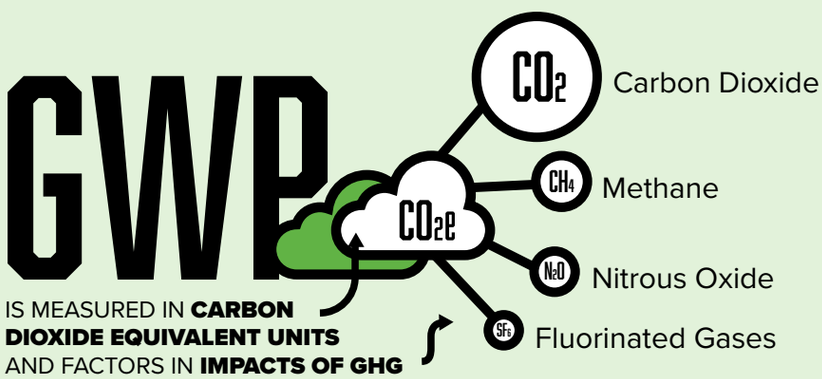
LOW EMBODIED CARBON MATERIALS

WHAT ARE LOW EMBODIED CARBON MATERIALS?

Low embodied carbon (LEC) materials (commonly referred to as low carbon transportation materials or low carbon materials) have low climate impacts throughout their life cycle, specifically in terms of the embodied greenhouse gas emissions (GHG) associated with extraction, processing, transport of material to final manufacture, and manufacturing. The term generally refers to materials with lower GHG emissions as compared to similar materials.[1]

WHAT ARE EMBODIED EMISSIONS?

Embodied carbon emissions refer to the amount of GHG emissions released during extraction, production, manufacturing, transport, construction, use and disposal of a material.[2] Construction materials embodied carbon emissions are disclosed as global warming potential (GWP).[3] GWP is a measure of the embodied GHG emission intensities at the product level, expressed in $kgCO_2e$ per unit of product/material.[4]



FHWA Low-Carbon Transportation Materials Grants Program

- When calculating embodied emissions, it is critical to understand which life cycle stages are being considered. For example, the Inflation Reduction Act Sections 60506 and 60503[5] direct the Environmental Protection Agency (EPA) to define "substantially lower level of embodied GHG emissions" and consider all relevant stages of production, use, and disposal.
- The EPA Interim Determination[6] prioritizes construction materials and products that have the highest GHG emissions in the materials production stage (A1-A3).[7]
- As such, the FHWA Low-Carbon Transportation Materials Grants Program only considers the materials production stage[8] (also known as cradle-to-gate) embodied carbon emissions for identifying materials that can qualify for funding.

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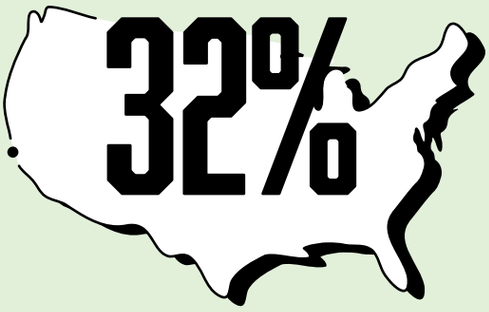
>11% OF GHG EMISSIONS IN THE INFRASTRUCTURE SECTOR COME FROM EMBODIED CARBON ASSOCIATED WITH **CONSTRUCTION MATERIALS**



OF CONSTRUCTION-RELATED EMBODIED CARBON EMISSIONS IN U.S. COME FROM **GOVERNMENT-FUNDED PROJECTS**

WHY DO EMBODIED EMISSIONS MATTER?

