

# Introduction to Life Cycle Assessment: EPDs in Policy

Amlan Mukherjee, PhD, PE

Professor, Dept. of Civil, Environmental & Geospatial Engineering

**Michigan Technological University**

Life Cycle Assessment Technical Specialist, Climate Challenge Program

**Office of Infrastructure, Federal Highway Administration (FHWA)**

*January 19, 2023*

## Agenda:

### Elements of Life Cycle Thinking

- Life Cycle Assessment
- Life Cycle Cost Analysis
- Life Cycle Thinking

### Communicating LCA Outcomes

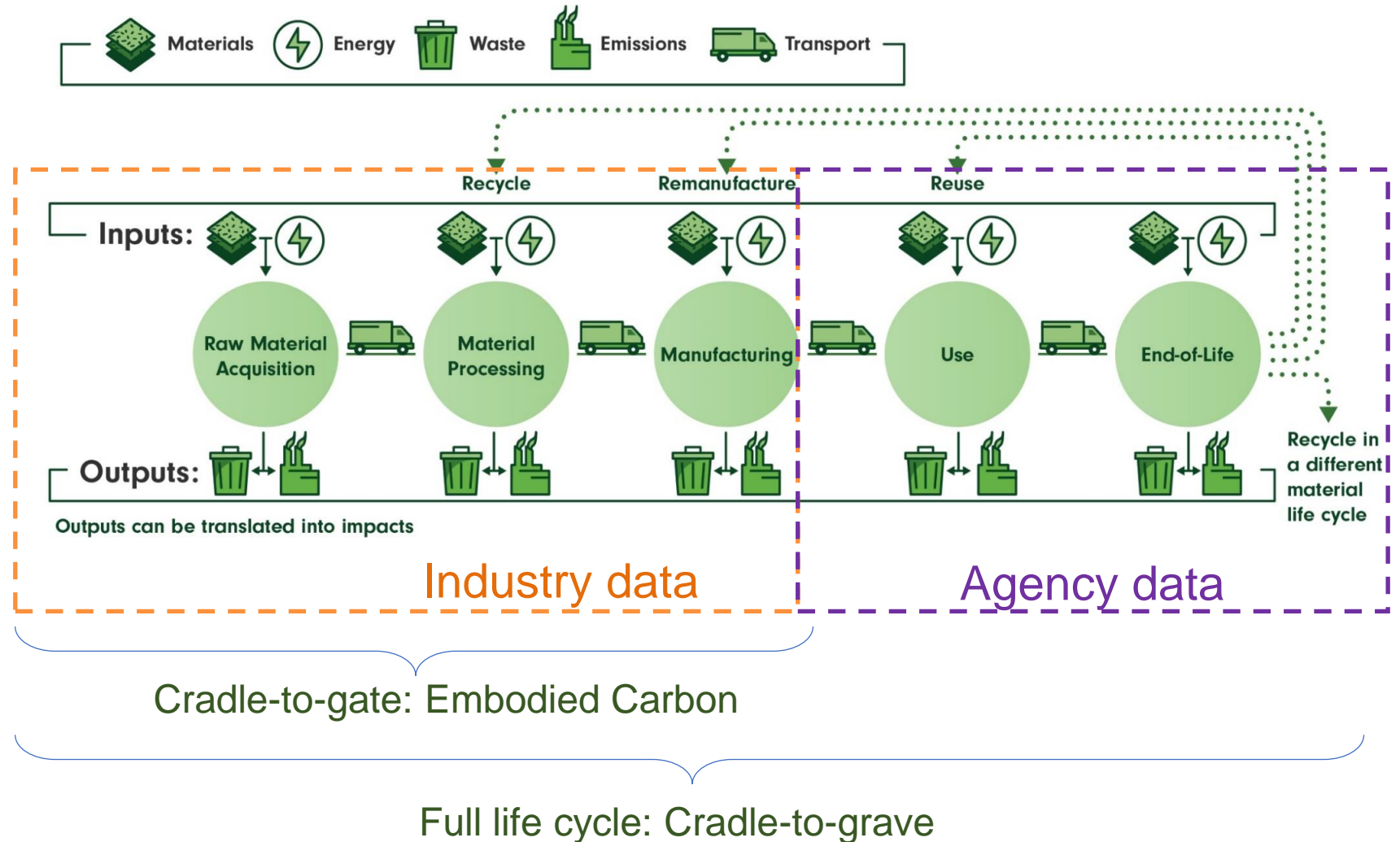
- Product Category Rules
- Environmental Product Declarations (EPD)
- EPD Programs

