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TRANSPORTATION RESEARCH BOARD

Use of Life Cycle Assessment in Public Procurement: State of Practice

Tuesday, August 20, 2019
2:00-3:30 PM ET

The Transportation Research Board has met the standards and requirements of the Registered Continuing Education Providers Program. Credit earned on completion of this program will be reported to RCEP. A certificate of completion will be issued to participants that have registered and attended the entire session. As such, it does not include content that may be deemed or construed to be an approval or endorsement by RCEP.

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REGISTERED CONTINUING EDUCATION PROGRAM

Purpose

Highlight efforts across United States' departments of transportation to integrate Life Cycle Assessment (LCA)-based instruments into the project procurement process, including Environmental Product Declarations (EPD)

Learning Objectives

At the end of this webinar, you will be able to:

- Identify resources and tools to facilitate the use of LCA and adoption of EPD
- Identify lessons learned at the state agency level
- Formulate practices and strategies when integrating LCA and EPD

Use of Life Cycle Assessment in Public Procurement: State of Practice

August 20, 2019

Amlan Mukherjee, PhD, PE
Associate Professor
Michigan Technological University
Webinar for the Transportation Research Board

FHWA Sustainable Pavement TWG

Knowledge of sustainability in all the life cycle phases of pavement systems.

2010

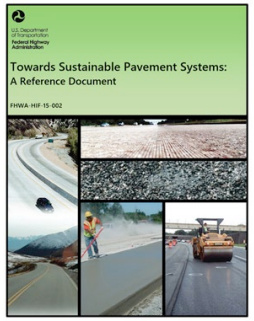
2011

UCPRC

Working group of stakeholders

Sustainable Pavements

Guidelines and framework



2013

PCR for Concrete

2015

2016

PCR for Asphalt

LEED v4

EPDs as baselines

2016

California Buy Clean Act

Using EPD in procurement

2017

Stakeholders:

- State agencies (DOT)
- City municipalities
- Industry
- Private owners

Drivers: LEED v4

Challenges:

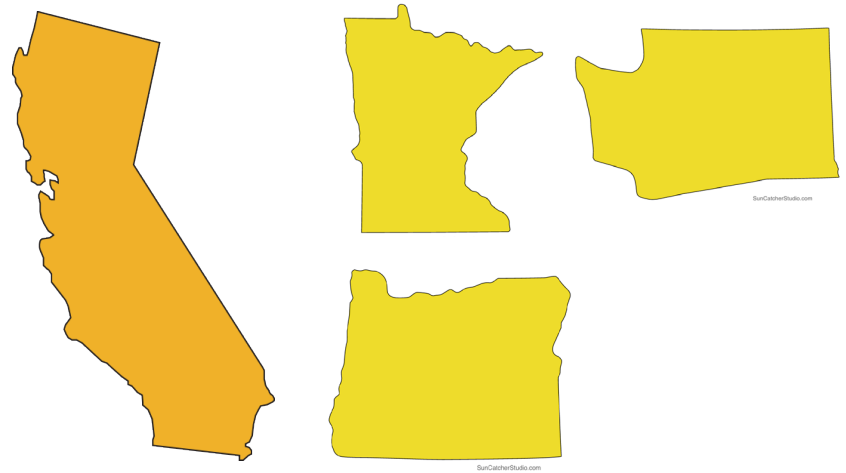
- Organizational Challenges
- Technological Challenges

The Case for Environmental Product Declarations

- Life cycle flows across disparate industries
  - Collaborative networks to understand supply chains
- Protocols for generating, archiving and accessing data
  - Creating reliable and transparent databases for LCAs
  - Agreement on system boundaries and allocation
- A solution to one is necessary to support a solution to the other.

EPDs in Procurement

- LEED v.4 led adoption of EPDs
  - Up to two points available in its green building rating system
  - Most impact in vertical infrastructure products (steel, concrete, wood)
- EPDs in Procurement
  - Buy Clean California Act (2017)
  - Oregon DEQ – supporting concrete EPD
  - Washington and Minnesota considering use
- What matters?
  - Transparency
  - Reliability



Stakeholders: Data Matters

- Agencies:
  - Required: when to ask, How to use?
  - Not required: how to feasibly improve process?
- Construction Materials Industry:
  - Transparency
  - Credible communication tool
  - Benefits to improving internal processes
- LCA Consultants and Data Providers:
  - Ensure credibility

Challenges

Inconsistent use of data
Data gaps not acknowledged
Inconsistent allocation protocols
PCRs that are not harmonized
Uninformed use of EPDs in decision-making

Webinar Objective

- Provide pointers to the use of LCA and adoption of EPD for construction procurement.
- Identify lessons learned in encountering organizational challenges at the state agency level.
- Help formulate best practices and strategies when integrating LCA and EPD into existing procurement practices.

Sustainable Pavements Program Updates: EPDs and procurement

TRB Webinar
August 20th, 2019.

Milena Rangelov, Ph.D.
Visiting Postdoctoral Fellow
National Research Council
Federal Highway Administration

Unless otherwise noted, FHWA is the source for all images in this presentation.

Vision and Mission

- To advance the knowledge and practice of designing, constructing, and maintaining more sustainable pavement through:
  - Stakeholder engagement
  - Education
  - Development of guidance and tools

Stakeholder Engagement

Industry

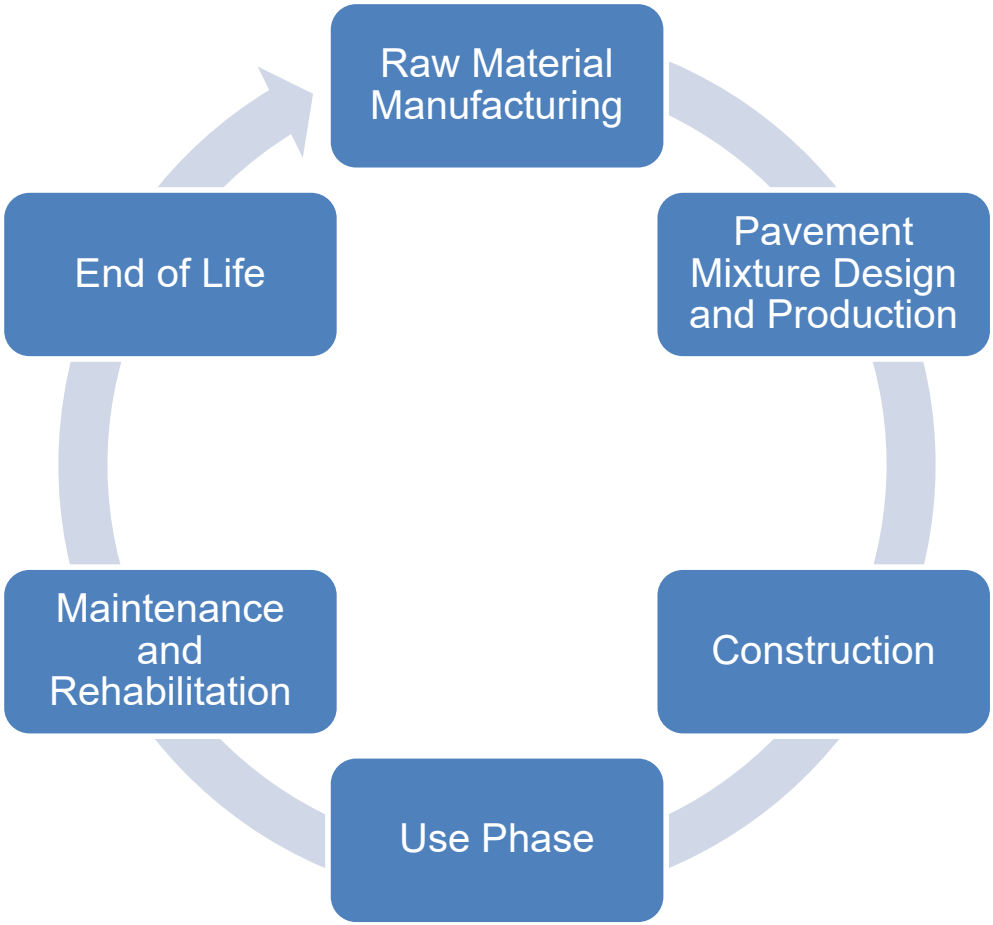
- Engineers
- LCA Professionals
- Material Manufactures
- Construction Contractors

