



U.S. Department of Transportation
Federal Highway Administration

FHWA Update

Wisconsin Concrete Pavement Association

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Who Am I?

- B.S. in Civil Engineering from Virginia Tech
- Worked at NIST
- M.S. in Civil Engineering from UIUC
- Worked as a forensic structural engineer
- Concrete Materials Research Engineer for FHWA TFHRC
- Concrete Sustainability Ph.D. student at Michigan Tech



Virginia Tech, <https://brand.vt.edu/identity/logo.html>



University of Illinois, <https://marketing.illinois.edu/visual-identity/logo>

Turner-Fairbank
| Highway Research Center



Michigan
Technological
University

Michigan Tech,
<https://www.mtu.edu/umc/resources/download/>



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Abbreviations

AASHTO American Association of State Highway
and Transportation Officials

EDC Every Day Counts

EPDs Environmental Product Declarations

FHWA Federal Highway Administration

GWP Global Warming Potential

LCA Life Cycle Assessment

P&R Preservation and Repair

PCR Product Category Rule

PEM Performance Engineered Mixtures

QC Quality Control

SCMs Supplementary Cementitious Materials

TFHRC Turner-Fairbank Highway Research
Center

UHPC Ultra-High Performance Concrete



FHWA's Vision for Pavements

Pavements are designed, constructed, preserved, and maintained to accommodate current and predicted traffic needs in a safe and sustainable manner considering economic, environmental, and social impacts throughout the pavement's life cycle.



FHWA's Vision for Pavements

Pavements are designed, constructed, preserved, and maintained to accommodate current and predicted traffic needs in a safe and **sustainable** manner considering economic, environmental, and social impacts throughout the pavement's life cycle.



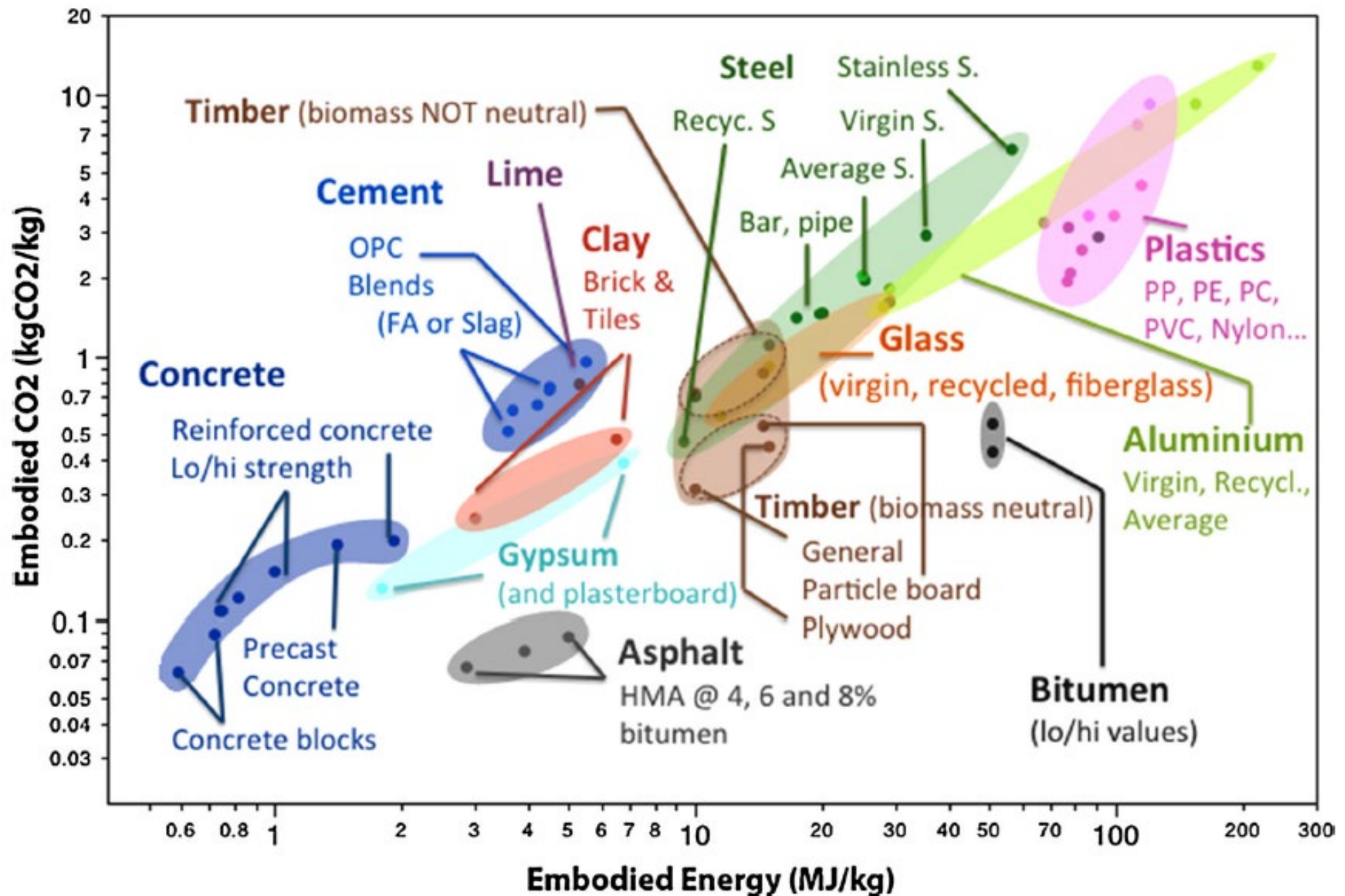


Best of 2019

Concrete: the most destructive material on Earth

📷 Limestone quarries and cement factories are often sources of air pollution. Photograph: Zoonar GmbH/Alamy

Source: [Guardian.com](https://www.guardian.com)



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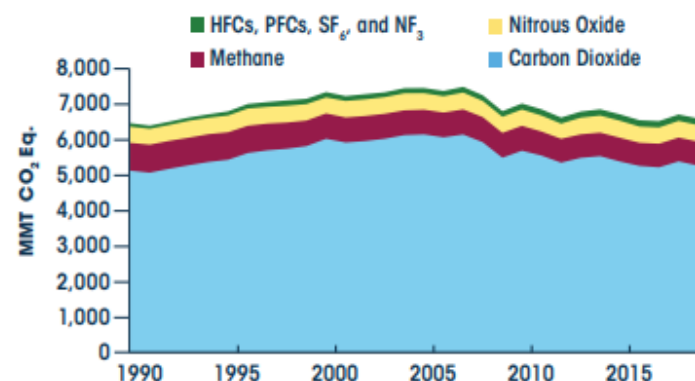
Million Metric Tons¹

Apparent annual U.S. Consumption of domestically-produced and imported cement.