### EPDs in Procurement Policy

- Initiatives within EPA, FHWA and GSA
- Implementation: Climate Challenge

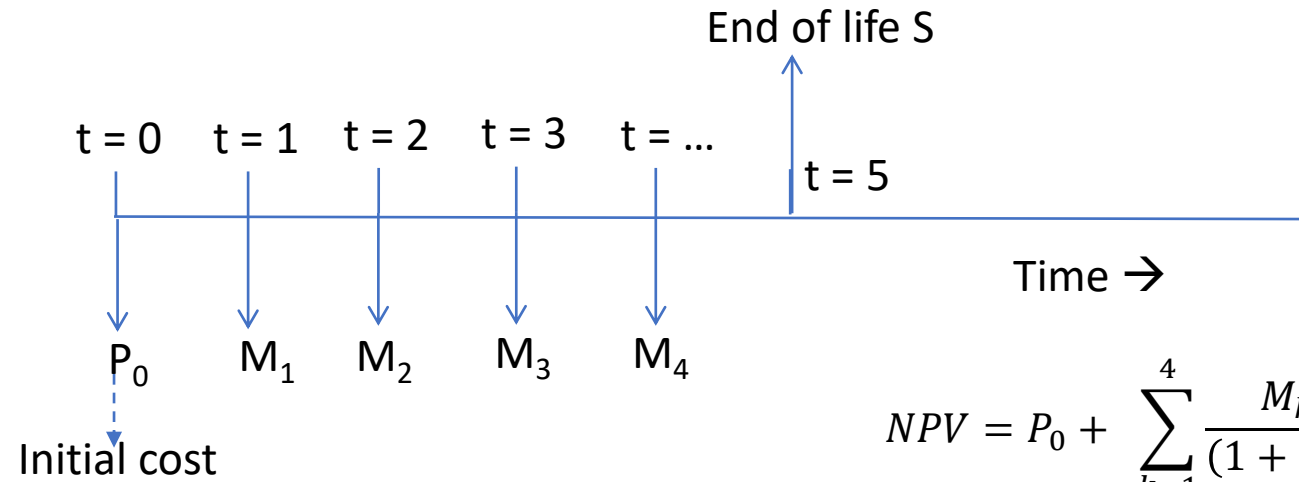
# Life Cycle Assessment

- Technique to quantify environmental impacts of products and processes
- Track all material and energy flows from the system over the life cycle
- Convert environmental outputs into environmental impact potentials using TRACI – impact assessment method
- Mid-point indicators such as Global Warming Potential (GWP) – kg of CO2 equiv.

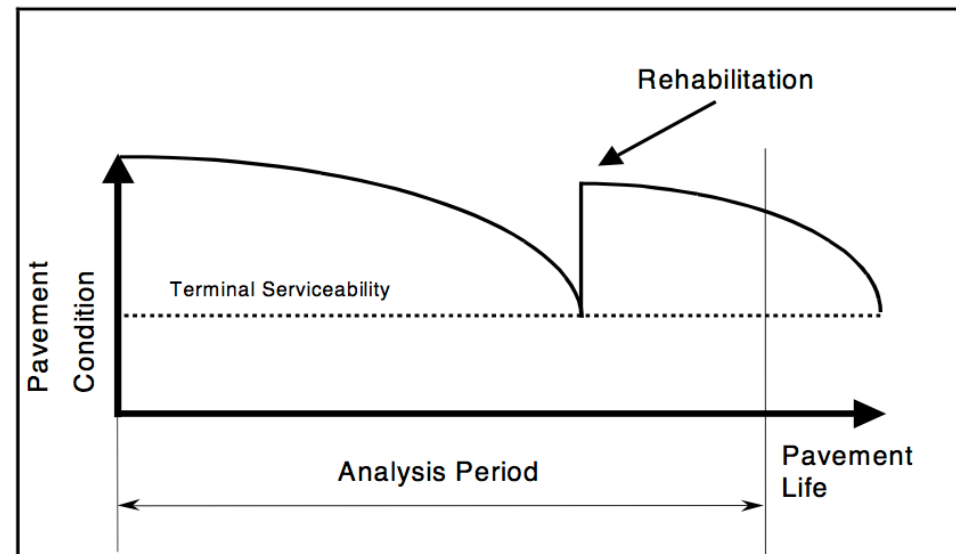


# Life Cycle Cost Analysis

- Determine what is the best investment opportunity given alternatives for a project over the long term (complete life cycle).
- Does not address equity issues
- Does not account for environmental impacts
- Transportation Equity Act for the 21<sup>st</sup> Century (TEA-21) – 1998
- Required when:
  - Conducting value engineering of large projects (23 CFR 627) (all NHS > \$50M + Fed \$\$)
  - Using alternate bidding for pavement type selection (TA5040.39)



