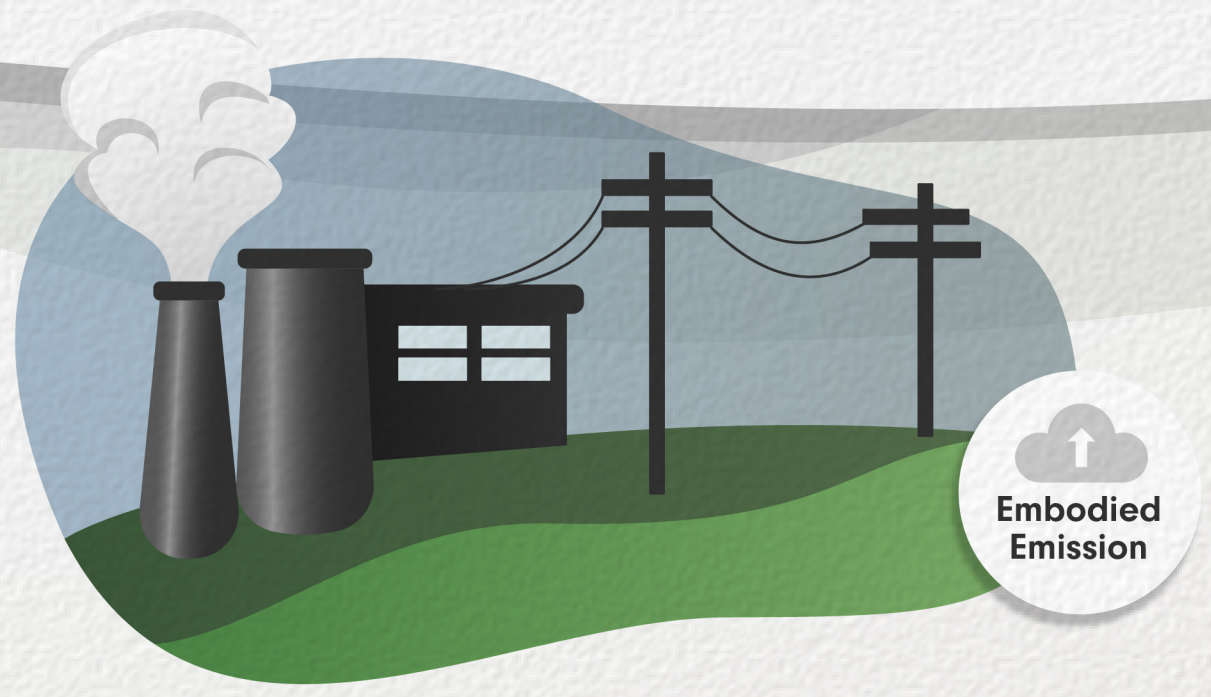


EMISSIONS FROM HIGHWAY TRANSPORTATION SYSTEMS

A Look Beyond the Tailpipe



What are tailpipe emissions?

Tailpipe emissions are pollutants from exhaust gases discharged from vehicles equipped with an internal combustion engine. Tailpipe emissions incurred during the use stage of the pavement life cycle are considered operational emissions.

What are embodied emissions?

Embodied emissions include emissions from manufacturing, material transport, construction, maintenance, and disposal of transportation infrastructure building materials. Embodied emissions of greenhouse gases (GHG) are also known as embodied carbon.

TOTAL EMISSIONS INCLUDE BOTH TAILPIPE AND EMBODIED EMISSIONS

29%

of U.S. GHG emissions come from the transportation sector.

Source: [U.S. Environmental Protection Agency](#)

Why is it important to consider embodied emissions?

29 percent of total U.S. GHG emissions come from transportation industry tailpipes—mainly from burning fossil fuels in vehicles, trucks, ships, and airplanes ...

BUT

... embodied emissions from constructing and maintaining highways are sometimes omitted in the quantification of transportation GHG emissions, yet, they can be significant.

Materials Production

Manufacturing cost, recycled material content, renewable resources

Pavement Design

Initial and life-cycle cost, recycled material content, local material usage, durability and longevity

Construction

Workzone traffic delay, dust suppression, worker safety

Use Stage

Pavement smoothness, structural response, texture, noise reduction, stormwater management, thermal environment, safety

Maintenance & Preservation

Workzone traffic delay, pavement smoothness

End-of-life

Re-use and recyclability

Pavement Life Cycle

Life-cycle emissions of pavement infrastructure consist of embodied emissions from the following processes that are typically not included in the transportation sector GHG emissions:

- Acquisition and processing of construction materials
- Asphalt and concrete plant processes
- Construction equipment and other field processes
- Energy production (fossil fuels and electricity)

Embodied Emissions

Tailpipe Emissions

Focusing on mitigating tailpipe emissions alone may not provide sufficient reductions to meet an agency's environmental goals.

What can State DOTs do?

State Departments of Transportation (DOTs) may have limited control over fuel standards, fuel type, and transportation mode selection, all of which can influence tailpipe emissions.

DOTs influence pavement design, material selection, material and construction specifications, and pavement treatment selection, and can therefore drive improvements in these areas.

How do we reduce emissions from pavement systems?

State DOTs can start using **life-cycle assessment (LCA)** to assess embodied environmental impacts of highway transportation systems. LCA can provide a comprehensive estimate of life-cycle impacts to decision-makers and can help indicate areas of improvement.



Typical Applications of LCA

- Document and benchmark environmental impacts of current best materials
- Determine pavement structural and mixture designs with lower environmental impact
- Evaluate impacts of agency policies (such as increased use of recycled materials)
- Develop and collect **environmental product declarations (EPDs)** for specific products (such as asphalt mixtures, cement, or aggregates), that provide transparent, verified information to communicate environmental impacts of the production of construction materials
- Demonstrate good environmental stewardship to internal and external stakeholders

What are agencies doing today?

Some state and local agencies are including EPDs in public purchasing decisions. Examples include:

- **Buy Clean California Act**
- City of Portland, Oregon **Low Carbon Concrete Initiative**
- Colorado's **Global Warming Potential for Public Project Materials Act**

States that have considered legislation requiring **EPDs for public purchasing** include Oregon, Minnesota, New York, and Washington

How can FHWA help?

FHWA's **Sustainable Pavements Program** was initiated in 2010 to increase the knowledge and practice of designing, constructing, and maintaining more sustainable pavements. The key LCA efforts have included the development of the **Pavement LCA Framework**, demonstrated use of LCA through **case studies**, deployment of a series of **webinars** and publication of **tech briefs**, and the development of an LCA tool specific to pavement systems—**LCA Pave**.

LCA PAVE