¹USGS's 2022 Mineral Commodity Summary available at:
<https://pubs.usgs.gov/periodicals/mcs2022/mcs2022.pdf>

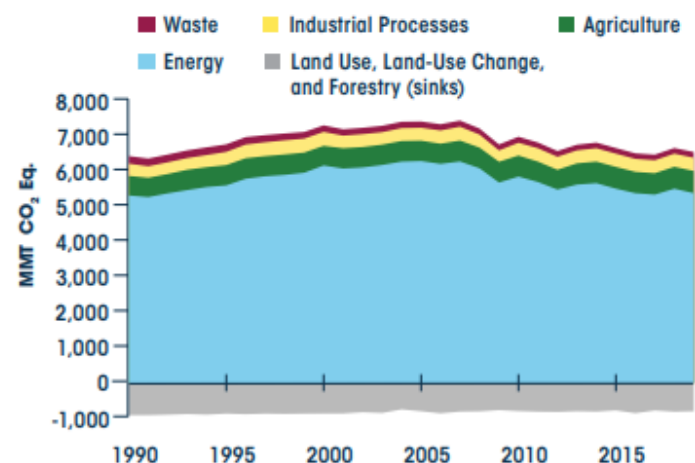
U.S. Greenhouse Gas Emissions

by Gas



U.S. Greenhouse Gas Emissions/Sinks

by Chapter/IPCC Sector



U.S. Greenhouse Gas Emissions and Sinks (MMT CO₂ Equivalents)

Gas/Source*	1990	2005	2015	2016	2017	2018	2019
CO₂	5,113.5	6,134.5	5,371.8	5,248.0	5,207.8	5,375.5	5,255.8
Fossil Fuel Combustion	4,731.5	5,753.5	5,008.3	4,911.5	4,854.5	4,991.4	4,856.7
Transportation	1,469.1	1,858.6	1,719.2	1,759.9	1,782.4	1,816.6	1,817.2
Electric Power Sector	1,820.0	2,400.1	1,900.6	1,808.9	1,732.0	1,752.9	1,606.0
Industrial	853.8	852.9	797.3	792.5	790.1	813.6	822.5
Residential	338.6	358.9	317.3	292.8	293.4	338.1	336.8
Commercial	228.3	227.1	244.6	231.6	232.0	245.7	249.7
U.S. Territories	21.7	55.9	29.2	26.0	24.6	24.6	24.6
Non-Energy Use of Fuels	112.8	129.1	108.5	99.8	113.5	129.7	128.8
Petroleum Systems	9.7	12.1	32.4	21.8	25.0	37.1	47.3
Iron and Steel Production & Metallurgical Coke Production	104.7	70.1	47.9	43.6	40.6	42.6	41.3
Cement Production	33.5	46.2	39.9	39.4	40.3	39.0	40.9
Natural Gas Systems	32.0	25.2	29.1	30.1	31.2	33.9	37.2
Petrochemical Production	21.6	27.4	28.1	28.3	28.9	29.3	30.8
Ammonia Production	13.0	9.2	10.6	10.2	11.1	12.2	12.3
Lime Production	11.7	14.6	13.3	12.6	12.9	13.1	12.1
Incineration of Waste	8.1	12.7	11.5	11.5	11.5	11.5	11.5
Other Process Uses of Carbonates	6.3	7.6	12.2	11.0	9.9	7.5	7.5
Urea Consumption for Non-Agricultural Purposes	3.8	3.7	4.6	5.1	5.0	5.9	6.2
Urea Fertilization	2.4	3.5	4.7	4.9	5.1	5.2	5.3
Carbon Dioxide Consumption	1.5	1.4	4.9	4.6	4.6	4.1	4.9
Liming	4.7	4.3	3.7	3.1	3.1	2.2	2.4
Aluminum Production	6.8	4.1	2.8	1.3	1.2	1.5	1.9
Soda Ash Production	1.4	1.7	1.7	1.7	1.8	1.7	1.8
Ferroalloy Production	2.2	1.4	2.0	1.8	2.0	2.1	1.6
Titanium Dioxide Production	1.2	1.8	1.6	1.7	1.7	1.5	1.5
Glass Production	1.5	1.9	1.3	1.2	1.3	1.3	1.3
Zinc Production	0.6	1.0	0.9	0.8	0.9	1.0	1.0

Sustainability

=

Good Engineering

Agenda

1

Define Sustainability

2

Accomplishments

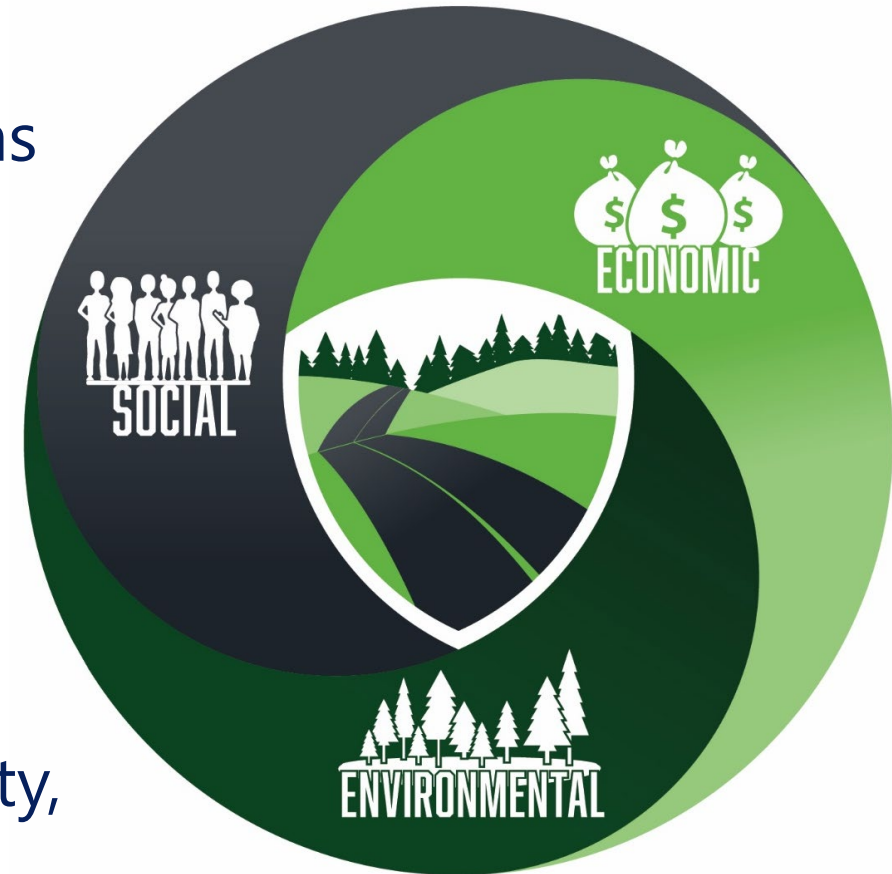
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What's Next?