$$NPV = P_0 + \sum_{k=1}^4 \frac{M_k}{(1 + i_1)^k} - \frac{S}{(1 + i_1)^k}$$



# Life Cycle Thinking

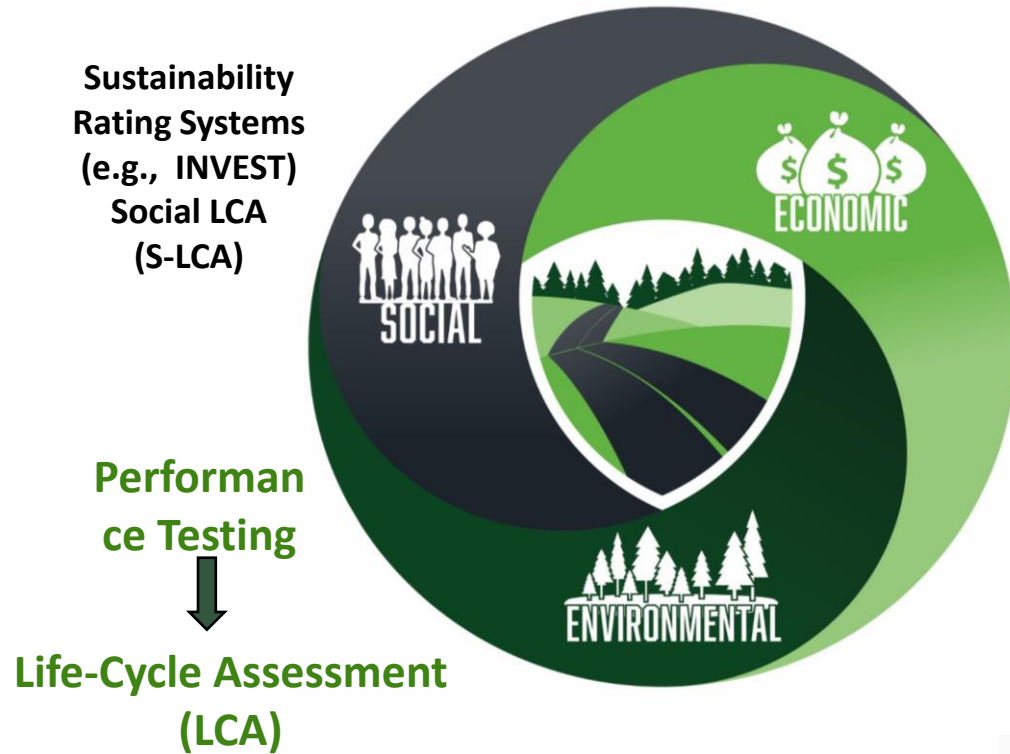


Image Source: FHWA/APTech

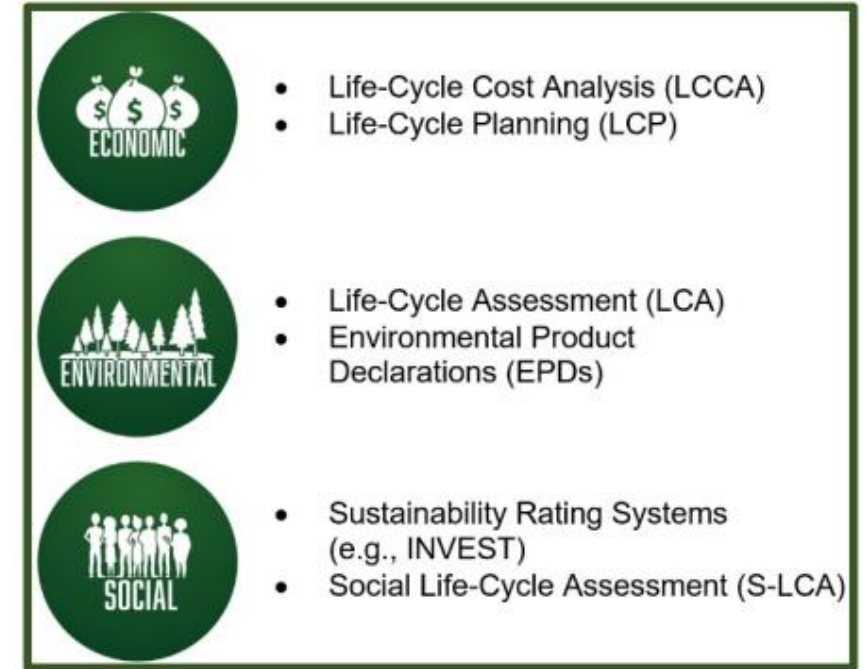


Figure 1. Pillars of sustainability with methods for measurement and communication.



**An Environmental Product Declaration  
for Asphalt Mixtures**

# How do we Communicate LCA Outcomes?

Product Category Rules and  
Environmental Product Declaration

**Portland  
Cements**

(per ASTM C150,  
ASTM C1157,  
AASHTO M 85  
or CSA A3001)

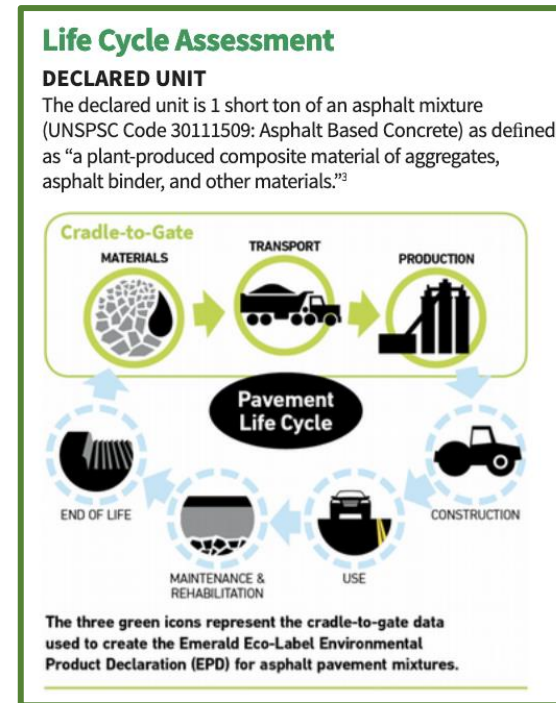
# Product Category Rules

PCR Principles and  
Procedures: ISO 14025  
Core PCR (part A): ISO 21930

## Rules that govern LCA supporting an Environmental Product Declaration (EPD)

A PCR specifies:

- The goal, scope
- Functional and/or declared units
- The modules and processes
- Guidelines for data collection
- Time horizon of reporting
- Use of geographically pertinent data.



### Background Data

- Fuels
- Electricity
- Transportation

FEDERAL  
COMMONS



This declaration is an EPD in accordance with ISO 14025:2006<sup>1</sup> and ISO 21930:2017<sup>2</sup>. The PCR is *Product Category Rules for Asphalt Mixtures*<sup>3,4</sup>. This EPD transparently describes the potential environmental impacts associated with the identified life cycle stages of the described product.

**Declaration Number:** 44.130.293 v5

**Software Version:** 2.0.0

**Date of Issue:** April 27, 2022

**Period of Validity:** March 31, 2027

This EPD is valid for asphalt mixtures produced at the location indicated on this page. Data used to inform this EPD reflect plant operations from a 12-month period beginning on Jan. 1, 2021.