The infrastructure sector represents a significant portion of the global GHG emissions. Out of this sector's GHG emissions, at least 11 percent[9] result from embodied carbon associated with construction materials such as asphalt mixture, concrete, glass, and steel.[10] Traditionally, construction materials produce significant embodied carbon emissions due to the energy-intensive processes used to extract, process, transport between supply chain locations, and manufacture those products.[11] In the United States, roughly 32% of construction-related embodied carbon emissions come from government-funded projects, highlighting the critical role that public agencies play in reducing such emissions.[12]

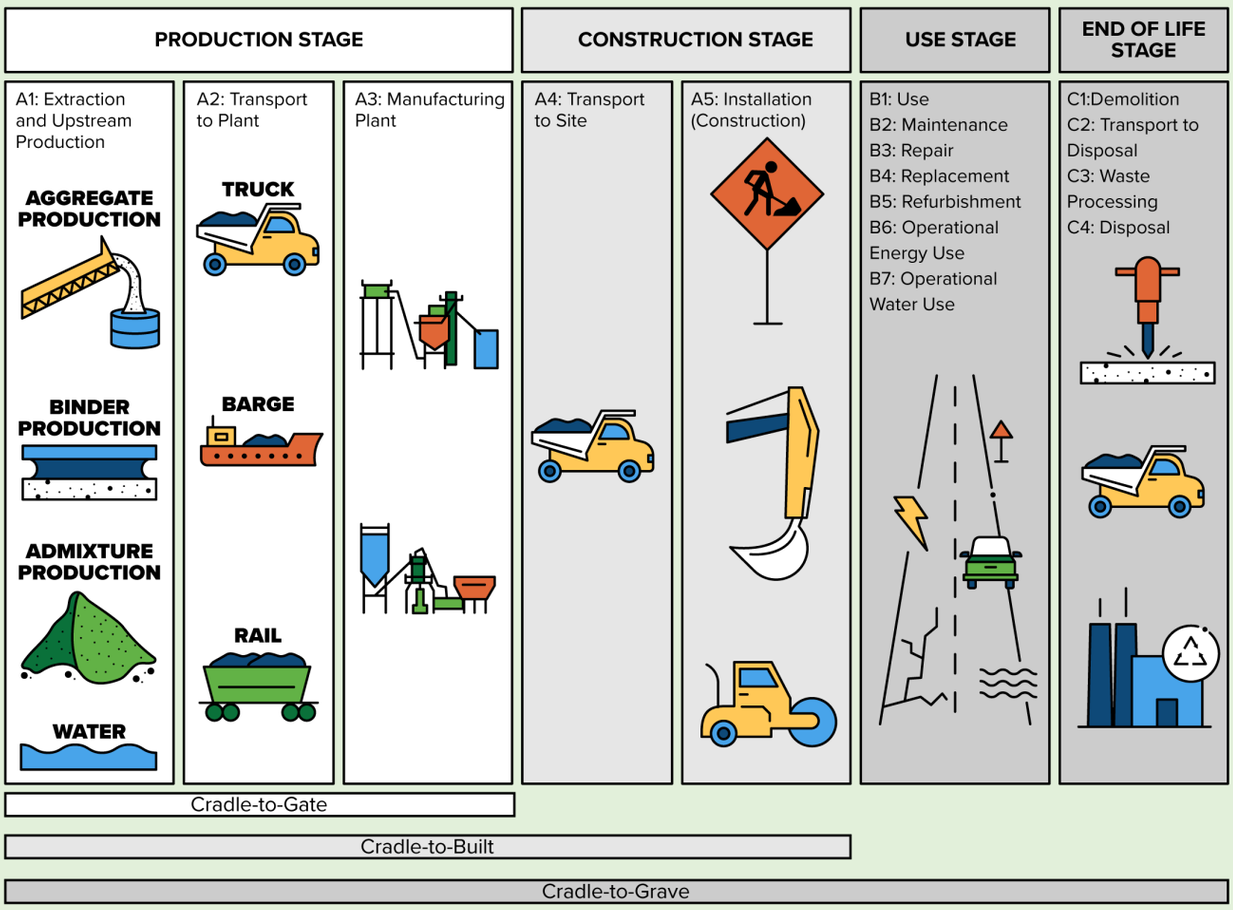
HOW ARE MATERIALS DEEMED LEC MATERIALS?