What is Sustainability?

- Achieve the engineering goals for which it was constructed. **(performance)**
- Preserve and (ideally) restore surrounding ecosystems.
- Use financial, human, and environmental resources economically.
- Meet basic human needs such as health, safety, equity, employment, comfort, and happiness.

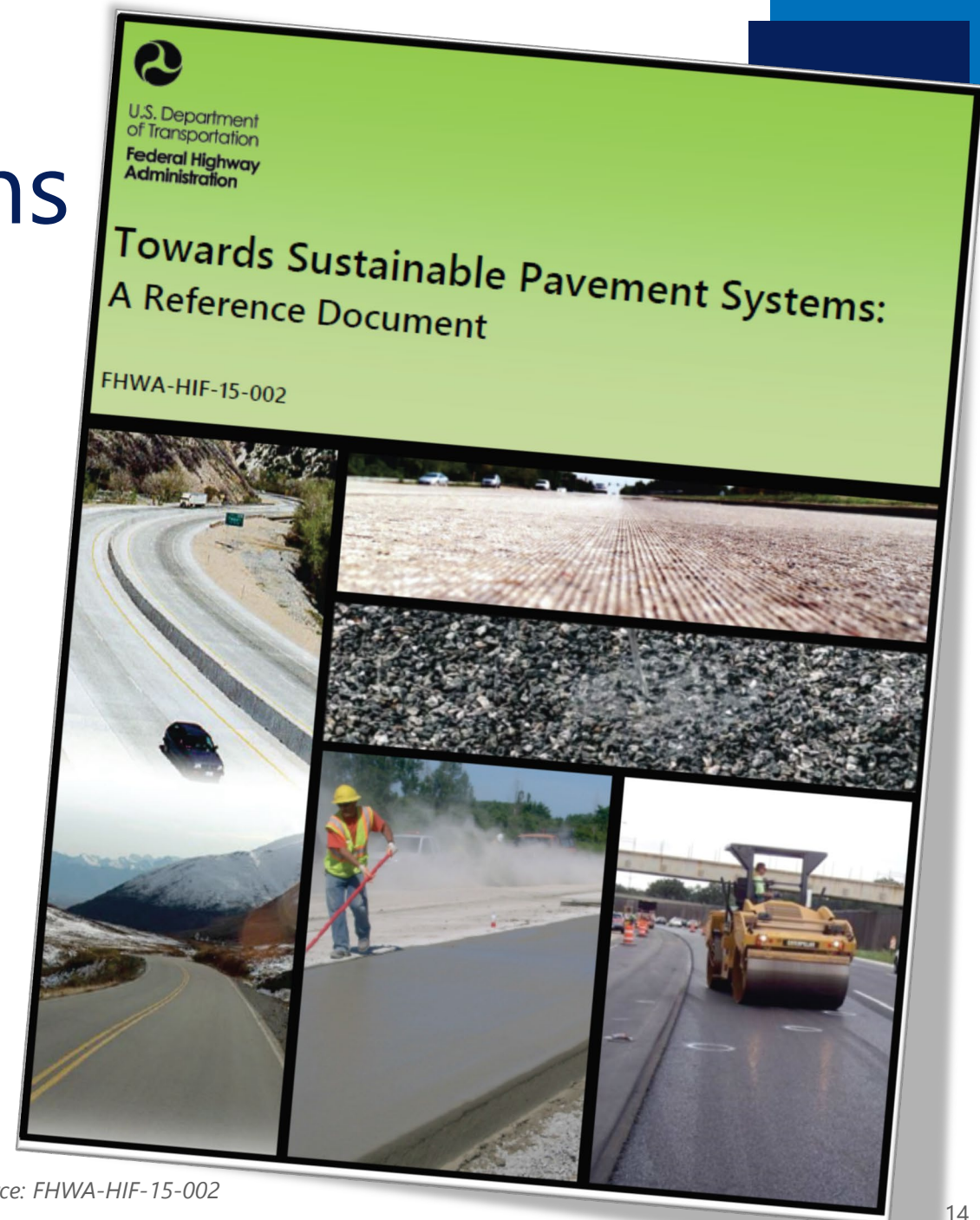


Source: FHWA-HIF-15-002



Important considerations

- Sustainability is an aspirational goal.
- Sustainability is context sensitive.
- Sustainability pertains to all areas related to pavement and materials.
- Sustainability assessment is an evolving field.
- Considerations of trade-offs is important.



Source: FHWA-HIF-15-002



U.S. Department of Transportation
Federal Highway Administration

**Everyone has a
place to
contribute**

Requirements

Standard Method of Test for

Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)