Academia

- Pavement Materials
- Construction

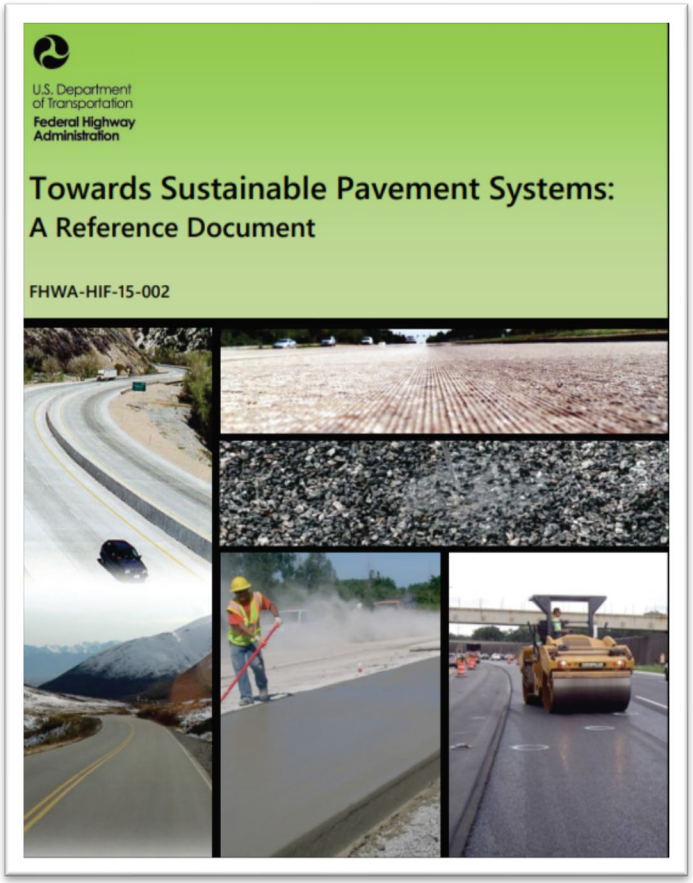
Agencies

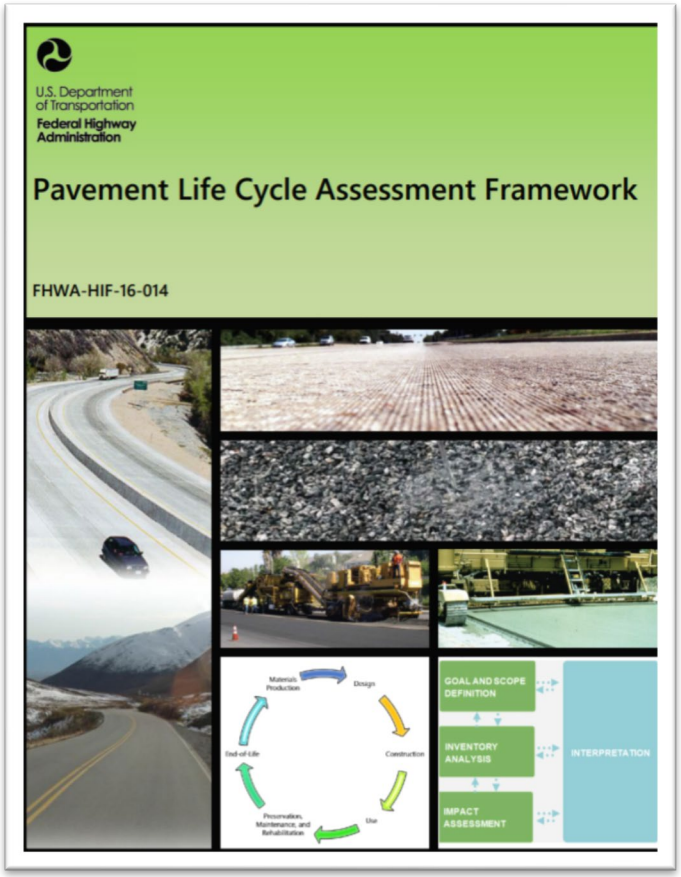
- State Departments of Transportation
- Local Agencies



Phase 1: Benchmark State of Knowledge

2010-2015





Source: FHWA

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

Definition: Sustainable Pavements

1. Achieve the engineering goals.
2. Preserve and (ideally) restore surrounding ecosystems.
3. Use financial, human, and environmental resources wisely.
4. Meet basic human needs such as health, safety, equity, employment, comfort, and happiness.

Phase 2: Performance Measures 2016-2021

Sustainability Rating Systems (e.g., INVEST)

Performance Testing

Life-Cycle Cost Analysis (LCCA)

Performance Testing

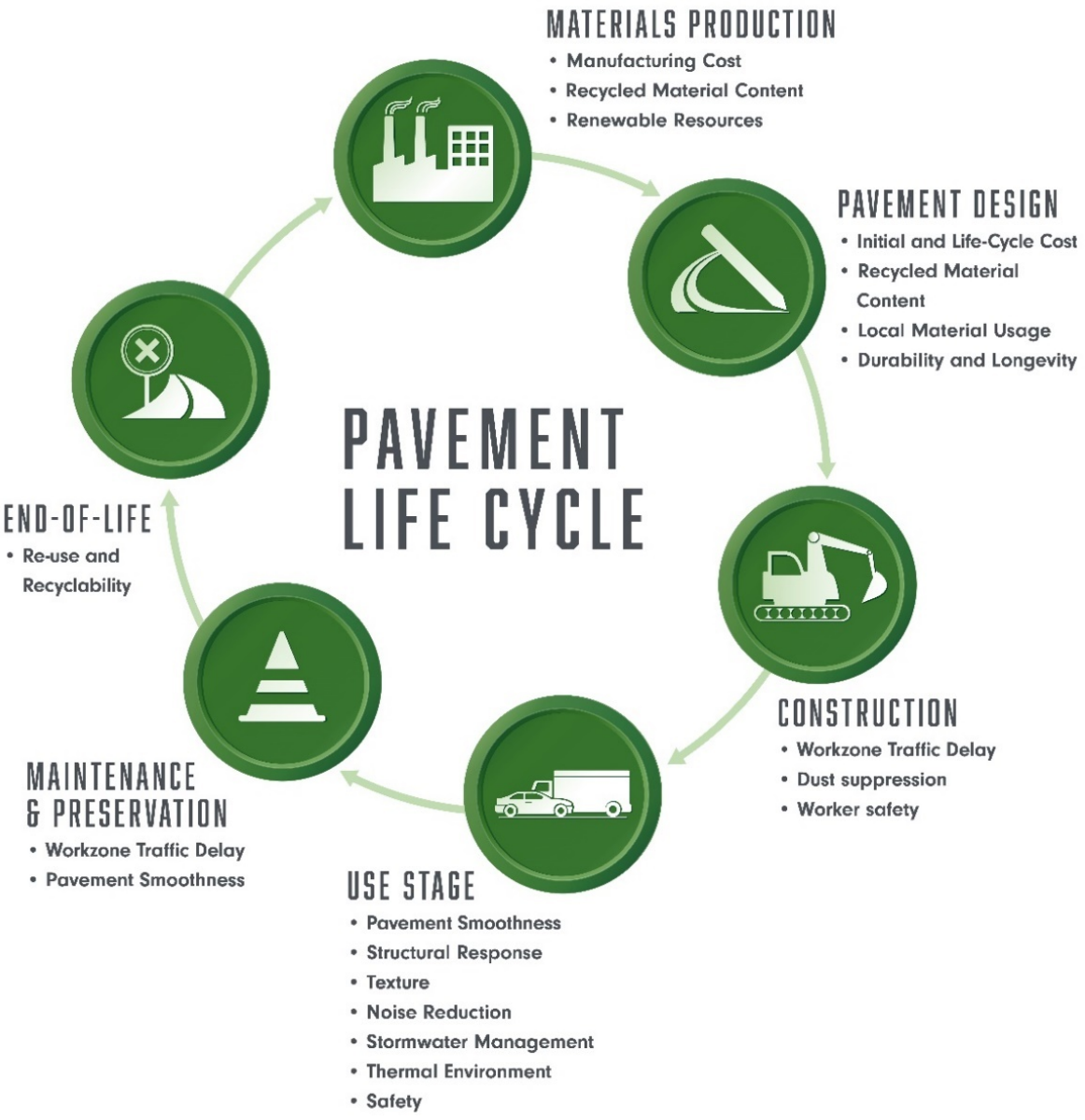
Life-Cycle Assessment (LCA)

Image Source: FHWA/APTech

Life Cycle Assessment (LCA)

- Comprehensive and systematic approach
- Involves life-cycle perspective
- Quantifies multiple environmental impacts throughout product life
- Context-specific
- Data-intensive process
- Results should be interpreted with caution
- Uncertainty should be evaluated

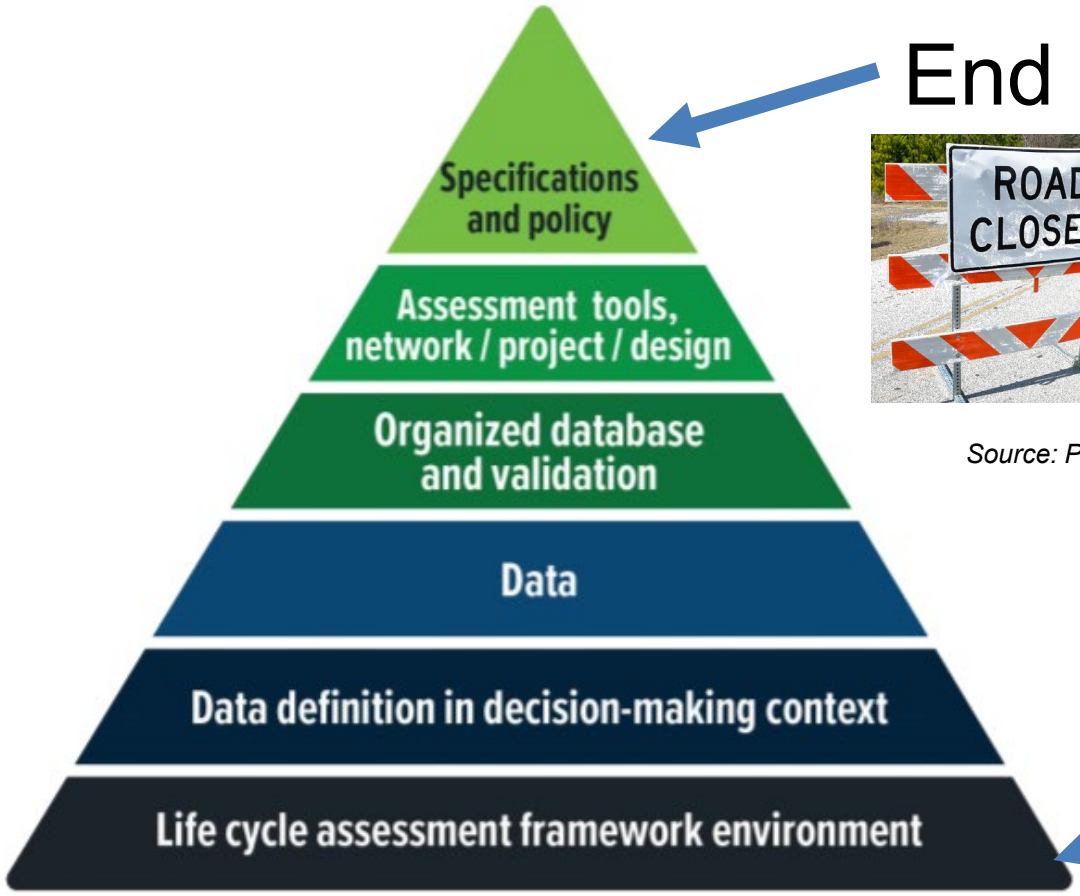
Improving Sustainability Throughout Pavement Life Cycle