EPDs + GWP THRESHOLDS + STRATEGIES TO REDUCE EMISSIONS = LEC MATERIALS

EPDs report embodied carbon emissions

- Environmental Product Declarations (EPDs) provide verifiable and transparent environmental data using predetermined parameters and, where relevant, additional environmental information related to the life cycle stages declared.[13]
- EPDs are a key tool that allow agencies to verify compliance with embodied carbon emission policies.
- EPDs are developed based on a standardized methodology called life cycle assessment (LCA)[14] conducted in accordance with the appropriate Product Category Rules (PCRs).[15] PCRs provide a set of specific rules, requirements, and guidelines for developing EPDs for one or more product categories.[16]
- Most EPDs for construction materials in the United States have a cradle-to-gate scope, which includes the embodied carbon impacts associated with the production stage (A1-A3).

Common Life Cycle Stages and Informational Modules for Asphalt/Concrete Pavement Systems



GWP thresholds for defining LEC Materials

- A GWP threshold can serve as the maximum acceptable GWP limit for construction materials to qualify as LEC materials. When establishing GWP thresholds for a material or product category, data from verified sources should be used, and accepted common practices established by the International Organization for Standardization (ISO) should be followed.
- Several Federal and state agencies are making determinations to what constitutes a LEC material. For example, EPA outlines a “waterfall” quintile approach for defining LEC materials in their December 22, 2022, Interim Determination. These determinations may be used to develop GWP thresholds, which are established for similar materials that conform to a defined product category and PCR.
- Due to the inherent regional variability of manufacturing processes for some construction materials, the establishment of regional/local thresholds is frequently the appropriate way to qualify certain LEC materials.[17] Understanding regional differences within product categories is essential when setting thresholds for effective procurement and adoption of LEC materials.

Key Takeaways for GWP Thresholds

A GWP threshold can serve as the maximum acceptable GWP limit for construction materials to qualify as LEC materials.

Due to the inherent regional variability of manufacturing processes for some construction materials, the establishment of regional/local thresholds is frequently the appropriate way to qualify certain LEC materials.

Strategies to reduce embodied carbon emissions of construction materials

- Develop requirements, specifications, or programs for collecting documentation of materials' GWP emissions (e.g., require EPDs as part of the material submittal process).
- Develop or update performance-based specifications to facilitate the use of proven innovations (e.g., optimized mixtures, alternative sourcing, etc.) and optimize the use of recycled content [18] [e.g., reclaimed asphalt pavement (RAP), recycled asphalt shingles (RAS), recycled concrete aggregate (RCA), ground tire rubber (GTR)] to potentially achieve lower levels of embodied carbon, while ensuring adequate engineering performance over the material life cycle.
- Integrate GHG threshold values into standard specifications to increase the availability of LEC materials and practices across the industry.
- Foster innovation and use of incentives for ensuring quality engineering performance (i.e., GWP target values) to increase the use of LEC materials through green public procurement strategies.
- Foster demand for LEC materials to encourage industry strategies such as optimizing energy usage at manufacturing facilities and participating in the ENERGY STAR Program.[19]

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https://www.fhwa.dot.gov/pavement/sustainability

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FOOTNOTES AND REFERENCES

[1] Similar materials/products are defined as materials/products within the same product category (i.e., concrete, glass, asphalt mixture, or steel) that meet the same functional (i.e., performance) requirements. Product category refers to a group of construction products, construction elements, or integrated technical systems that can fulfill equivalent functions. ISO 14025:2006.