AASHTO Designation: T 97-14

ASTM Designation: C 78-08



1 SCOPE

PCR

(Product Category Rule)
defined by Program Operator

Process



LCA

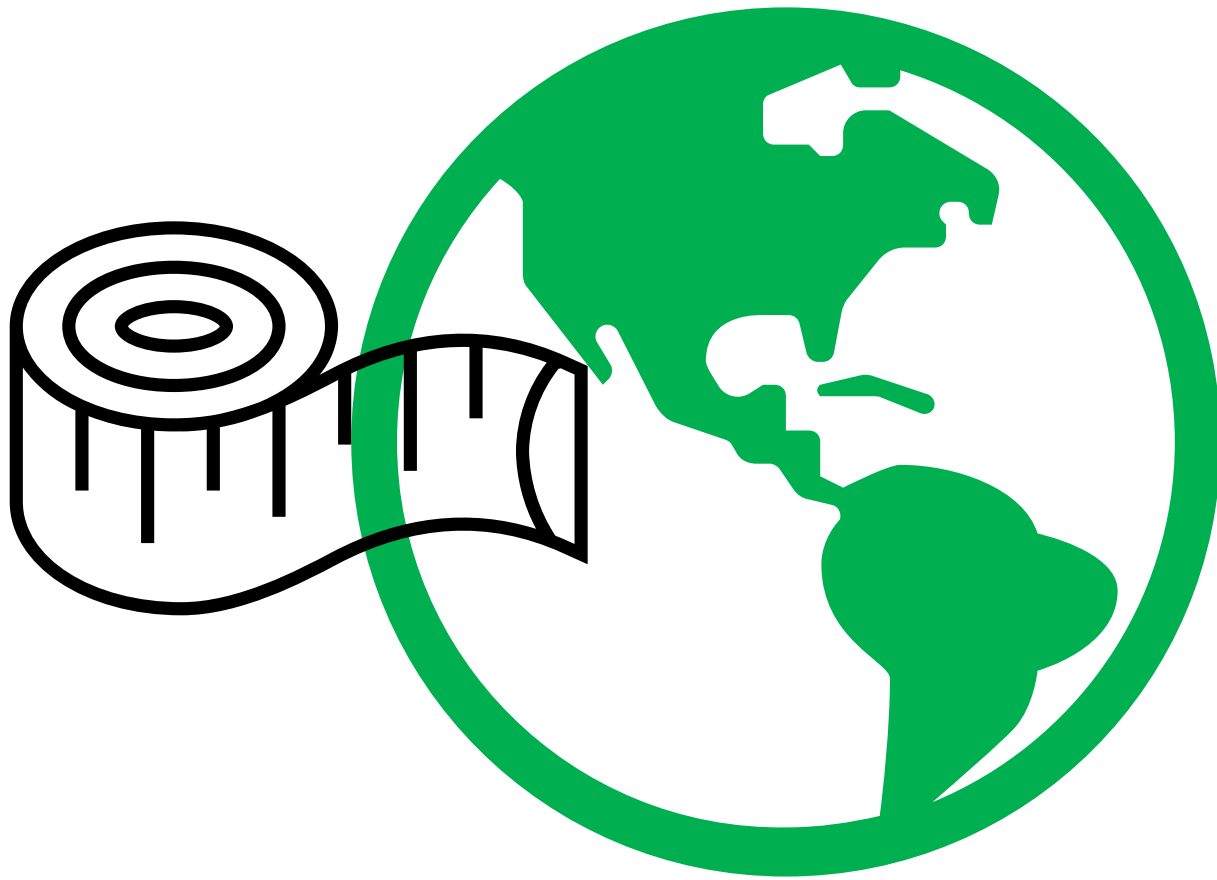
(Life Cycle Assessment)
Can be simplified
using automated systems

Result



EPD

(Environmental Product
Declaration)



If we do not
measure,
we cannot
improve!





Current North American EPDs are limited to upfront carbon. Such, they can help make choices within **similar materials**¹. EPDs from current North American PCRs are inappropriate for decision making and comparison between **dissimilar materials**.



¹**Similar materials or products**: any material, product, or structural element with the same specification requirements and covered under the same PCR.

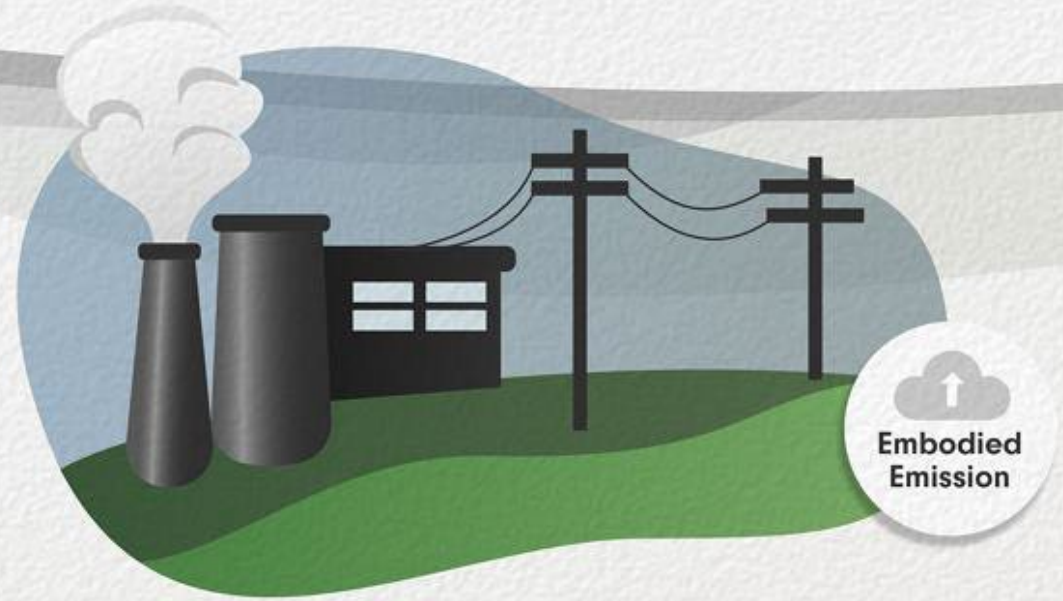
EMISSIONS FROM HIGHWAY TRANSPORTATION SYSTEMS

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.

Goal:

- **Quantifiable:** Demonstrate with EPD (using PCR that is ISO 14025/21930 conformant).
- **Practical:** An agency needs to be able to use it and incorporate it into their programs.
- **Implementation-Ready:** Needs a defined framework (i.e., can't be foundational concept).



Agenda

1

Define Sustainability

2

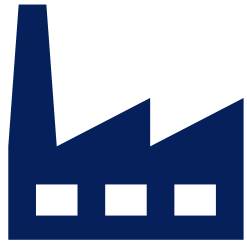
Accomplishments

3

What's next?



PLC



Suppliers seem to be driving the transition to PLC.



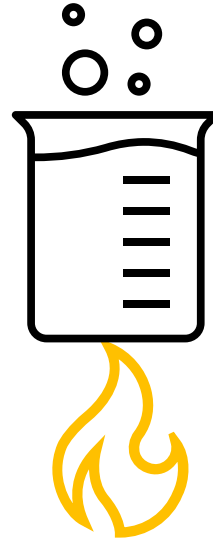
Opportunity to address open questions.



Case Studies?