Growing Need for LCA

- Meet Agency Environmental Goals
- Tell a Good Story to Public
- Obtain Additional Funding
- Assess Tradeoffs
- Aid Decision Making
  - **Procurement**
  - Design
  - Policies

Elements Necessary for Pavement LCA



End Goal

Biggest Barrier: Data

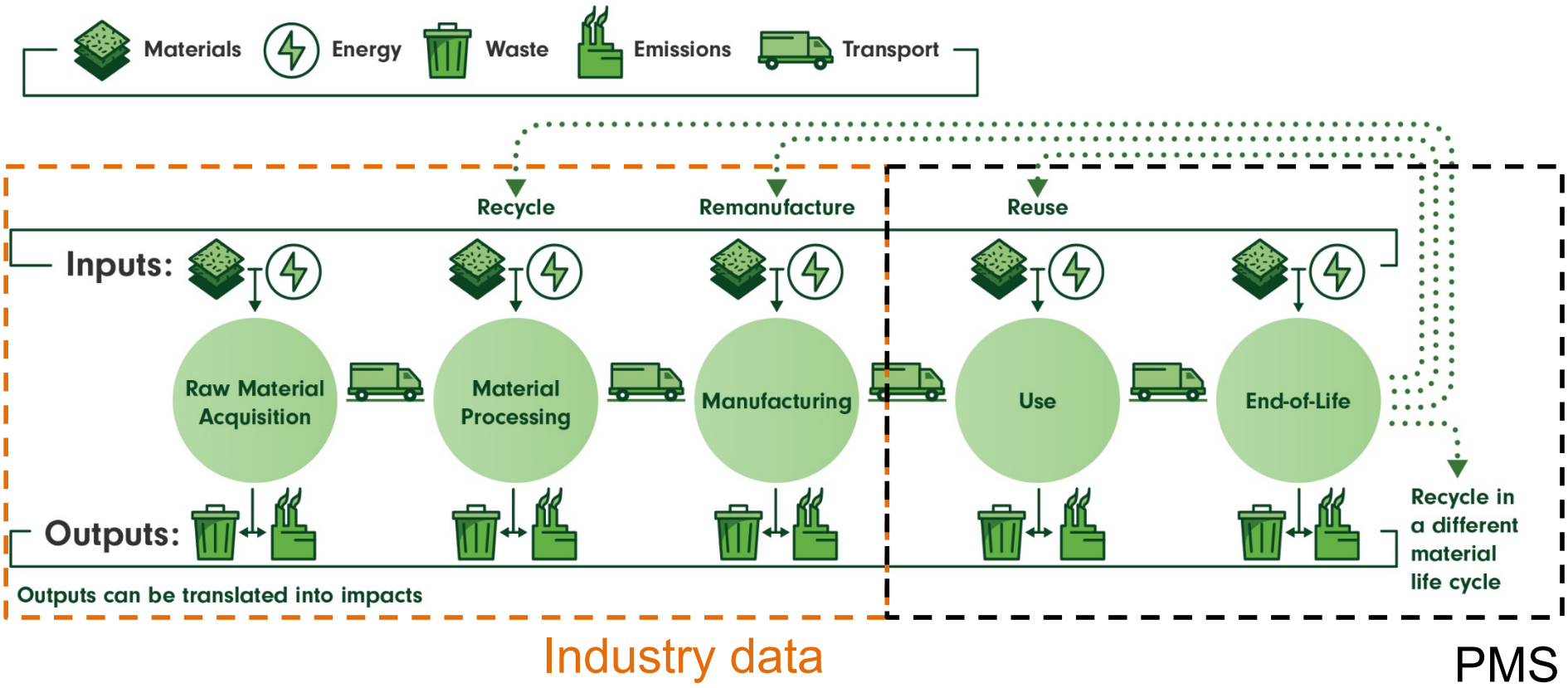
Source: Pixabay

Current

Source: FHWA

Pavement LCA Data Needs

- Track all the inputs and outputs from the system



Industry Data

- Background data sets for materials
- Plant operations data
- Emission factors for categories of vehicles using the pavement
- Emission factors for construction equipment
- Environmental Product Declarations (EPDs)

What Are EPDs?

- Communicate environmental impacts of material or product
- Express the results of a life-cycle assessment (LCA)
- Developed with stakeholder input
- Follow industry standards described in the PCR
- EPDs are not required by law or Federal regulations

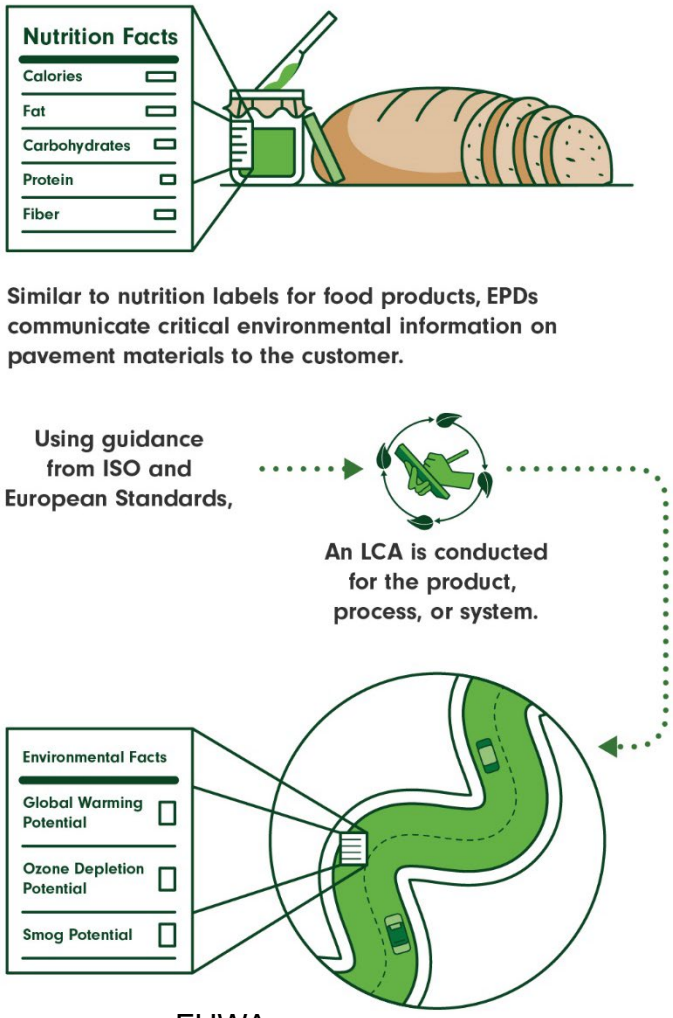


Image source: FHWA

Motivation to use EPDs

- Material Manufacturers Use Environmental Product Declarations for Marketing
- State and Local Interest in Requiring EPDs for Purchasing
  - Oregon
  - City of Portland, OR
  - California
  - Washington State
  - Minnesota
- Green Rating Systems Request EPDs

Product Category Rules (PCR)

- PCRs are sets of industry-consensus standards and guidelines used to develop EPDs
- PCRs ensure EPD:
  - Consistency
  - Transparency
- PCRs and EPDs are not required by law or federal regulations

Current Status of PCRs and EPDs

- No overarching agency governing harmonization between PCRs
- Limited collaboration between some program operators
- FHWA works on documenting best practices for pavement materials' PCRs and EPDs

FHWA Activities

LCA Benchmarking Tool

- Created with stakeholder input
- Use the identified background datasets
- Incorporate material EPDs

Project-Level Applications

- Determine pavement structural and mixture design with lowest environmental impact
- Evaluate strategies for preservation, maintenance, and rehabilitation
- Develop end-of-life recycling strategies
- Evaluate material sources and transportation alternatives

FHWA Activities

Collaborate with Federal LCA Commons to identify common public background datasets

- Roadmap for background datasets for Federal LCA Commons
- PCR development considerations
- Pavement LCA framework in OpenLCA

https://www.lcacommons.gov/

Agencies' possible involvement with EPDs

- Establish an EPDs database
- Encourage development and use of EPDs
- Compile EPDs to track and communicate progress towards agency goals
- Use EPDs as input in LCA
- Conduct pilot program to introduce industry to EPDs and their applications
- Consider EPDs for material procurement
- Participate as a stakeholder for creating PCRs

Agencies' possible involvement with PCRs

- Contribute to PCR development
- Review PCRs
- Can encourage industries to develop PCRs
- Encourage harmonization of PCRs

FHWA Contacts

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LaToya Johnson (LaToya.Johnson@dot.gov)
Office of Construction, Preconstruction and Pavements

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

Sustainability In Procurement

Curt Turgeon, PE

State Pavement Engineer

Minnesota DOT

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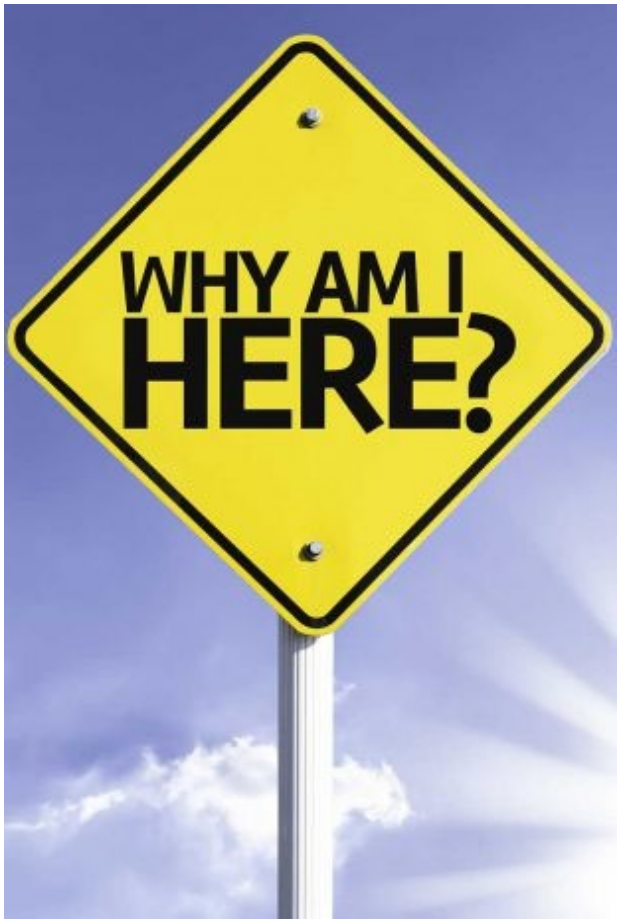


MnDOT Pavement Engineer

- Bituminous
- Concrete
- Pavement Design
- Pavement Management
- Advanced Materials and Tech

How did I get here?