[2] EPA's Sustainable Marketplace: Greener Products and Services website.
Link: https://www.epa.gov/greenerproducts/what-embodied-carbon

[3] The term "GWP" is used in EPDs, PCRs, and Buy Clean policies for construction products as an impact category to report on embodied GHG emissions (per ISO 21930:2017, Section 7.3, Table 5). It is to be noted that this usage is inconsistent with how GWP is defined by the Intergovernmental Panel on Climate Change (IPCC) and in other GHG accounting efforts, including national reporting by Parties to the Paris Agreement. Per IPCC, GWP is an index measuring the radiative forcing following an emission of a unit mass of a given substance, accumulated over a chosen time horizon, relative to that of the reference substance, carbon dioxide (CO_2).

[4] EPA's Understanding Global Warming Potentials website.
Link: https://www.epa.gov/ghgemissions/understanding-global-warming-potentials

[5] 23 USC 179: Low-Carbon Transportation Materials Grants
Link: https://uscode.house.gov/view.xhtml?req=granuleid:USC-prelim-title23-section179&num=0&edition=prelim

[6] U.S. Environmental Protection Agency Interim Determination on Low-Carbon Materials for 60503 and 60506, December 22, 2022.
Link: https://www.epa.gov/system/files/documents/2023-01/2022.12.22%20Interim%20Determination%20on%20Low%20Carbon%20Materials%20under%20IRA%2060503%20and%2060506_508.pdf

[7] The material production stage considers the embodied carbon emissions associated with the extraction (A1) and transportation of raw materials (A2), the production, and manufacturing process (A3).

[8] Although EPA indicates that its determination may evolve to include other stages such as construction, use and disposal, these stages are not in the scope of the current determination on selecting low embodied carbon materials.

[9] Bringing embodied carbon upfront. This number may be higher as it does not include transport to site and chemical conversion process emissions released during the manufacture of a number of key construction materials.
Link: https://worldgbc.s3.eu-west-2.amazonaws.com/wp-content/uploads/2022/09/22123951/WorldGBC_Bringing_Embodied_Carbon_Upfront.pdf

[10] Bringing embodied carbon upfront. Coordinated action for the building and construction sector to tackle embodied carbon. World Green Building Council. Published September 2019.
Link: https://worldgbc.s3.eu-west-2.amazonaws.com/wp-content/uploads/2022/09/22123951/WorldGBC_Bringing_Embodied_Carbon_Upfront.pdf

[11] Federal Buy Clean Initiative, Frequently Asked Questions - What are embodied emissions?.
Link: https://www.sustainability.gov/buyclean/index.html

[12] Green Building Advisory Committee Advice Letter approved February 2021.
Link: https://www.gsa.gov/system/files/GSA%20GBAC%20Low%20EC%20Procurement%20Policy%20Advice%20Letter-2-17-21.pdf

[13] To learn more about EPDs, please refer to FHWA-HIF-21-024: Tech Brief: Environmental Product Declarations--Communicating Environmental Impact for Transportation Products.
Link: https://www.fhwa.dot.gov/pavement/sustainability/hif21025.pdf

[14] To learn more about LCA, please refer to FHWA-HIF-15-001: Tech Brief: Life Cycle Assessment of Pavements.
Link: https://www.fhwa.dot.gov/pavement/sustainability/hif15001.pdf

[15] ISO 21930:2017 Sustainability in buildings and civil engineering works - Core rules for environmental product declarations of construction products and services.

[16] Product category refers to a group of construction products, construction elements, or integrated technical systems that can fulfill equivalent functions. ISO 14025:2006.

[17] ISO 21678:2020 Sustainability in buildings and civil engineering works — Indicators and benchmarks — Principles, requirements and guidelines.

[18] To learn more about FHWA's recycling policy, visit FHWA's Recycling Webpage.
Link: https://www.fhwa.dot.gov/pavement/recycling/

[19] To learn more about the EPA ENERGY STAR Program, visit EPA's ENERGY STAR webpage.
Link: https://www.energystar.gov/industrial_plants

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