This EPD can be found at <https://asphaltcpd.org/epd/d/eBUxv/>

**LCA performed by:** Ben Ciavola, PhD



# Environmental Product Declarations

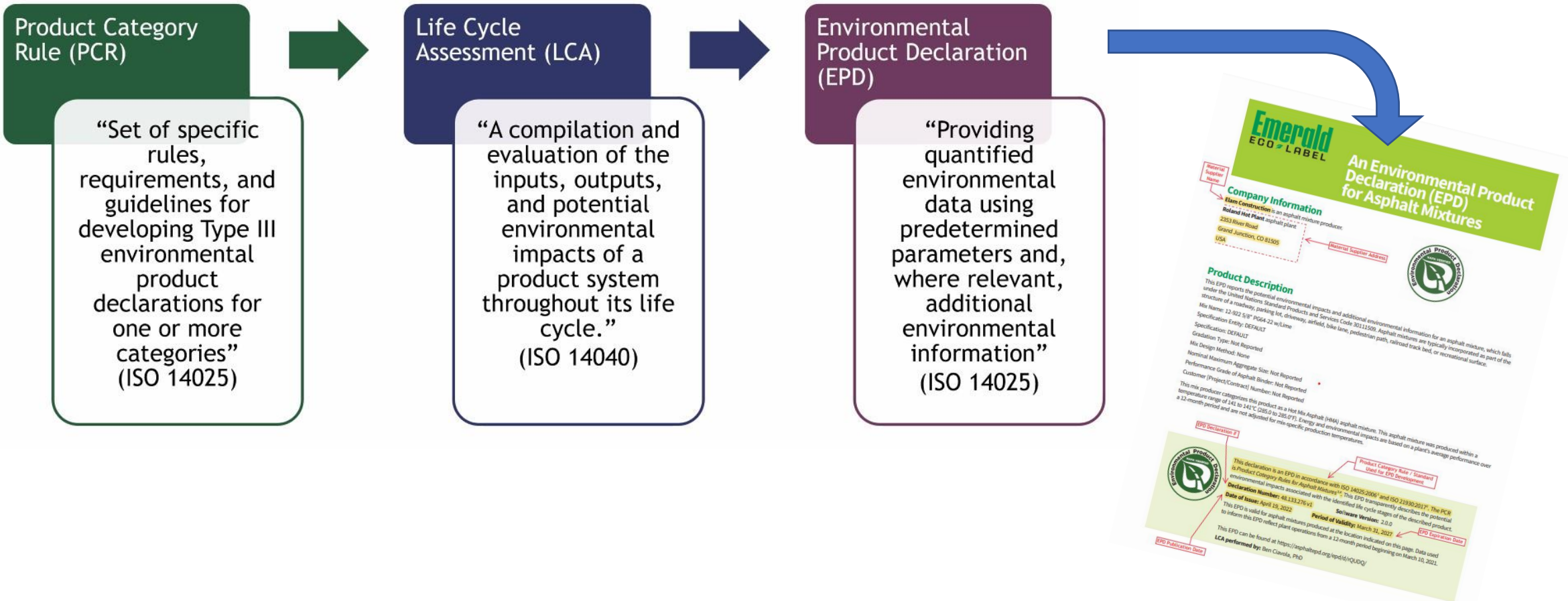
## Standard instrument to reporting LCA outcomes based on a Product Category Rule

- ✓ Environmental impact indicators (such as Global Warming Potential),
- ✓ Total primary energy consumption and material resource consumption.

**TABLE 3. ENVIRONMENTAL IMPACT SUMMARY TABLE**

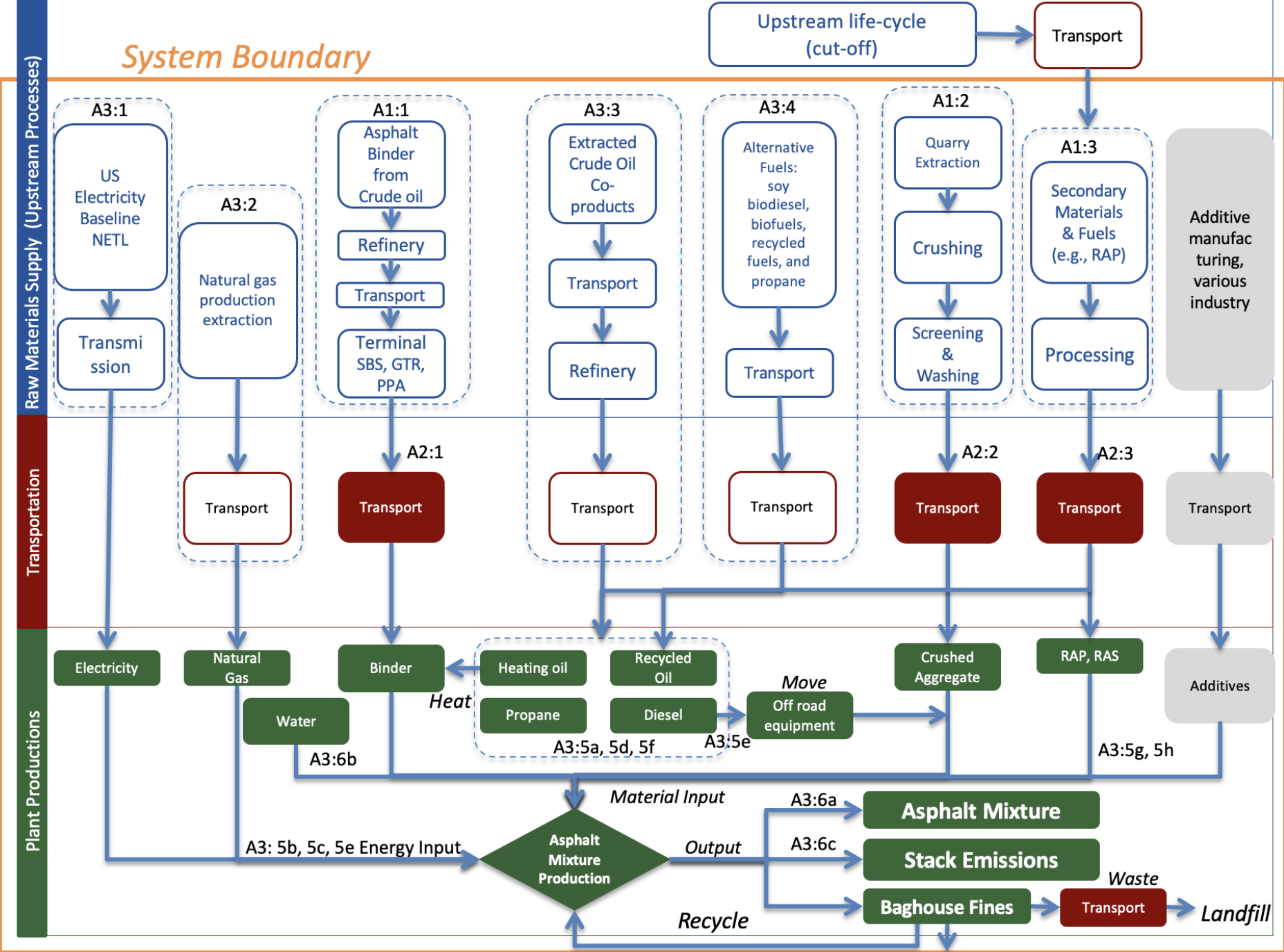
<b>IMPACT CATEGORY</b>	<b>POTENTIAL IMPACT PER METRIC TONNE ASPHALT MIXTURE (PER TON ASPHALT MIXTURE)</b>
<i>Global warming potential (GWP-100)</i>	<i>67.09 (60.87) kg CO<sub>2</sub> Equiv.</i>
<i>Ozone depletion potential (ODP)</i>	<i>8.33e-08 (7.55e-08) kg CFC-11 Equiv.</i>
<i>Eutrophication potential (EP)</i>	<i>1.22e-02 (1.11e-02) kg N Equiv.</i>
<i>Acidification potential (AP)</i>	<i>1.99e-01 (1.81e-01) kg SO<sub>2</sub> Equiv</i>
<i>Photochemical ozone creation potential (POCP)</i>	<i>4.34 (3.94) kg O<sub>3</sub> Equiv.</i>