BIG BOOK received

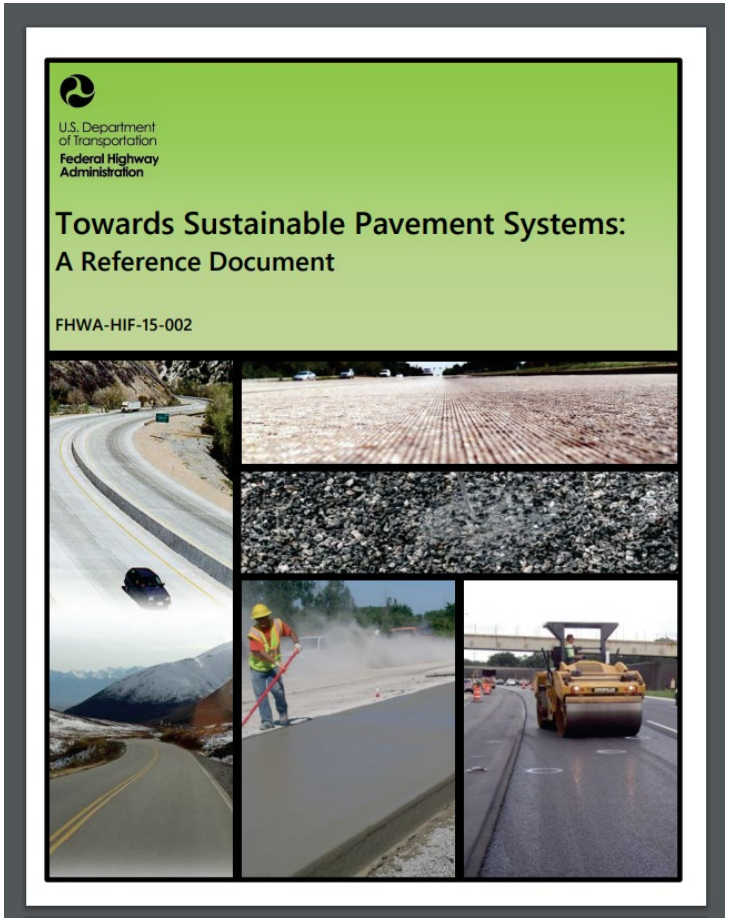
Working Group Member contacted MnDOT Sustainability Director

Determined that FHWA was looking for new TWG members for next five year cycle.

MnDOT Sustainability Report - Construction GHG values.

Chair AASHTO Committee on Materials and Pavements Tech Subcommittee on Quality Assurance and Environmental

Definitely learn something



Hurdle #1- Engineer Preconceived Notions

- Me – Sustainable pavement projects consume few resources while providing immediate impact (smoothness). For example – micromill and thin asphalt surface treatment or diamond grind concrete
- Group – Sustainable pavement projects should focus on maximizing the life of the fix. Consume resources in an efficient manner that leads to fewer resources needed in the future.
- *Are these mutually exclusive?*

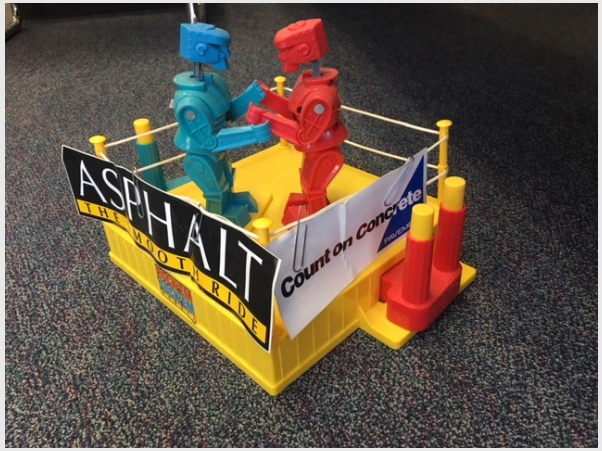
Hurdle #2 -The Battle of the Industries

Minnesota Asphalt Pavement Association

https://www.asphaltisbest.com/

Concrete Pavement Association of Minnesota

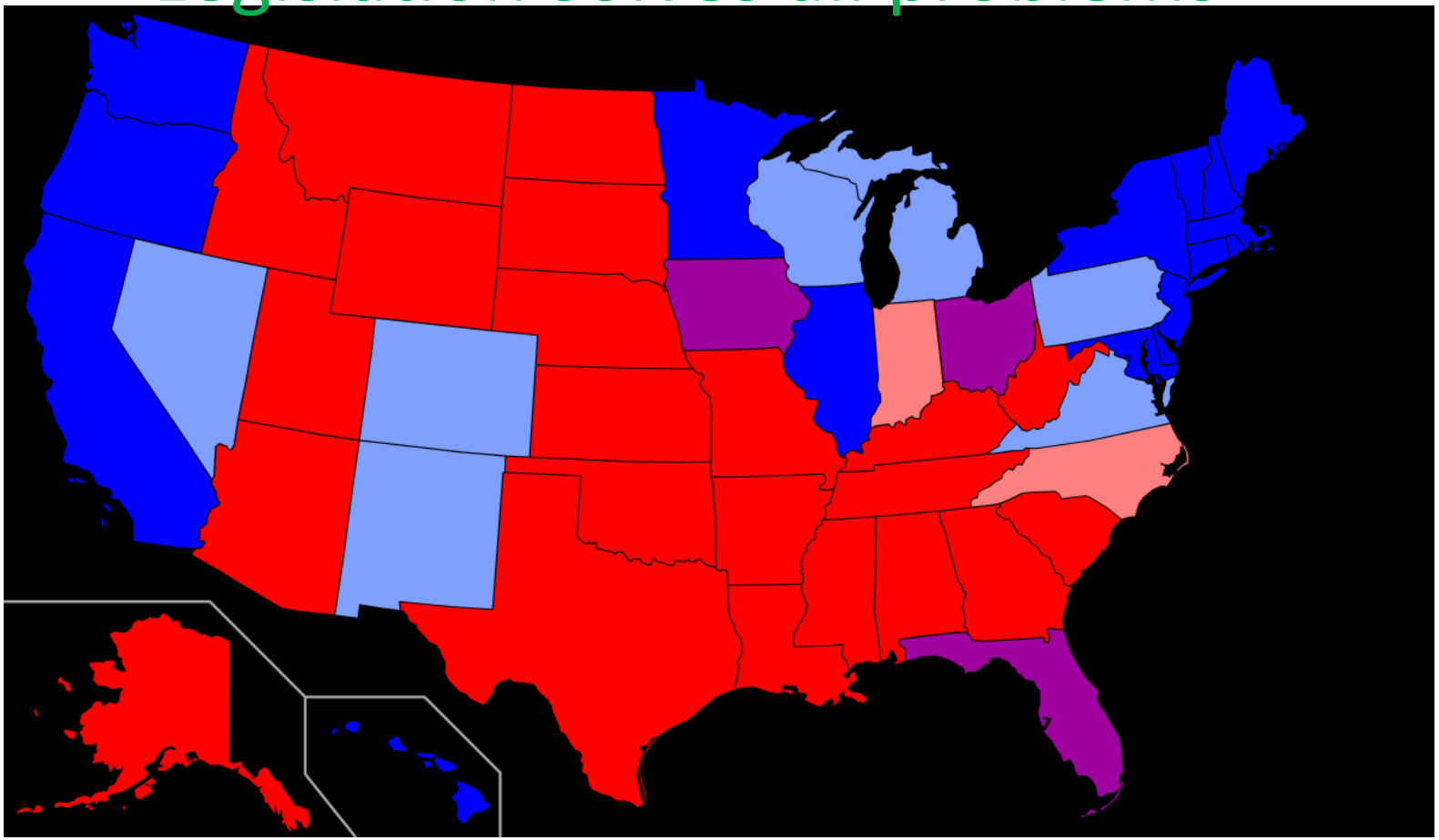
http://www.concreteisbetter.com/



Life Cycle Cost Analysis – Cost of Ownership over the life of asset

Hurdle #3 - Politics

Legislation solves all problems



Things Clicked

- Fall of 2017 FHWA Sustainable Pavements Technical Working Group meet.
  - #3 Politics: California passes limited law requiring Environmental Product Declarations
  - #2 Industry: National Asphalt Pavement Association releases Emerald Eco-Label Program for EPD calculation. National Ready Mixed Concrete Association has EPD calculator in place for 4 years. American Concrete Pavement Association ready to use NRMCA approach.
  - #1 Engineering: I have no idea how to incorporate sustainability into any of our decision processes. Few people in Minnesota have heard of EPDs

Simply Put

- Politicians are acting
- Industry is ready to go (at it)
- Engineering is lagging

MnDOT Michigan Tech Workshops

- #1 MnDOT Construction, Materials, Sustainability and Environmental Staff
- #2 MnDOT Staff, Concrete Pavement Association of MN, MN Asphalt Pavement Association, MN Association of General Contractors. MN Ready Mix Association. Presentations by NRMCA and NAPA.
- PLUS FHWA Workshop for Pavement Engineers and Planners from Washington, California, New York, Minnesota, and Iowa.

When to Consider Sustainability?

