify embodied carbon, practitioners use a method called ***life cycle assessment (LCA)*** to track the greenhouse gas emissions produced over the full life cycle of a product, building or infrastructure asset. These emissions are converted into metrics that reflect their potential effects on the environment. One of these metrics is ***global warming potential (GWP)***, which is quantified in kilograms of CO_2 equivalent (kg CO_2e). This measure of embodied carbon is also referred to as a ***carbon footprint***.

LCA can be done at multiple scales. The most common scales are:

1. Product-level LCAs focus on quantifying extraction and manufacturing impacts of a specific product. Read more in factsheet *II. Environmental Product Declaration 101: Housing.*
2. Project-level LCAs focus on quantifying the impacts of the materials and processes used to construct a building across its life cycle. Read more in factsheet *III. Building LCA 101: Housing.*

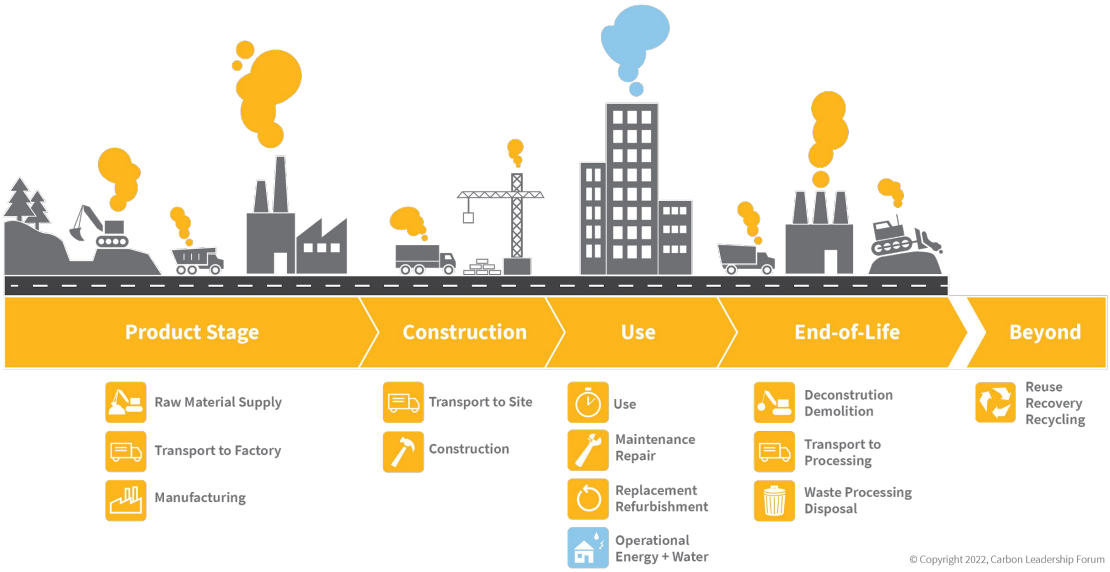

Figure 1. Embodied carbon (yellow) and operational carbon (blue) across the life cycle stage of a building

Embodied carbon is still a gap in climate policy

The majority of a product or building's embodied emissions are generated before the building is constructed and is driven by facilities and supply chains across the globe. Historically, climate policy has been focused on operational carbon (emissions from a building's energy consumption) and only recently has started to address embodied carbon. However a focus on commercial construction often misses the embodied carbon of residential buildings, which account for a large share of US's building stock and newly constructed area annually.

Embodied carbon is inherently connected to climate justice and issues of public health and equity because frontline communities tend to experience climate impacts "first and worst."

KEY TERMS

Embodied carbon

GHG emissions generated by the manufacturing, transportation, installation, maintenance, and disposal of construction materials used in buildings, roads, and other infrastructure.

Life Cycle Assessment (LCA)

A systematic set of procedures for compiling and evaluating the inputs and outputs of materials and energy, and the associated environmental impacts directly attributable to a product or process throughout its life cycle.

Global Warming Potential (GWP)

The potential climate change impact of a product or process as measured by an LCA. GWP is reported in units of carbon dioxide equivalent (CO_2e) and is the agreed-upon metric for tracking embodied carbon.

REFERENCES

1. Daniel Moran et al. (2018). *The Carbon Loophole in Climate Policy: Quantifying the Embodied Carbon in Traded Products*.

Embodied carbon in housing is a significant contributor to US emissions

Buildings are top contributors to global climate change, and residential construction represents a little over 50% of all building square footage newly constructed in the US.[2] As operational carbon emissions trend downward in the US from energy efficiency measures, embodied carbon will continue to increase as a portion of overall building emissions. Building materials are one of the largest sources of industrial emissions and therefore are potential solutions for reducing emissions from this sector.