# EPD Program





# System Boundary



**Scope: Cradle-to-grave**

Improved Background Data sets

Foreground Data supported by EPD data collected 2016 – 2020

Portable Plants included

Baghouse fines: waste to landfill and beneficial reuse

Extended sensitivity analysis

# Inventory Status

- Parameterized life cycle inventory available on FLCAC in .zolca (OpenLCA) format
- Life cycle information models:
  - Background data included
  - Impact assessment methods, including for waste and water
  - Foreground data as reported in parametric form - **customizable**



Federal Highway Administration/MTU  
Asphalt Pavement Framework

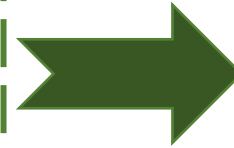
8423 data sets 

[Browse](#)

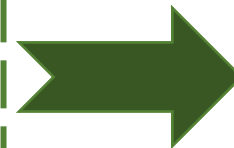
# Structure of PCR Guidance Toolkit



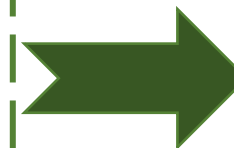
Program Operator  
Decides Program  
Implementation Plan




PCR Committee Decides  
LCA Framework Models  
and Assumptions



Reviewer Decides  
Conformance





ACLCA

---

**2022 ACLCA PCR Guidance –  
Process and Methods Toolkit**

*Creating standardized, consistent, and reliable PCRs & EPDs  
for transparency, procurement, and supply chain data*

**Version 1.0 | May 25, 2022**

Program Operator
PCR Committee
PCR Review Panel

American Center for Life Cycle Assessment | [aclca.org](http://aclca.org)

# EPDs in Procurement Policy



Climate Challenge

EPDs for Advancing Project Delivery

Slides provided by Migdalia Carrion, FHWA



# Sustainability Initiatives in the Spotlight



**EO 14057**  
specified goal of  
Net Zero Federal  
Procurement



**25 States  
(+2 Locals)  
Participating**  
35+ projects from  
27 agencies  
\$7.1M



**Inflation  
Reduction Act**  
**\$2 Billion for FHWA**  
Low-carbon  
transportation  
materials grants



**EDC-7**  
EPDs for  
Sustainable  
Project Delivery

# White House Buy Clean Task Force – First set of recommendations



- Priority materials and pollutant recommendations **(GHG)**:
  - Asphalt
  - Concrete
  - Flat glass
  - Steel
- Reporting tool recommended: **EPDs**
- Aligned with Inflation Reduction Act of 2022 funding

Source: [Fact Sheet: Biden-Harris Administration Announces New Buy Clean Actions](#)



# Inflation Reduction Act of 2022 (Pub. L. 117-169) -

[link](#)

Section No.	Agency	Funding	Title	Expiration Date
60112	EPA	\$250M	Environmental Product Declaration Assistance	Sept. 30, 2031
60116	EPA	\$100M	Low-Embodied Carbon Labeling for Construction Materials <ul style="list-style-type: none"> <li>Identify and label construction materials with lower embodied GHG</li> <li>Production, Use, and Disposal</li> </ul>	Sept. 30, 2026
60503	GSA Federal Buildings Fund	\$2.15B	Use of Low-Carbon Materials	Sept. 30, 2026
60506	DOT FHWA	\$2B	Low-Carbon Transportation Materials Grants <ul style="list-style-type: none"> <li>Use of construction materials and products that have substantially lower embodied GHG Production, Use, and Disposal</li> </ul>	Sept. 30, 2026

## Inflation Reduction Act

[CONTACT US](#)
[Inflation Reduction Act Home](#)
[Advancing Environmental Justice](#)
[Delivering Cleaner Air](#)
[Tackling Climate Pollution](#)

Purchase Categories	Justification	Interim Determination
<p><b>Newly Manufactured Construction Materials:</b></p> <ul style="list-style-type: none"> <li>-Concrete (and cement)</li> <li>-Glass (including, but not limited to, flat/float glass, processed glass, and insulated glazing units)</li> <li>-Asphalt mix</li> <li>-Steel (including, but not limited to, hot rolled sections, plate, hollow structural sections, steel reinforcing bars/rebar, cold formed steel framing and steel joists)</li> <li>-Assemblies comprised of at least 80 percent of materials that qualify</li> </ul>	<p>Based on the EPA’s initial review of state and local Buy Clean approaches and other research to-date, these materials offer the most significant opportunities to lower the embodied greenhouse-gas emissions of federal construction projects. EPDs and EPSs, are sufficient data sources to ensure compliance with Sections 60503 and 60506.</p>	<p>These materials/products qualify if their product-specific GWP is in the best performing 20 percent (Top 20 percent or lowest 20 percent in embodied greenhouse-gas emissions), when compared to similar materials/products (for example, materials/products within the same product category that meet the same functional requirements). If materials/products in the Top 20 percent are not available in a project’s location, then a material/product qualifies per this determination if its GWP is in the Top 40 percent (lowest 40 percent in embodied greenhouse gas emissions). If materials/products in the Top 40 percent are not available in a project’s location, then a material/product qualifies per this determination if its GWP is better than the estimated industry average.<sup>4</sup></p> <p>To determine whether a specific material/product qualifies under the EPA’s interim determination, above, an agency must determine both the material/product-specific GWP and estimate the Top 20 percent (or Top 40 percent) and the industry average.</p> <p><b>Identifying the material/product-specific GWP.</b>  <b>Environmental Product Declaration.</b> A facility-specific, material/product-specific cradle-to-gate Type III (third-party verified) EPD is required that (i) is based on the PCR for the applicable product category that was active when the EPD was issued, and (ii) conforms with ISO 14025 and ISO 21930. When an EPD with facility-specific data is not available, for this interim determination, EPDs consistent with (i) and (ii) but not using facility-specific data are sufficient. EPDs must also be based on supply chain-specific data for the associated unit processes, where feasible. For example:</p> <ul style="list-style-type: none"> <li>• Concrete EPDs must, where available, rely on facility specific data for the upstream cement plant;</li> <li>• Fabricated steel EPDs must, where available, rely on facility specific data for the upstream steel mill(s); and,</li> </ul>