- Programming – network level mix of projects, network performance
- Scoping – individual project intent; budget and anticipated life
- Design – Choosing structural elements, asphalt or concrete and thickness
- Material Specifications – Recycling – hot, warm or cold; in-place or central plant; additives, re use as base; supplementary cementitious materials
- Project Award – Provide bidding advantage to Contractors (cost plus time, A+B; award criteria or technical score in Design Build)
- Contract Administration – incentives for Contractor activities and processes that achieve preset standards
- As Built Documentation – accounting of actual impacts from a project
- Network Level Documentation – accounting of agency impacts, annual or impact/mile.
- Operations and Maintenance – snow and ice, safety, durability

Direct Impacts to Procurement

- Design – Choosing structural elements, asphalt or concrete and thickness
- Material Specifications – Recycling – hot, warm or cold; in-place or central plant; additives, re-use as base; supplementary cementitious materials
- Project Award – Provide bidding advantage to Contractors (similar to cost plus time, A+B; award criteria or technical score in Design Build)
- Contract Administration – Incentives for Contractor activities and processes that achieve preset standards

Design

- Currently - Life Cycle Cost Analysis $$$$
  - Total cost of ownership,
    - Initial – quantities and unit prices
    - Maintenance – what, when, cost
    - End of Life – recycled, dispose, reuse in place
    - Design Life (20 yrs) and Analysis Period (35 yrs)
    - Cost of Money – Discount Rate
  - Many details, Industry debate
  - Low Cost Wins

Design - Sustainability

- Future - Life Cycle Assessment
  - Total ~~cost~~ ENVIRONMENTAL IMPACTS of ownership,
    - Initial – quantities and unit ENVIRONMENTAL IMPACTS ~~prices~~
    - Maintenance – what, when~~, cost~~ ENVIRONMENTAL IMPACTS
    - End of Life – recycled, dispose, res-use in place ENVIRONMENTAL IMPACTS
    - Design Life and Analysis Period ENVIRONMENTAL IMPACTS (Today or Later)
    - Cost of Money – Discount Rate ENVIRONMENTAL IMPACTS (Today or Later)
  - Many details, Industry debate
  - Low ~~Cost~~ Wins ??????? How will this be weighted in decision?

Materials

- Cost vs Performance
- Recycled Materials – Must perform as well or better than conventional at same or lower cost.
- Design – Initial costs and Maintenance costs come from
- Unit Prices $/ton; $/cu yd; $/lin ft.

Materials, Asphalt Example

Asphalt Recycling Options	
Plant	In Place
HOT	HOT
WARM	
COLD	COLD

At least five options
Different:

- Cost $
- Performance
- Equipment
- Additives
- Percentages of recycle content

Each of the five options has a different
AS YET UNDEFINED,
Environmental Impact

Project Award and Contract Administration

- Contractors need to know what they are bidding
- Weigh value to taxpayers vs. selection criteria or incentive
  - A+B: quantified financial benefit from completing the project early included in determining the value of the bid
  - Smoothness: defined incentive/disincentive based upon achieved smoothness vs predefined standard
  - Sustainability: clearly defined achievable target that can be used in the letting or incentive/disincentive format

Where to Start: Top Down or Bottom Up?

- Programming – network level mix of projects, network performance
- Scoping – individual project intent; budget and anticipated life
- Design – Choosing structural elements, asphalt or concrete and thickness
- Material Specifications – Recycling – hot, warm or cold; in-place or central plant; additives, re use as base; supplementary cementitious materials

THE MIDDLE

- Project Award – Provide bidding advantage to Contractors (similar to cost plus time, A+B, award criteria or technical score in Design Build)
- Contract Administration – incentives for Contractor activities and processes that achieve preset standards
- As Built Documentation – accounting of actual impacts from a project
- Network Level Documentation – accounting of agency impacts, annual or impact/mile.
- Operations and Maintenance - snow and ice, safety, durability

In the End

- Meet the Project Intent at Minimum Cost $.
- How do factor Environmental Impacts into the Project Intent and at what Cost $?
- Need clearly quantify Environmental Impacts
- NEED Environmental Impact per item

Environmental Product Declarations

Workshop Results in one Chart

Minnesota Sustainable Procurement

DRIVERS

- LEED v4
- PCR for Concrete
- PCR for Asphalt
- California Buy Clean Act
- MN Bill HF2203 2019
- MN Bill HF2204 2019
- Executive orde 17-12 2018

WORKSHOP 1
Internal stakeholders

WORKSHOP 2
External stakeholders

OUTCOMES

- Education: applied understanding of LCA and EPD
- Need to identify process for using EPD in procurement
- Recommend draft timeline for Phase 2 & identify potential participants
- Create a roadmap for Minnesota

RESOURCES

- UC- Davis PRC
- EPDs for Asphalt, Concrete Ready Mix, and Aggregate
- FHWA Pavement LCA Framework
- FHWA Sustainable Pavement TWG

TOGETHER, DRIVERS, RESOURCES, AND OUTCOMES INFORM THE ROADMAP.

Roadmap

TECHNICAL

- System boundaries
- Data fidelity
- Indicators
- Benchmarking

To Be Conducted in Conjunction with FHWA TO-8

ORGANIZATIONAL

- Data management
- EPD pilots & adoption
- EPD repository or database
- Administrative infrastructure
- Education & outreach
- EPD in Best Value Procur.

Seeking NRRA Funding

IMPLEMENT PILOTS

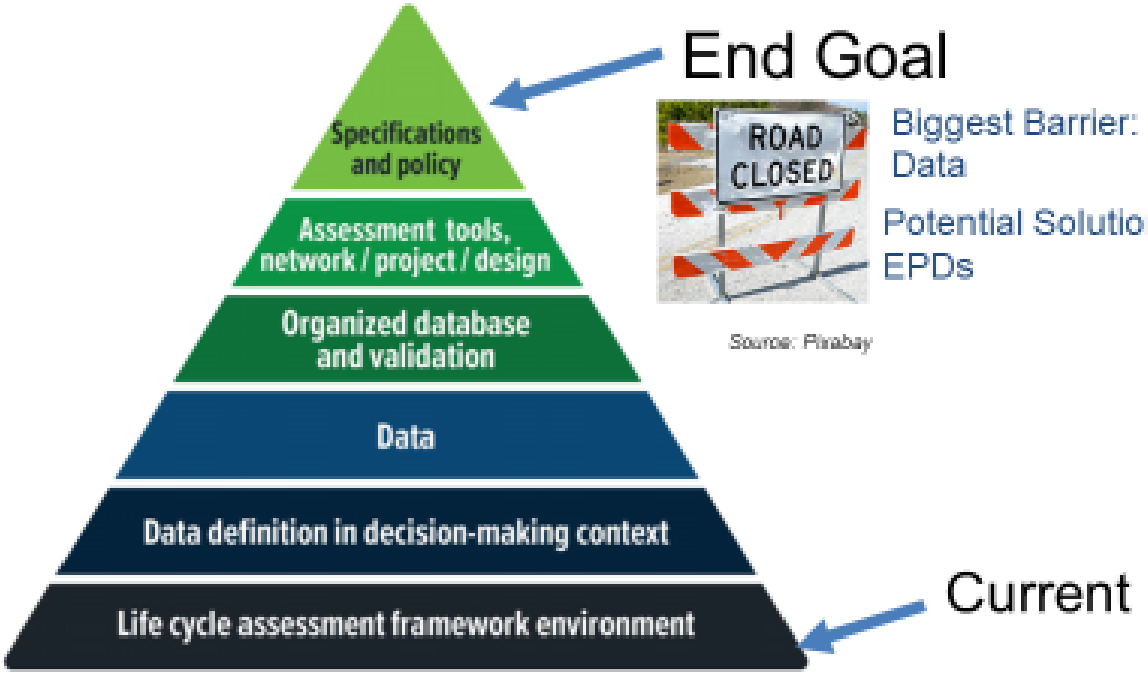
- Pilots with early partners
- Cost quantification
- Evaluate benefits and integration
- Data verification requirements

Seeking NRRA Funding

Local Needs for MN

Current Status from FHWA

Elements Necessary for Pavement LCA Implementation



Source: Pixabay

Biggest Barrier: Data

Potential Solution: EPDs

Source: FHWA

Heather Dylla
FHWA

Can We Use EPD Type Environmental Impacts in Procurement?

NOT YET

EXPECTATIONS ARE RISING QUICKLY

Thank you again!

Curt Turgeon, PE

Minnesota Pavement Engineer

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651-366-5535

CALTRANS' CONSIDERATIONS FOR USE OF LIFE CYCLE ASSESSMENT AND ENVIRONMENTAL PRODUCT DECLARATIONS

Jacquelyn Wong, P.E.

Environmental Product Declaration Implementation Manager

California Department of Transportation

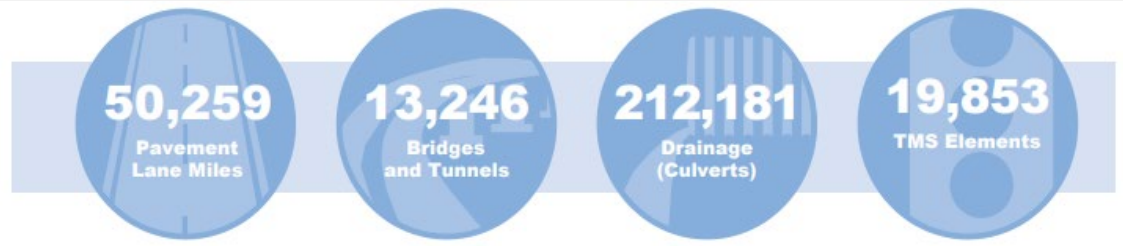
August 20, 2019

CALTRANS

WHAT WE'LL COVER

- CA Department of Transportation (Caltrans)
- Life Cycle Assessment (LCA), Why is Caltrans interested
- Current Use of LCA thinking and tools
- Environmental Product Declarations (EPDs)
- Connecting The Dots