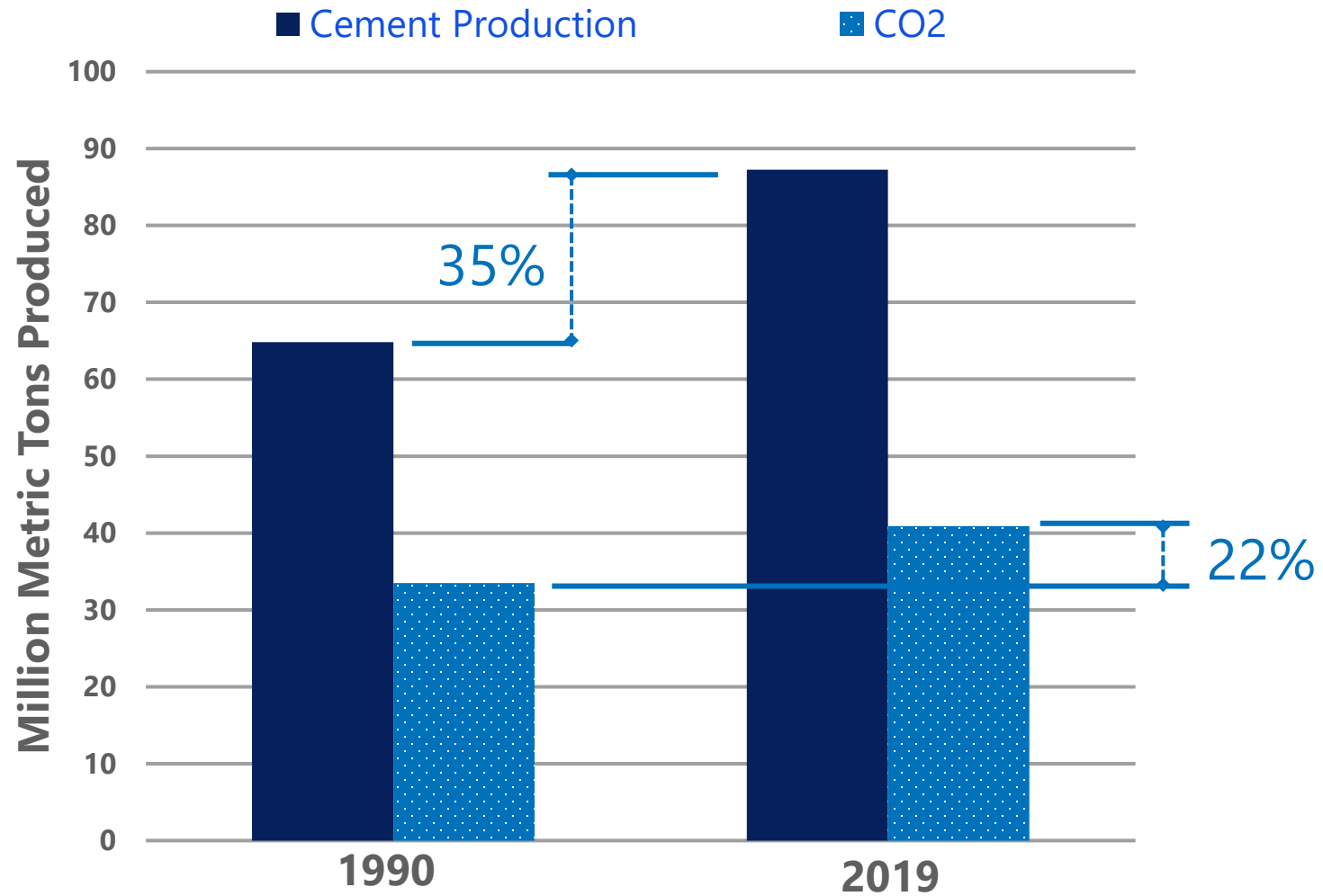


PLC



TFHRC Study on PLC reactivity





Cement statistics obtained from USGS at:
<https://www.usgs.gov/centers/nmic/cement-statistics-and-information>

CO₂ Emissions from National-Level U.S. Greenhouse Gas Inventory at:
<https://www.epa.gov/sites/default/files/2021-04/documents/fastfacts-1990-2019.pdf.pdf>



Concrete Industry's Support of EPDs

- 40k + EPDs developed.
- NRMCA Program Operator for Concrete EPD:
 - High Quality PCRs: ACLCA PCR Best Practices and ISO
 - Industry Average
 - Education and Communication Tools

¹**Similar materials or products**: any material, product, or structural element with the same specification requirements and covered under the same PCR.



Support of EPDs Going Forward

- FHWA: Research on impact of data granularity
- NRMCA: Regional Industry-wide averages of similar material or products¹.



¹**Similar materials or products**: any material, product, or structural element with the same specification requirements and covered under the same PCR.