# GSA – Lower Embodied Carbon Materials

- March 30, 2022 – GSA published Concrete and Asphalt Specifications requesting EPDs at installation
- Developed in collaboration with FHWA SPP
- Waiver process requires the use of tools such as the FHWA LCA Pave Tool to estimate GWP

**Low Embodied Carbon Concrete Standards for all GSA Projects**  
March 2022 version

1. The [prime contractor] shall provide a product-specific cradle-to-gate Type III environmental product declaration (EPD) for each concrete mix design specified in the contract and used at the project, using NSF International's [product category rule for concrete](#). Please send EPD(s) with each concrete mix batch design (including type [e.g. standard or lightweight mix] and volume) to [embodiedcarbon@gsa.gov](mailto:embodiedcarbon@gsa.gov), and upload the submittals into GSA's project management information system.
2. The [prime contractor] shall provide **low embodied carbon concrete** that meets the global warming potential (GWP) limits of the table below, for concrete of the mix type and strength class.

Specified compressive strength (f'c in PSI)	Maximum Global Warming Potential Limits for GSA Low Embodied Carbon Concrete (kilograms of carbon dioxide equivalent per cubic meter - CO <sub>2</sub> e kg/m <sup>3</sup> )		
	Standard Mix	High Early Strength	Lightweight
up to 2499	242	328	462
2500-3499	306	413	462
3500-4499	346	466	501
4500-5499	385	519	540
5500-6499	404	546	N/A
6500 and up	414	544	N/A

These numbers reflect a 20% reduction from GWP (CO<sub>2</sub>e) limits in proposed code language: "Lifecycle GHG Impacts in Building Codes" by the New Buildings Institute, January 2022.

3. These requirements apply to all GSA projects that use at least ten (10) cubic yards of concrete.
4. If it is not feasible to meet GSA's EPD requirement or GWP limits, the [prime contractor] shall ask the GSA project manager to request a [P100 waiver](#).
  - a. The [prime contractor] shall outline and provide evidence of the specific circumstances that make compliance infeasible. For example, the only concrete suppliers within the maximum transport range for the mix design:
    - i. are small businesses that have not yet invested in EPDs; or
    - ii. do not yet offer mixes that meet GSA's GWP limits, e.g. because lower-carbon materials are unavailable, or do not meet specific client-driven performance requirements.
  - b. Any requests for waivers from the GWP limits must include the strategies, if any, that will be used to reduce GWP to the extent feasible. Such strategies include, but are not limited to, the use of alternative cements, supplementary cementitious materials, or alternative aggregates.
  - c. For each concrete mix for which GSA has granted a waiver from the EPD requirement, the [prime contractor] shall send a GWP estimate generated with a tool such as [ZGF's LCA Tool](#), [Athena I/E](#), or the Federal Highway Administration's [LCA Pave Tool](#) to [embodiedcarbon@gsa.gov](mailto:embodiedcarbon@gsa.gov).
  - d. GSA will respond to each complete P100 waiver request with a decision or a request for more detail within ten (10) business days. A complete waiver request is deemed granted if no response is provided within that time.

Source: [GSA Concrete Spec.](#)

**Environmentally Preferable Asphalt Standards for all GSA Projects**  
Revised March 29, 2022

1. The [prime contractor] shall provide a product-specific cradle-to-gate Type III environmental product declaration (EPD) for each asphalt mix specified in the design and used at the project, using version 2 of the National Asphalt Paving Association's [product category rule](#) for asphalt mixtures. Please send EPD(s) to [embodiedcarbon@gsa.gov](mailto:embodiedcarbon@gsa.gov), and upload EPD(s) into GSA's project management information system.
2. The [prime contractor] shall provide **environmentally preferable asphalt**, which is defined in this context as material manufactured or installed using at least two (2) of the following techniques. Please send each asphalt mix batch design (including type, volume, and a description of the proposed techniques) to [embodiedcarbon@gsa.gov](mailto:embodiedcarbon@gsa.gov), and upload the submittals into GSA's project management information system.
  - a. Greater than 20% recycled asphalt pavement (RAP) content (specify percentage, and whether in-place or central plant recycling is used);
  - b. Warm mix technology (reduced onsite mix temperature);
  - c. Non-pavement recycled content (e.g. roof shingles, rubber, or plastic);
  - d. Bio-based or other alternative binders;
  - e. Improved energy/carbon efficiency of manufacturing plants or equipment (e.g. using natural gas or electric for heating materials); or
  - f. Other environmentally preferable features or techniques (please specify).
3. These requirements apply to all GSA projects that use at least ten (10) cubic yards of asphalt.
4. If it is not feasible to meet GSA's EPD requirement or to implement at least two of the listed environmentally preferable features or techniques, the [prime contractor] shall ask the GSA project manager to request a [P100 waiver](#).
  - a. The [prime contractor] shall outline and provide evidence of the specific circumstances that make compliance infeasible. For example, the only asphalt suppliers within the maximum transport range for the mix design:
    - i. are small businesses that have not yet invested in EPDs; or
    - ii. do not yet offer mixes that use at least two environmentally preferable features or techniques while meeting specific client-driven performance requirements.
  - b. For each asphalt mix for which GSA has granted a waiver from the EPD requirement, the [prime contractor] shall send a GWP estimate generated with a tool such as [Athena Pavement LCA](#) or the Federal Highway Administration's [LCA Pave Tool](#) to [embodiedcarbon@gsa.gov](mailto:embodiedcarbon@gsa.gov).
  - c. GSA will respond to each complete P100 waiver request with a decision or a request for more detail within ten (10) business days. A complete waiver request is deemed granted if no response is provided within that time.