A BIT ABOUT CALTRANS



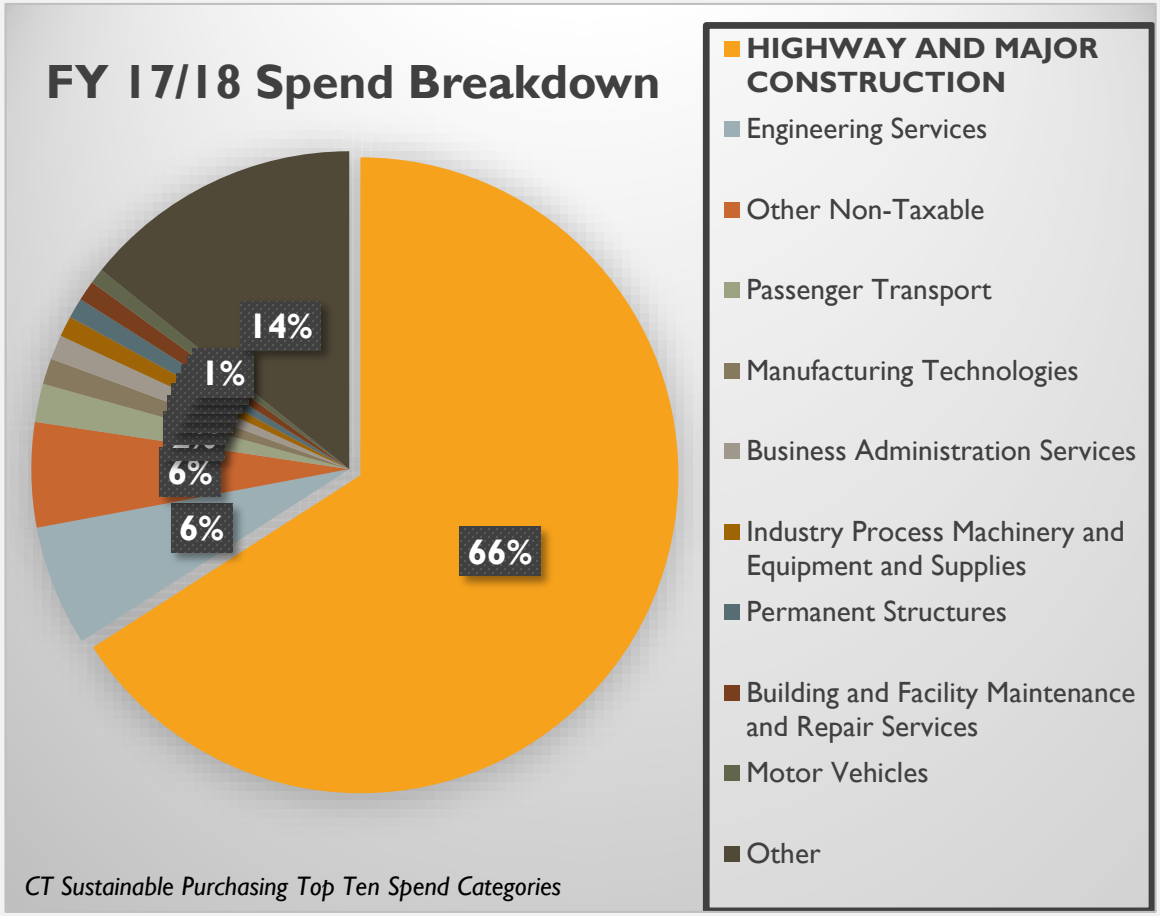
2019 CT Asset Management Data

Caltrans' Mission:

Provide a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability.

About two-thirds of our annual budget is spent on construction projects.

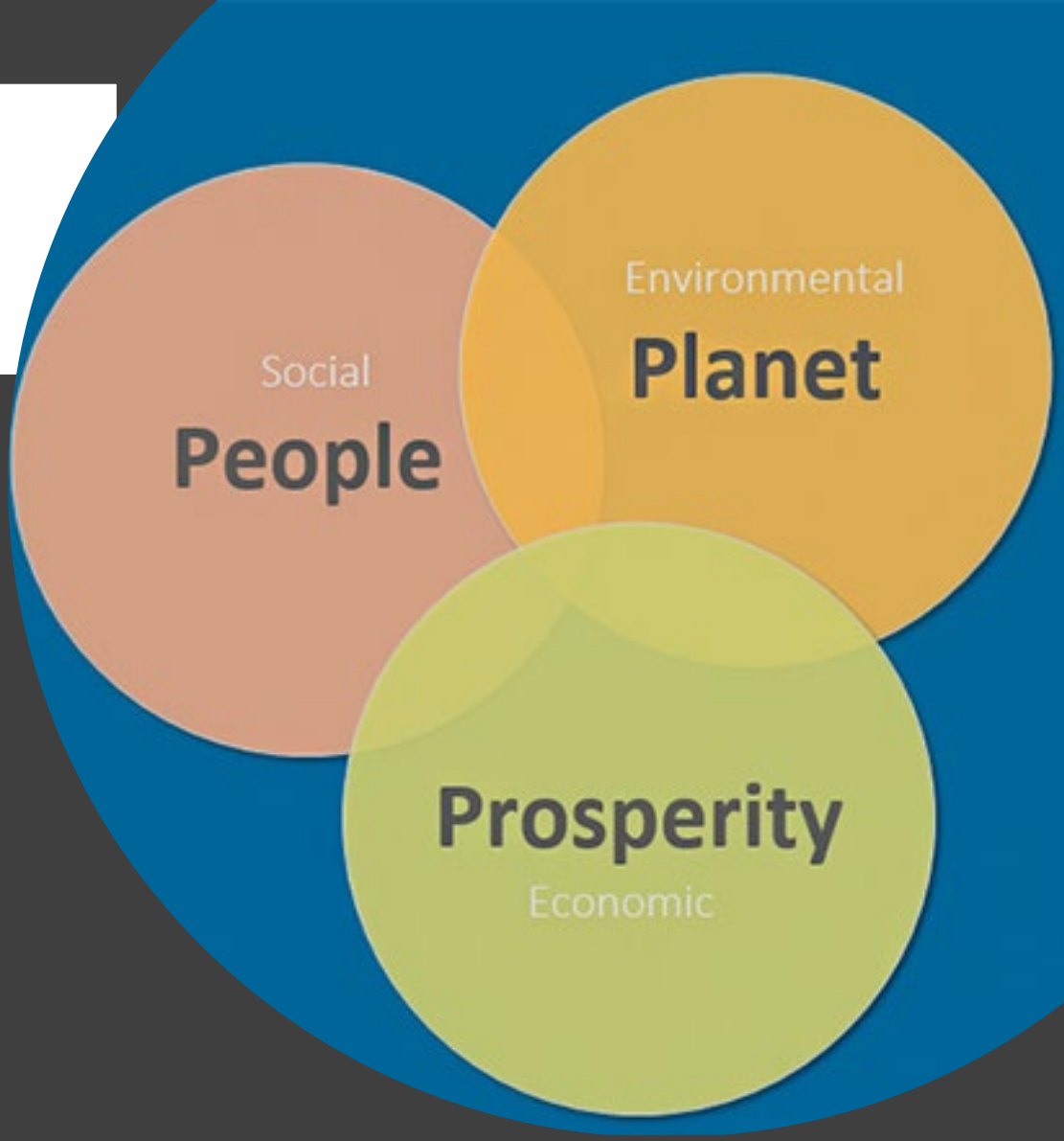
The majority of our construction projects are low cost bid in a design-bid-build procurement environment.



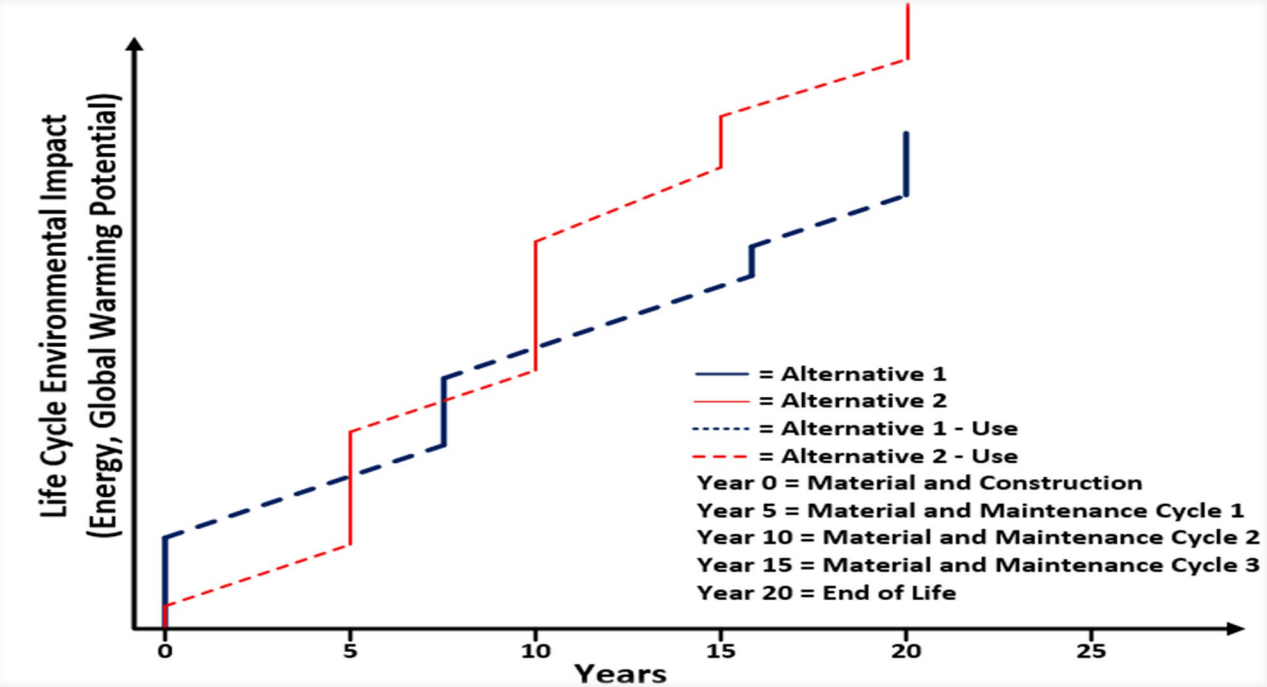
CT Sustainable Purchasing Top Ten Spend Categories

WHY IS CALTRANS INTERESTED IN LIFE CYCLE ASSESSMENT AND EPDS?