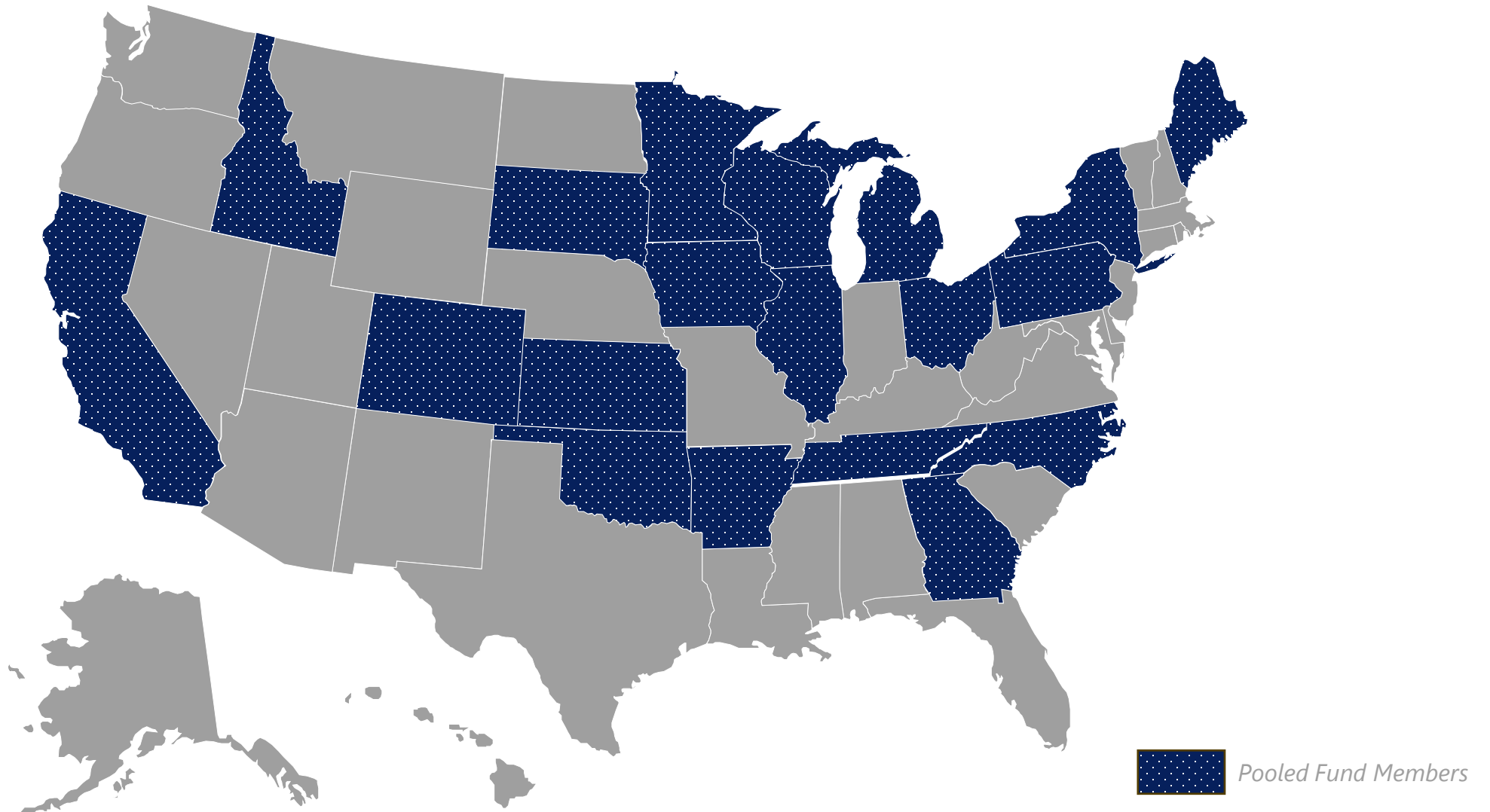


MnROAD

- FHWA contributed \$300k to this project.
- MCTC collected data typical of 3 site visits.
- TFHRC performing durability, reactivity, and microstructural testing.



PEM Pooled Fund

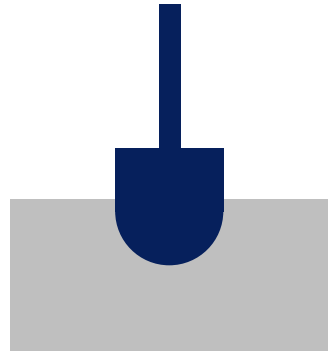


PEM – AASHTO R 101*

**Use of AASHTO R 101 is not a Federal requirement.*

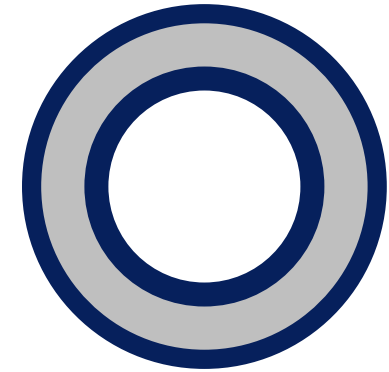


Resistivity



V Kelly for
Workability

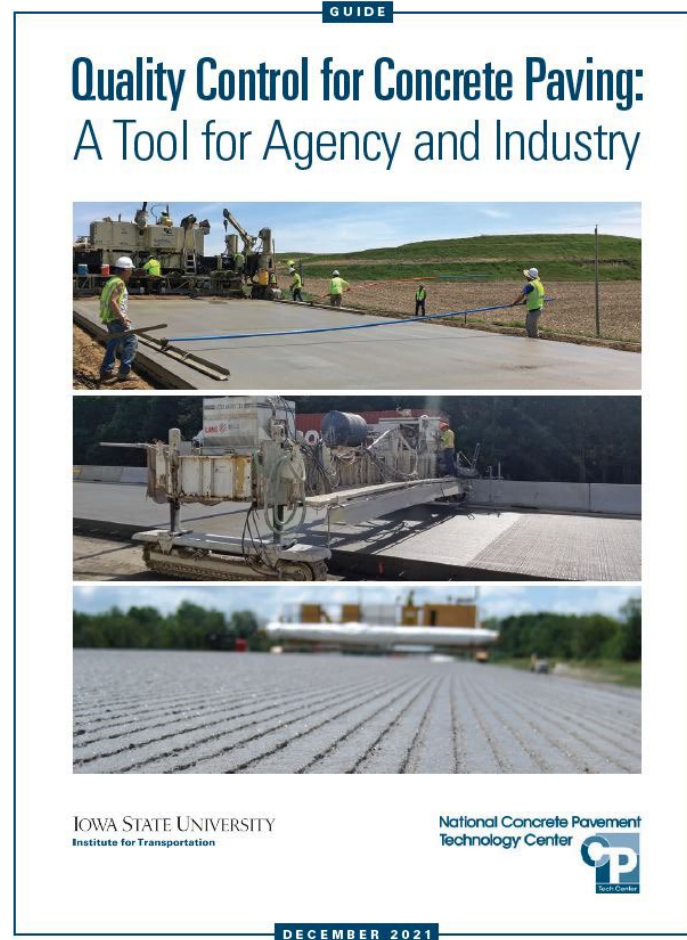
www.pooledfund.org/Details/Study/727



Shrinkage



PEM



The Role of Quality



Specification Language



P3C:

Performance Centered Concrete Construction

Actions between the batch plant and opening to traffic can significantly impact the performance of a concrete pavement.

More Info:

<https://www.pooledfund.org/Details/Solicitation/1582>



Agenda

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Define Sustainability

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Accomplishments

3

What's next?