Source: [GSA Asphalt Spec.](#)

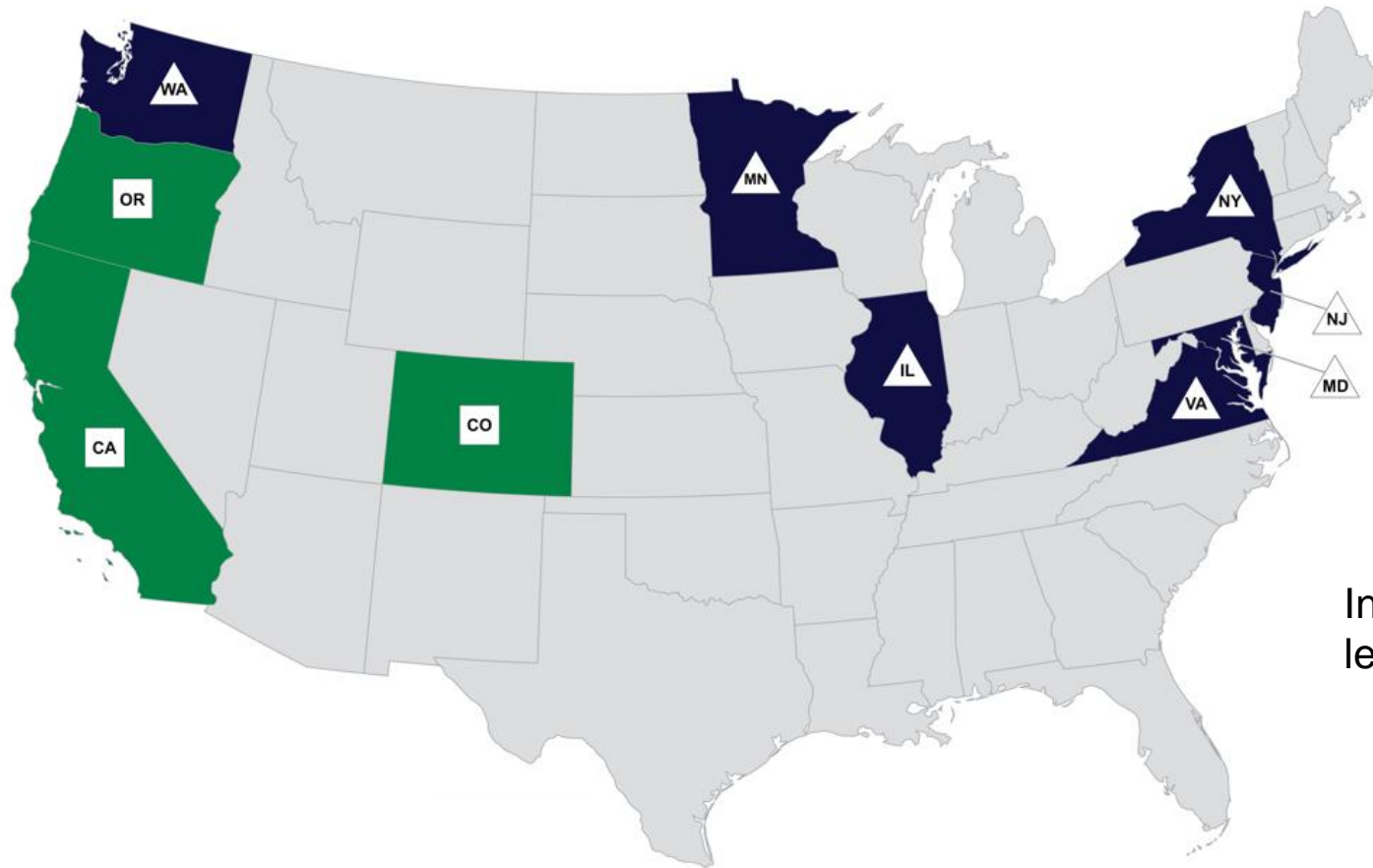
# DOT – Policy Statement on Buy Clean Initiative

- September 15, 2022 – first **Buy Clean Policy Statement**. DOT Embodied Carbon Working Group formed
- Details the commitment to assess and address the embodied carbon emissions from transportation projects
- Prioritize three actions
  - Use of EPDs
  - Develop a Buy Clean Policy
  - Education and Research commitments



Source: [DOT-signed Policy](#)

# State Level Initiatives



Information collected from State legislative websites.



States that legislated green public purchasing



States that have considered green public purchasing legislation in past 2 years

# FHWA Climate Challenge: Quantifying the Emissions of Sustainable Pavements

State DOTs and other public agencies explore the use of LCA and EPDs as a standard practice to inform pavement material and design selection for enhancing sustainable pavement practices and quantify the emissions and impacts of those practices.