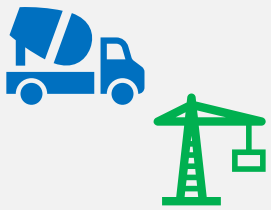
- **Strategic Goals:** Sustainability, Livability, Economy
- Introduced to and began strategizing about EPD concepts in *early 2016*
- State Legislation:
  - AB 32 (Greenhouse Gas Reduction)
  - AB 262 (EPDs)

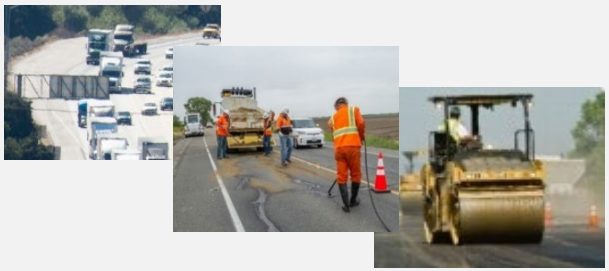


LIFE CYCLE ASSESSMENT FOR CALTRANS



Product Stage			Construction Stage		Use Stage					End-of-Life Stage				Benefits & Loads
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
Raw materials supply	Transport	Manufacturing	Transport	Installation	Use Stage	Maintenance	Repair	Replacement	Refurbishment	De-construction	Transport	Waste Processing	Disposal	Reuse, recovery, recycling potential





CURRENT TOOLS THAT SUPPORT LCA CONCEPTS (NATIONALLY AND LOCALLY)

Product Stage			Construction Stage		Use Stage					End-of-Life Stage				Benefits & Loads
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
Raw materials supply	Transport	Manufacturing	Transport	Installation	Use Stage	Maintenance	Repair	Replacement	Refurbishment	De-construction	Transport	Waste Processing	Disposal	Reuse, recovery, recycling potential

Network Level Estimates

FHWA ICE TOOL: Bridges, Pavement, Culverts, TMS (GHG and Energy)

EMFAC Tools (Vehicle Emissions)

Conceptual Project Level Estimates

eLCAP, environmental LCA for Pavement (GHG, CFC-11, SO_2, N, O_3, Energy)

CA/Caltrans Construction Emissions Calculators

Caltrans EMFAC Tools

EPDs (GHG, CFC-11, SO_2, N, O_3, Energy)

…and many more in the works.

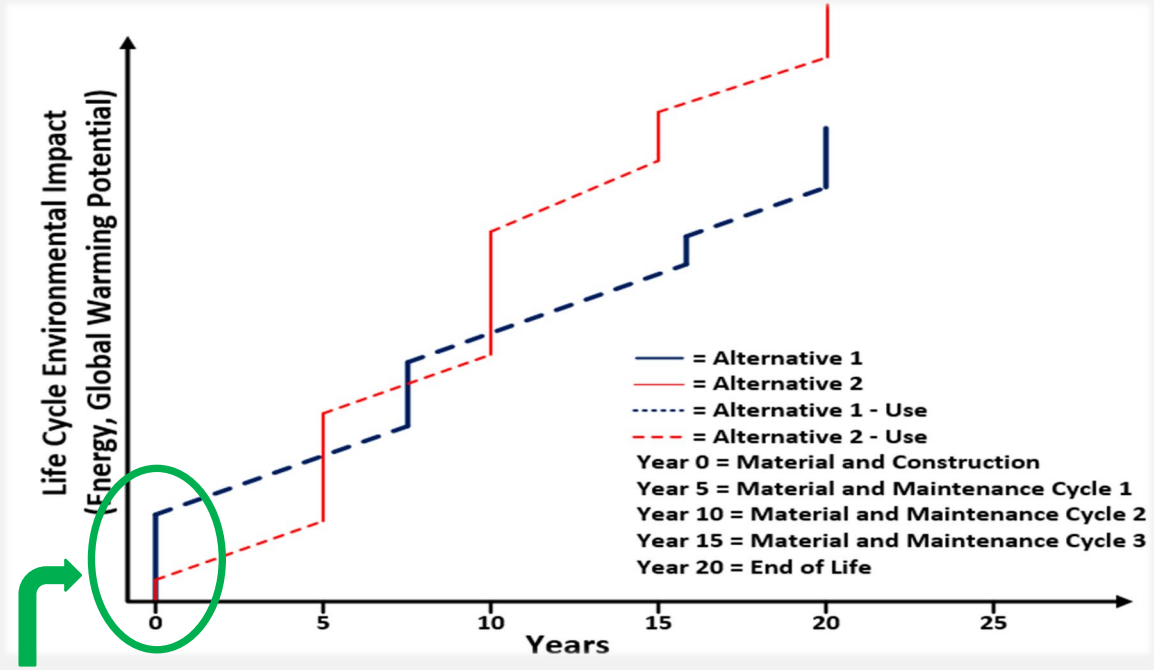
Project Level Estimates

WHERE DO EPDS FIT IN?

ABC Ready-Mix Environmental Impacts

Serving Size: 1 cubic yard of concrete mix no. 123

Global Warming Potential [kg CO_2 eq]	3.06×10^3
Ozone Depletion Potential [CFC-11 eq]	4.24×10^{-6}
Acidification Potential [kg SO_2 eq]	21.7
Eutrophication Potential [kg N eq]	9.25×10^{-2}
Photochemical Oxidant Creation Potential [kg O_3 eq]	30.7
TOTAL ENERGY DEMAND [MJ]:	1166
Non-renewable [MJ]	586
Renewable [MJ]	580

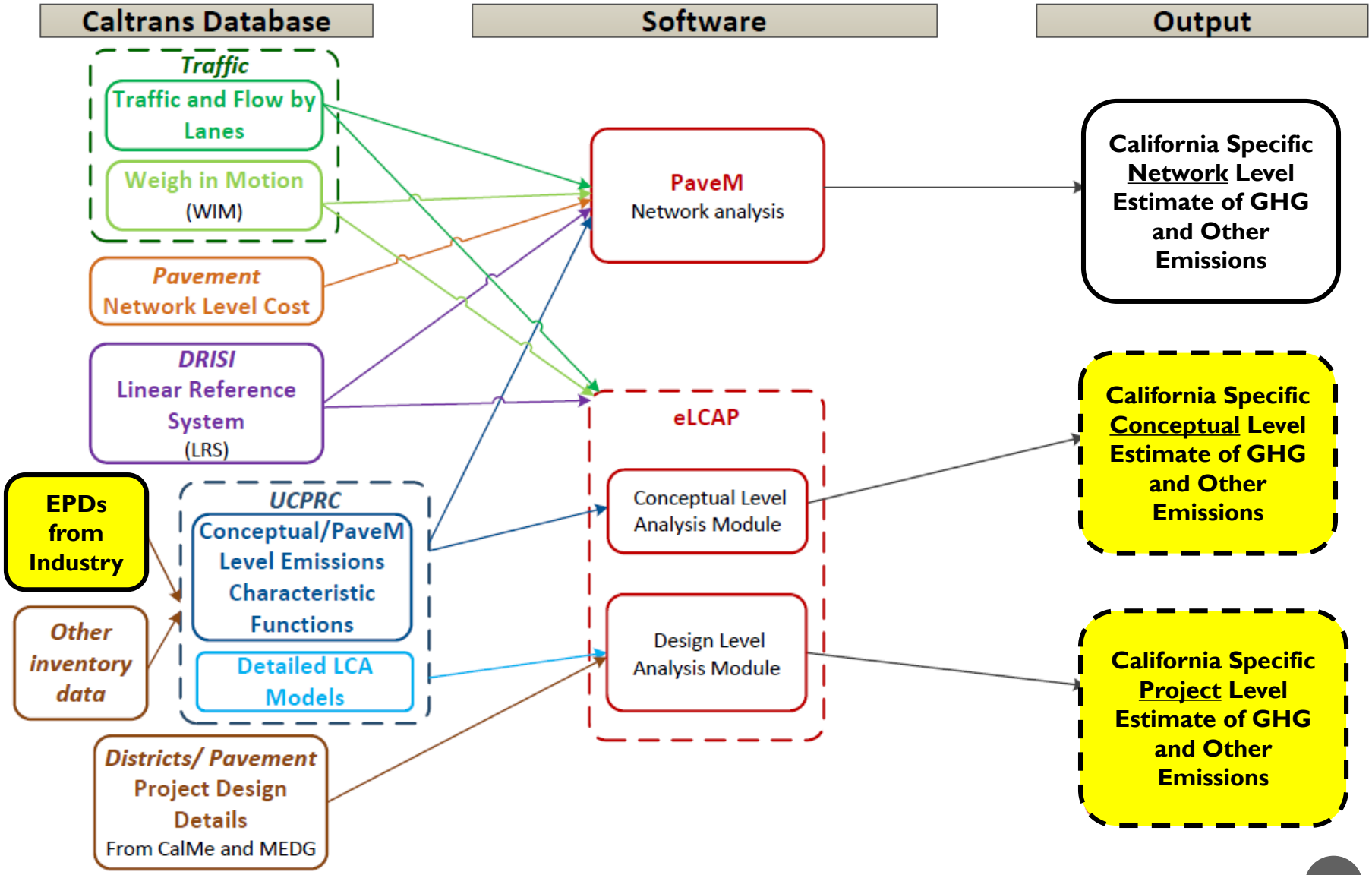


Supplier EPDs for materials

Product Stage			Construction Stage		Use Stage					End-of-Life Stage				Benefits & Loads
A1	A2	A3	A4	A5	B1	B2	B3	B4	B5	C1	C2	C3	C4	D
Raw materials supply	Transport	Manufacturing	Transport	Installation	Use Stage	Maintenance	Repair	Replacement	Refurbishment	De-construction	Transport	Waste Processing	Disposal	Reuse, recovery, recycling potential

Projects

LCA CONCEPTS FOR CALTRANS PAVEMENT (ELCAP - ENVIRONMENTAL LCA FOR PAVEMENT)



BUY CLEAN CALIFORNIA ACT

(PUBLIC CONTRACT CODE § 3500 ET SEQ.)