DOT Buy Clean Policy

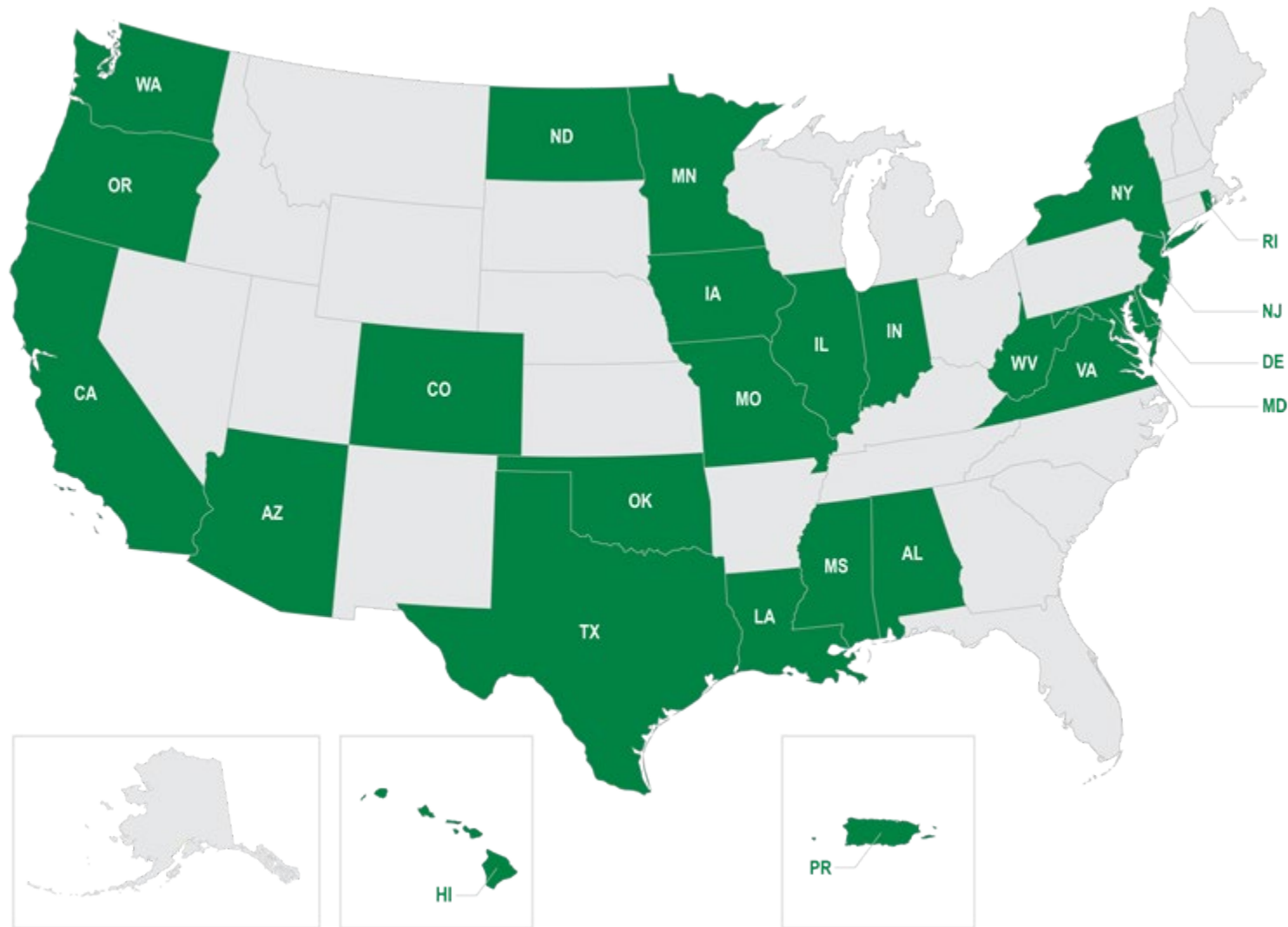
"So today, as we work to implement President Biden's historic Bipartisan Infrastructure Law, which will modernize our infrastructure and create good paying jobs across the nation, the U.S. Department of Transportation will launch a Buy Clean Initiative that will assess and address the embodied **carbon emissions** that come from the **engineering, design, construction, procurement, maintenance, and disposal** of transportation projects."

-- USDOT Secretary Pete Buttigieg

<https://www.transportation.gov/priorities/climate-and-sustainability/policy-statement-buy-clean-initiative>



FHWA Climate Challenge



Technical **Feedback** Group



November 2022 – Austin, TX

<https://cptechcenter.org/cpm-tfg/>



May 2022 – Rosemont, IL

Standard Specifications for Transportation Materials and Methods of Sampling and Testing and AASHTO Provisional Standards

CLICK
HERE



Standard Guide for Decreasing Concrete's Embodied Carbon Content

AASHTO Designation: PG xxx-24

Adopted: [Projected 2024]

AASHTO

Technical Subcommittee: 3a, 3b or 3c, Name [with line break if needed to keep space around logo]

1. SCOPE

1.1. This guide describes approaches to reduce the embodied carbon content (ECC) of concrete materials and mixtures. Embodied carbon is a component of the carbon in the total life-cycle of a pavement. It is the emissions attributed to materials production, generally called cradle-to-gate (see Figure 1). This guide will list the strategies for this for the materials selection and proportioning of them (concrete mix design). It will also include any strategies that can be employed from the mixing to the job site. This does not include the phases from Construction to End of Life.

2. REFERENCED STANDARDS

2.1. AASHTO Standards:

- M 6, Fine Aggregate for Hydraulic Cement Concrete
- M 80, Coarse Aggregate for Hydraulic Cement Concrete
- M 87, Portland Cement
- M 240, Blended Hydraulic Cement
- M 295, Coal Fly Ash and Raw or Calcined Natural Pozzolans for Use in Concrete
- M 302, Slag Cement for Use in Concrete and Mortars
- R 101, Developing Performance Engineered Concrete Pavement Mixtures
- R 80, Determining the Reactivity of Concrete Aggregates and Selecting Appropriate Measures for Preventing Deleterious Expansion in New Concrete Construction

2.2. ASTM Standards:

- C1157, Standard Performance Specification for Hydraulic Cement
- C1709, Standard Guide for Evaluation of Alternative Supplementary Cementitious Materials (ASCM) for Use in Concrete

2.3. Other Documents:

- 23 CFR 657 – Subpart B – Quality Assurance Procedures
- ACI 130R-19 – Report on the Role of Materials in Sustainable Concrete Construction