As of June 2025, in the United States, residential construction accounts for 42% of all construction dollars spent on construction, inclusive of both building and infrastructure construction.[3] In Oregon specifically, residential construction and remodeling represents about 40% of Oregon's 2021 consumption-based GHG emissions for all construction.[4] As a sector of the construction industry, residential construction is a significant contributor to US embodied carbon emissions.

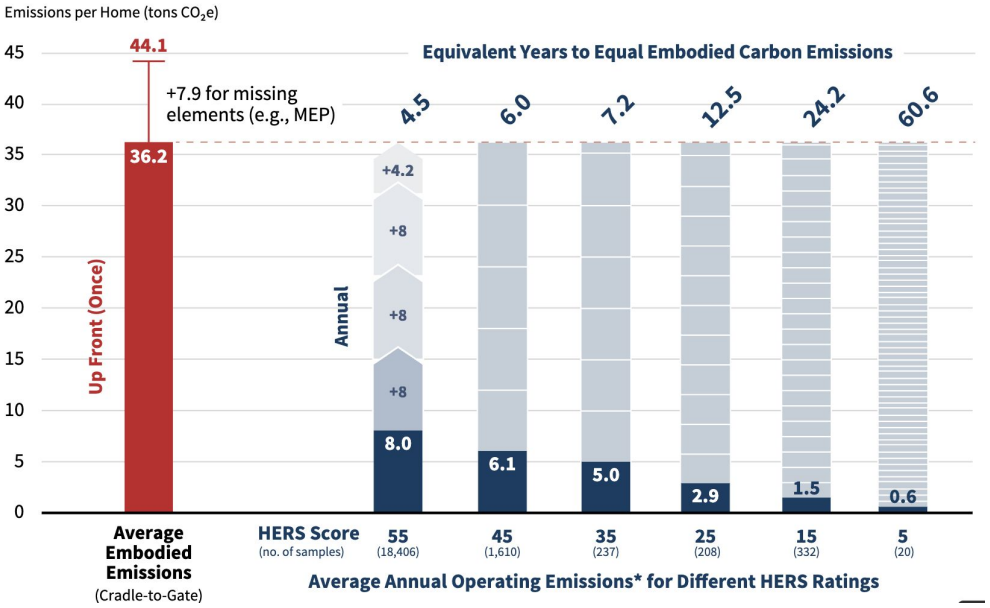

Figure 2. Average Embodied Carbon Emissions per Home Compared with Operational GHG Emissions for a Range of HERS Scores - Exhibit 2[5]. A HERS rating assesses the energy efficiency of a home compared to a baseline new home in 2006, with a lower score indicating higher energy efficiency. As homes become electrified and source energy from a greener grid, HERS scores will decrease towards zero and the upfront embodied carbon emissions will dominate the total carbon emissions associated with the building.

Operational carbon generated from the daily operations of a building can be decreased over time thanks to ongoing energy efficiency efforts, fuel-switching, and grid decarbonization. In contrast, once upfront embodied carbon emissions are released into the atmosphere, we can't take them back and they start affecting the climate immediately.

In order to avoid the most catastrophic impacts of climate change, it is essential that we reduce embodied carbon now, and integrate low-carbon construction methods on every building project. When considered over the full life cycle, built environment impacts are spread across:

- *Industry* - The materials used in construction, like concrete and steel. **The majority of embodied emissions for buildings are from the industrial sector.**
- *Agriculture, land use change, and forestry* - The production of bio-based building materials contributes emissions to these sectors.
- *Transport* - Materials are shipped between processing facilities, construction sites, and/or landfills, and these emissions are accounted for as transportation emissions.
- *Waste* - Building materials may end up in landfills or incinerators, where their decomposition or combustion are tracked as waste emissions. End of life emissions (C1-C3) can range from 3% to 15% of total life cycle emissions for building products.[5]

REFERENCES

2. Ashtiani, M., Jungclaus, M., Habchi, R., Jensen, A., Rempher, A., Esau, R., and Lewis, M. (2025). *Embodied Carbon Pathways to 2050 for the United States*. Carbon Leadership Forum. Seattle, WA.

3. Bureau, U. C. (2019, April 15). *Construction spending*. United States Census Bureau. https://www.census.gov/construction/c30/c30index.html

4. Oregon Department of Environmental Quality Materials Management Program. (2024). *Oregon's Consumption-Based Greenhouse Gas Emissions (1990 - 2021)*.

5. C. Magwood, T. Huynh, Olgyay V. (2023). *The Hidden Climate Impact of Residential Construction: Zeroing In on Embodied Carbon Emissions for Low-Rise Residential Buildings in the United States.*

TIPS

The time value of carbon

Emissions released now are more critical than emissions released later because (1) emissions will accumulate in the atmosphere and (2) there is limited time remaining before the tipping point of the climate crisis. This means that in the near-term, reducing embodied carbon is as important as—or more important than—operational carbon. The urgency of reducing emissions that will happen in the short-term between now and 2030 or 2050 is sometimes referenced as "the time value of carbon."