- *AB 262 approved October 2017, amended by AB 1817 approved June 2018*

Timeline	Requirement
Jan 1, 2019 – Dec 31, 2019	***Request existing EPDs***
On and after Jan 1, 2020	Require EPDs
By Jan 1, 2021	DGS establish GWP Baseline
On and after Jul 1, 2021	Required EPDs with materials < GWP Baseline prior to installation

- First mandated collection of EPDs in United States
- Facility-specific EPDs
- Allowance for exceptions
- Baseline set by consulting recognized databases of EPDs

LESSONS LEARNED AND ONGOING CHALLENGES

- Launched Pilot Program in 2019 to require EPDs on select projects across **seven material categories**:
  - Structural Steel
  - Carbon Reinforcing Bar
  - Mineral Wool Board Insulation
  - Flat Glass
  - Concrete
  - Asphalt Concrete
  - Aggregate

Preparation for Buy Clean CA Act

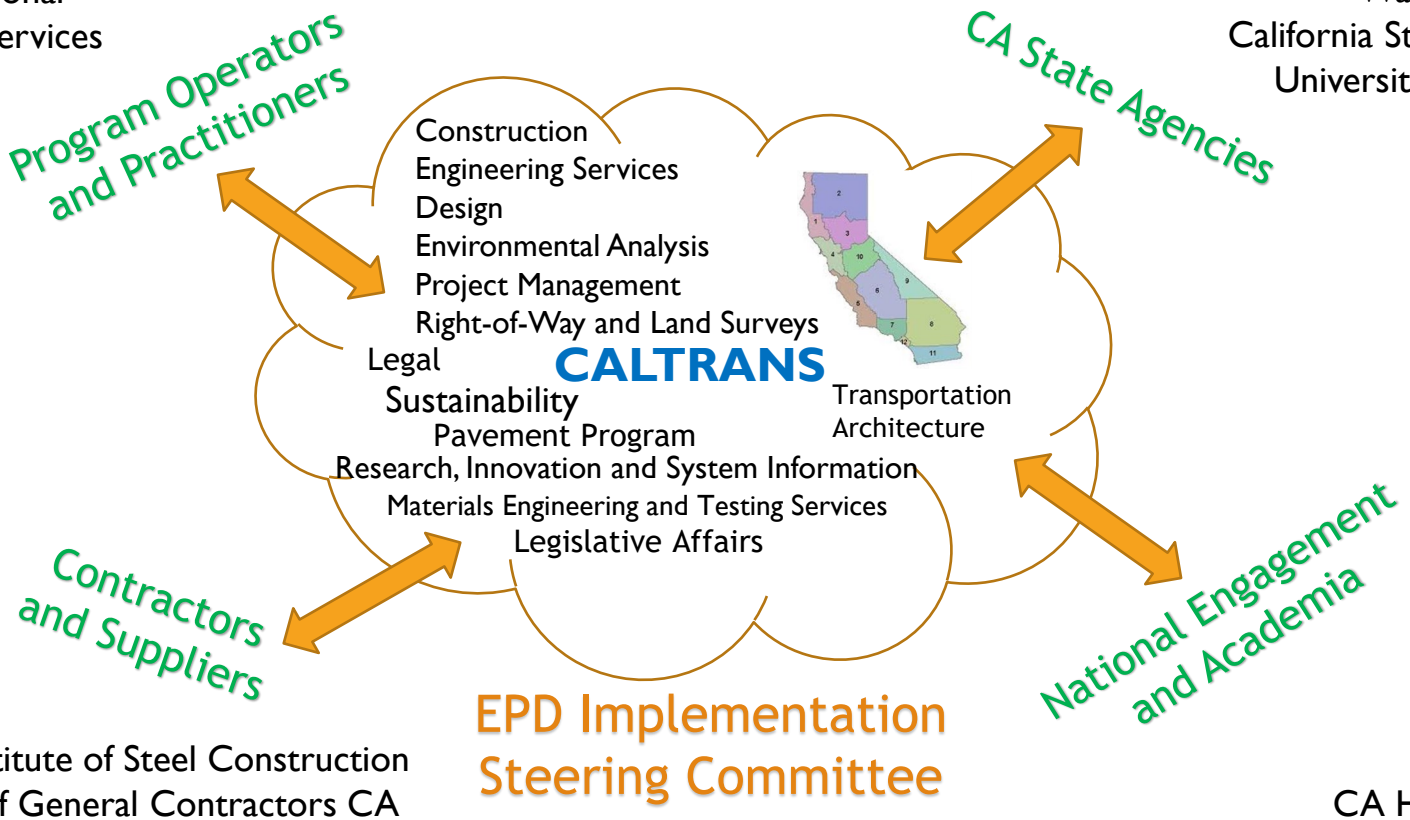
"High Volume Construction Materials"

- Specifications (Clear, Consistent, Biddable, Administer-able)
- Collecting and Sharing Data (How a database collects and disseminates data)
- Collaboration, Outreach (Minimize the element of surprise)

SOME OF MANY STAKEHOLDERS

ASTM International
Carbon Leadership Forum
Climate Earth
National Asphalt Pavement Association
National Ready Mix Concrete Association
NSF International
SCS Global Services
Thinkstep

General Services
State Parks
Military
Corrections and Rehabilitation
Real Estate Services Division
Water Resources
California State University
University of California



American Institute of Steel Construction
Association of General Contractors CA
CA Asphalt Pavement Association
CA Construction and Industrial Materials Association
Concrete Reinforcing Steel Institute
National Steel Bridge Alliance
Southern California Contractors Association
United Contractors

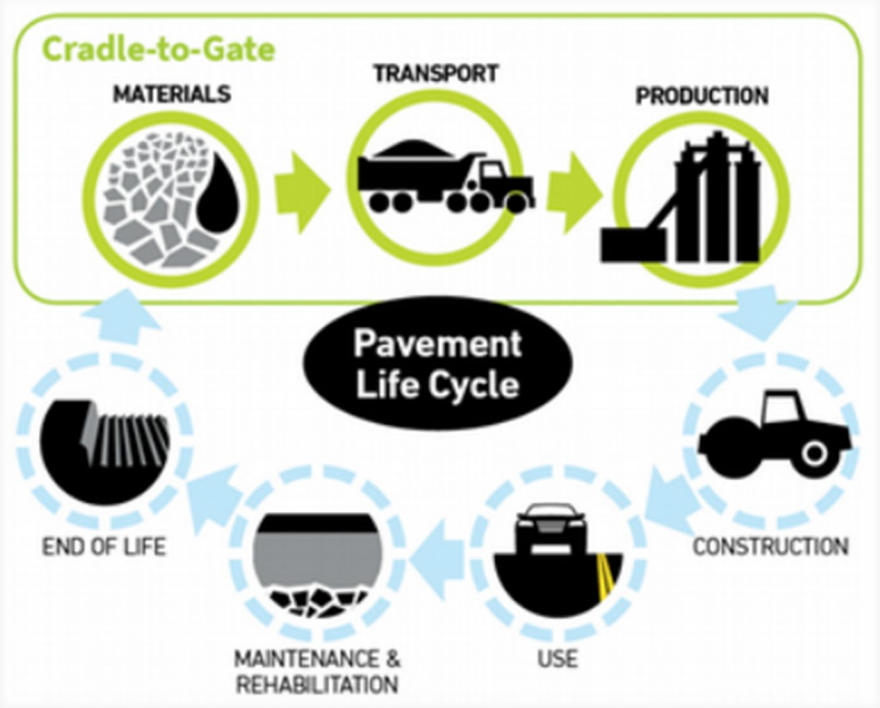
CA High Speed Rail
OR Dept. Environmental Quality
UW College of the Environment
UC Pavement Research Center
MTU Transportation Institute
MIT CSHub
FHWA Sustainable Pavements Technical Working Group

KEEPING THINGS CONNECTED

- LCA can be a tool for decision-making (planners, designers, construction, maintenance)
- EPDs are a tool for validating our environmental impact assumptions about products AND can provide a business-to-business playing field for sustainability metrics

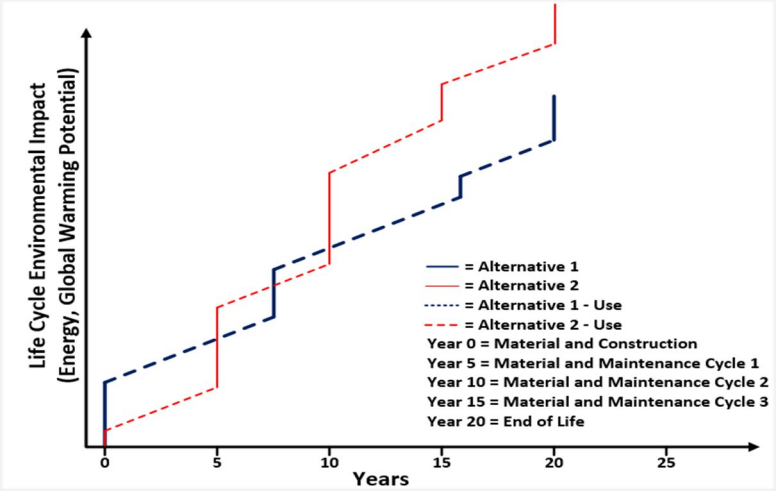
How these may affect procurement:

- Consider Environmental LCA like Life Cycle Cost Analysis (LCCA)? (potential)
- Administered appropriately, EPDs can support a competitive sustainability environment for suppliers (goal)
- EPDs can be used to feed back into LCA tools, refining and validating conceptual estimates for project designers (goal)



SUMMARY

- LCA and EPDs are still relatively new concepts in the United States and continue to evolve
- Communication between asset holders is vital to the successful use of LCA and EPDs
- Caltrans capitalized on existing tools and resources to make LCA thinking a possibility for our organization



Goal: The ability to assess environmental impacts of projects over its life cycle

THANK YOU

Visit Caltrans' EPD website:

https://dot.ca.gov/programs/engineering-services/environmental-product-declarations

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International Symposium on Pavement, Roadway, and Bridge Life Cycle Assessment 2020

Sacramento, California, USA
June 3-6, 2020

www.ucprc.ucdavis.edu/lca2020

Sponsored by TRB AFD30

Today's Participants

- Jacqueline Wong, *California Department of Transportation*, jacquelyn.wong@dot.ca.gov
- Curt Turgeon, *Minnesota Department of Transportation*, curt.turgeon@state.mn.us
- Milena Rangelov, *Federal Highway Administration – National Research Council*, milena.rangelov.ctr@dot.gov
- Amlan Mukherjee, *Michigan Technological University*, amlan@mtu.edu

Panelists Presentations

http://onlinepubs.trb.org/onlinepubs/webinars/190820.pdf

After the webinar, you will receive a follow-up email containing a link to the recording

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