TS-3x

PP xxx-1

AASHTO

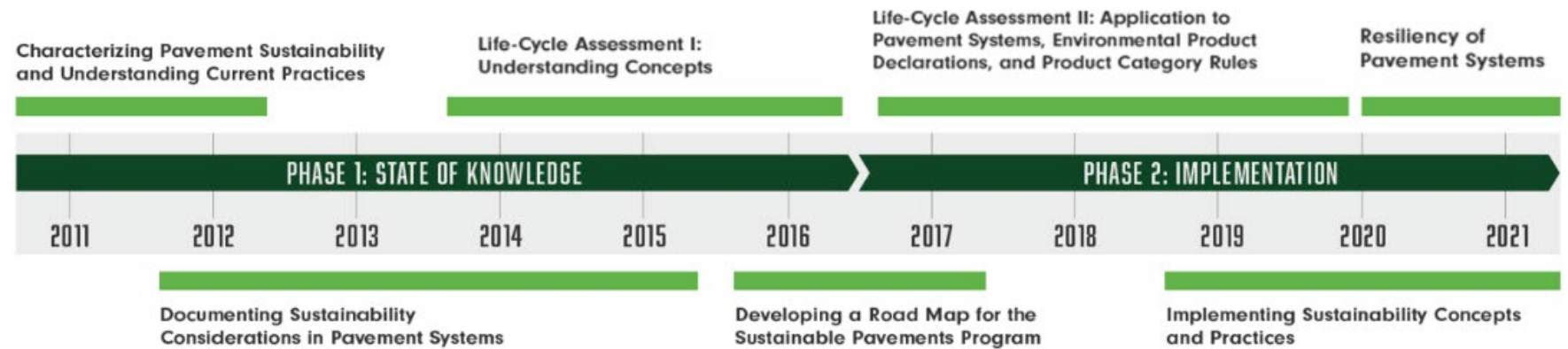
AASHTO Guide

Title: Standard Guide for Decreasing Concrete's Embodied Carbon Content

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- No correlation between concrete's embodied emissions and compressive strength
- Higher durability typically corresponds with low embodied emissions





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



[Pavement Sustainability: Start Here](#)



[Webinars](#)



[Library](#)



[Case Studies](#)



[Tools](#)



[Sustainable Pavements Technical Working Group \(SPTWG\)](#)



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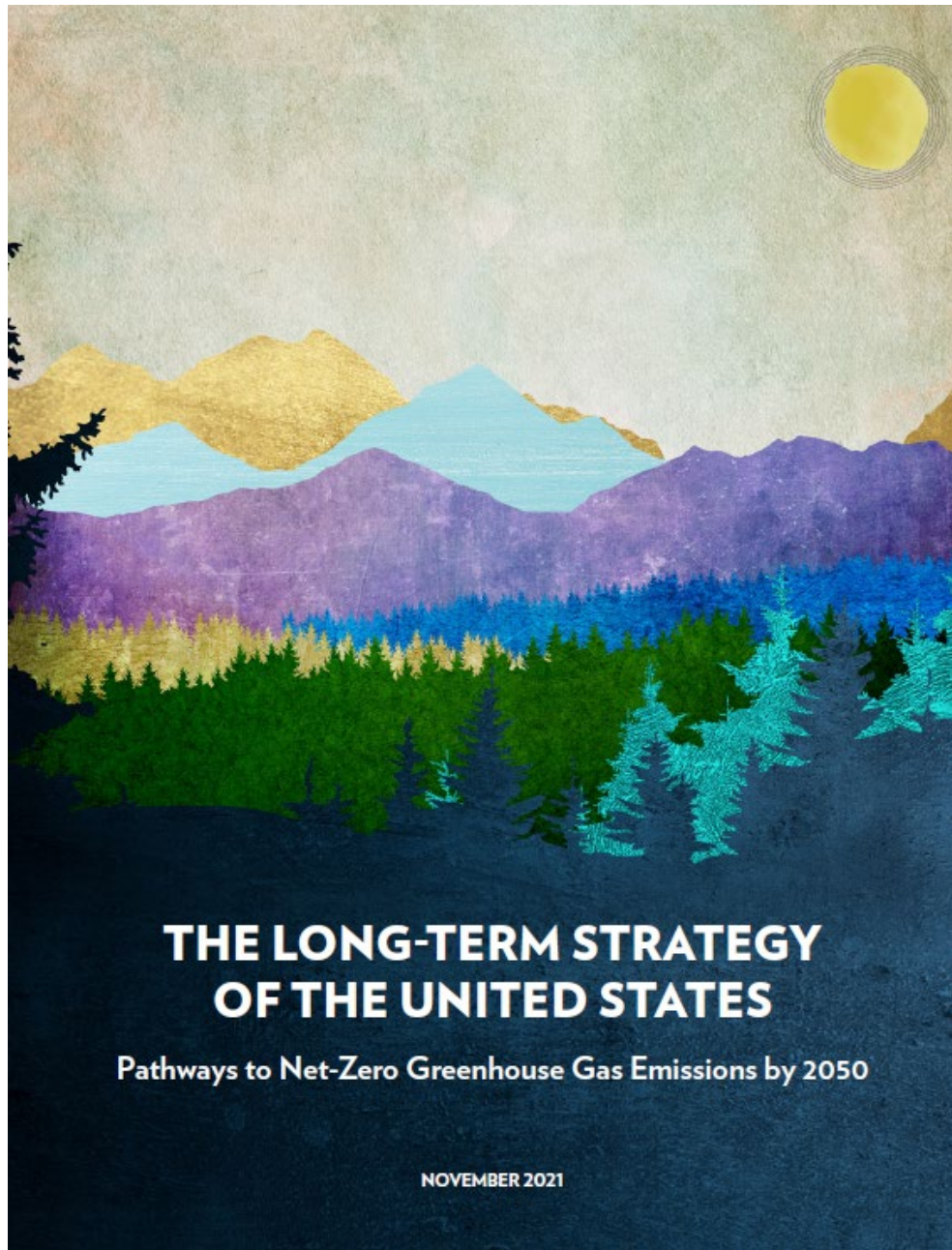
EPDs for Sustainable Project Delivery



Environmental product declarations, or EPDs, are reports that provide the life cycle assessment results of sustainable pavements.

Environmental Products Declarations (EPDs) will transform the procurement process by communicating GHG emissions in a transparent and standardized manner to reduce the environmental burdens of transportation infrastructure throughout the project delivery process. This initiative will work with agencies, contractors, consultants, and industry to increase their knowledge and identify successful practices for applying EPDs.

**FHWA's Center for Accelerating Innovation at:
www.fhwa.dot.gov/EDC**



**Economy-
wide
CO₂ Targets:**
50% by 2030
100% by 2050
(2005 baseline)

Low-Carbon Transportation Materials Grants

- Established under IRA (Pub. L. 117-169 § 60506) - [link](#)

*FEDERAL HIGHWAY ADMINISTRATION **APPROPRIATION.**— \$2B to remain available until September 2026, to reimburse or provide incentives for the use, of construction materials and products that have substantially **lower levels of embodied greenhouse gas emissions** associated with all relevant stages of production, use, and disposal as compared to **estimated industry averages of similar materials or products**, as determined by the **Administrator of the Environmental Protection Agency.***





Make It Smooth*

***Opportunities for pavements to realize benefits in operations phase.**



I WANT YOU

**To help define the
pathway to
sustainability.**



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