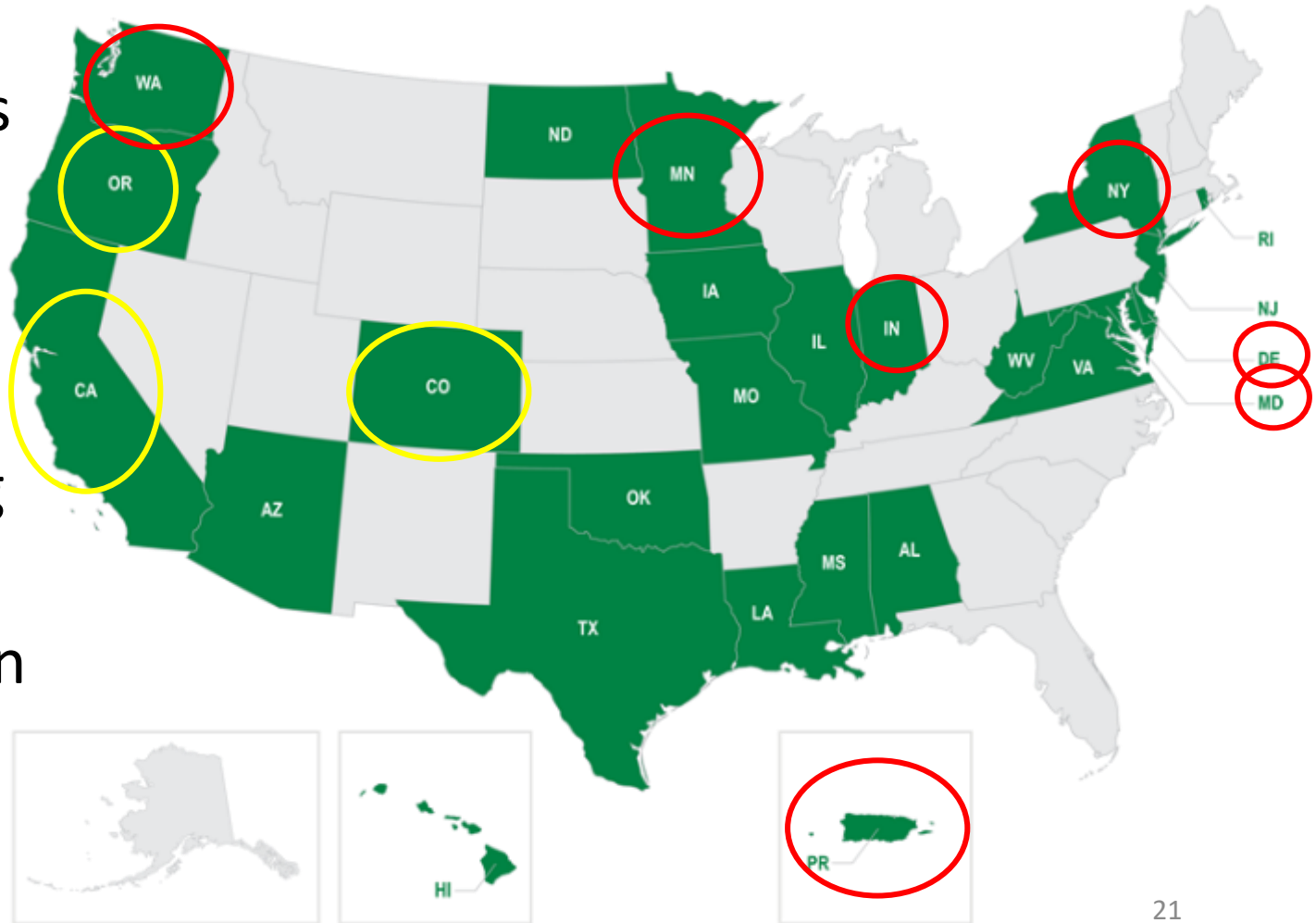


For the latest information, visit the website: <https://highways.dot.gov/climatechallenge>



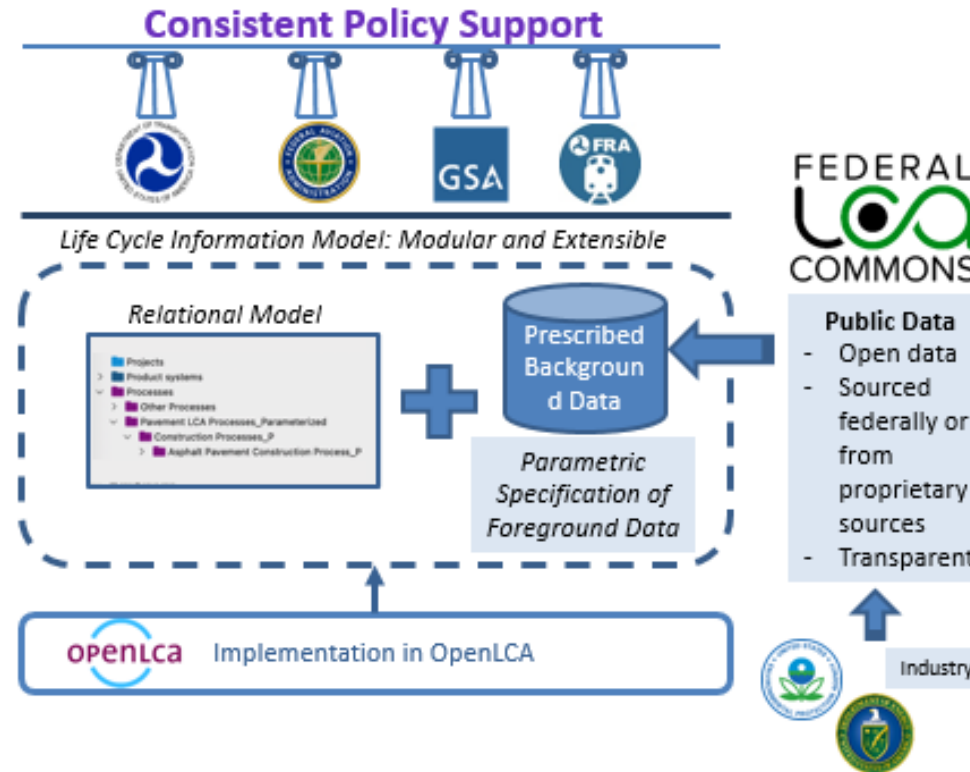
# Climate Challenge Participants

- 30+ proposals from 27 agencies (including 2 local agencies)
  - Education, implementation, benchmarking, fundamental research projects
- Providing technical and funding (\$7.1 million) assistance
- +7 DOTs are exploring Buy Clean Policy



# Buy Clean Policy – Our Vision

- Common background data sourced through LCA Commons and LCIM through Open LCA
- Common use across all US DOT modes (FHWA, FAA, FRA) and other federal agencies (GSA, DOD, DOE, etc.)
- Consistent Policy is crucial to achieve Buy Clean Policies successful implementation.



## Values Emphasized:

- Use of public “open” datasets that are “free” to use
- Transparency in LCI
- Appropriate review processes for system level data
- Protocols for reporting LCI and collaboration server for use

*If you want to go fast go alone,  
If you want to go far go together.*

- Wisdom of the Ancients

Thank You