Sustainability and Life Cycle Assessment of Electrical Products

Pacific Northwest National Laboratory
Kate Hickcox, Energy + Environment Research Scientist
(971) 940-7119 • Kathryn.Hickcox@pnnl.gov
WBS 3.2.1.02

New Project FY22

Sustainability and Life Cycle Assessment of Electrical Products Summary

Objective and outcome

Reduce the barriers for the lighting and Mechanical, Electrical, Plumbing (MEP) industries to participate in data-driven sustainability. Increase adoption and comparability of Life Cycle Assessments (LCAs) and Environmental Product Declarations (EPDs) across industries to support reduction of embodied carbon, Greenhouse Gas emissions and other environmental impacts.

Team and Partners

This project includes a diverse team of leading U.S. lighting manufacturers (**Finelite, Acuity, EldoLED**), a global circular economy focused lighting alliance (**GreenLight Alliance**), life cycle assessment practitioners and PNNL staff including members from the Lighting Systems team under the Electricity Infrastructure and Buildings (EI&B) Division, as well as members on the Sustainability Engineering team under the Earth Systems Science Division.

Stats

Performance Period: FY23 (Project kick-off in FY22)

DOE budget: $356k, Cost Share: $n/a

Milestone 1: Mid-Year Update Report, 04/15/23

Milestone 2: BETA release LCA Template, 05/01/23

Milestone 3: Final Summary Report, 09/15/23

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Image by MidJourney

Sustainability and LCA Problem / Opportunity

Life Cycle Assessment (**LCA**)

Summarized into Environmental Product Declaration report/label (**EPD**)

EO 14057 Federal Sustainability Plan requires high-quality carbon & sustainability reporting

- **High-quality sustainability reporting (e.g., EPDs)** for procurement policies—embodied emissions & pollutants of construction materials
- **Increase transparency** to help verify accuracy of reported data
- Support manufacturers to report & reduce emissions
- Incentivize consistent Federal GHG accounting for green procurement

Quality

Quantity

LACK of high-quality carbon & sustainability reporting for LIGHTING and electrical products

- There are **few EPDs available for Lighting** and certain high-impact electrical products [1]
- LED lighting systems make up the highest proportion of embodied carbon emissions for the electrical category (MEP) [2]

High-quality and representative sustainability reporting data are critical for accurate whole building life cycle assessment results

Identify and reduce barriers for LIGHTING and electrical products to achieve high-quality reporting

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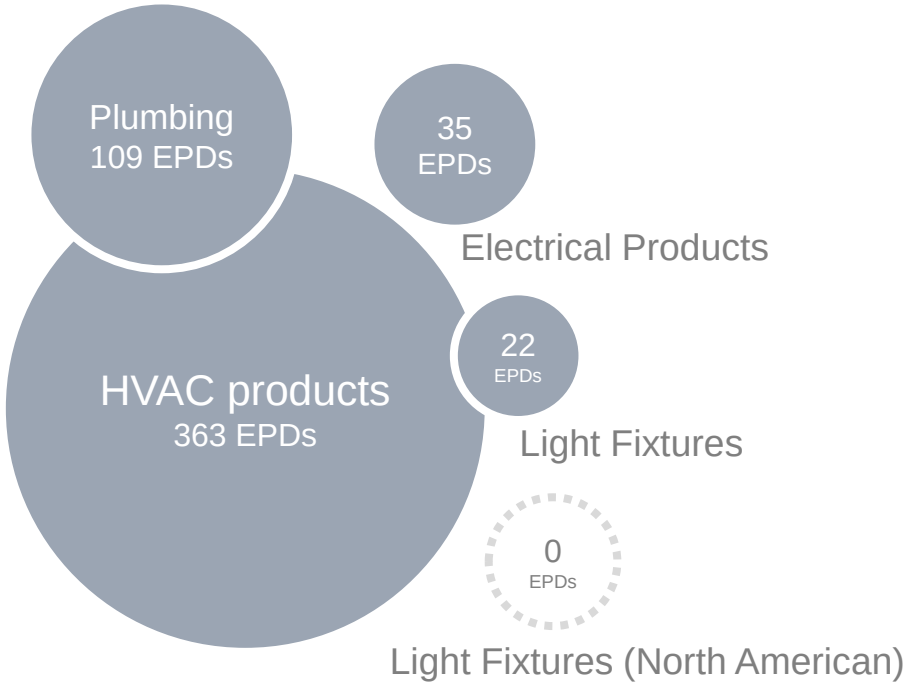
[1] Recent PNNL survey looking at PEP EcoPassport ® EPD database and Sustainable Minds Transparency Catalogue (EPDs)
[2] Elementa study that attempts to measure the whole-life carbon impact of building services - https://www.cibsejournal.com/general/getting-to-grips-with-whole-life-carbon/

Sustainability and LCA Problem / Opportunity

Life Cycle Assessment (**LCA**) → Summarized into Environmental Product Declaration report/label (**EPD**)



Number of high-quality sustainability reports (e.g., EPDs) found for each product type [1]

Quantity

LACK of high-quality carbon & sustainability reporting for LIGHTING and electrical products

Barriers to participation for lighting manufacturers

- Lighting and electrical industry has not fully adopted LCA process
- Process can be expensive and confusing
- No North American rules (PCR) for use in creating transparent and comparable North American lighting life cycle assessments
- Certain components (such as drivers and small electronics) can be very difficult to get information for, causing a roadblock
- Enormous push to get EPD info is producing a “wild west” in development, causing a lack of standardization and comparability
- Lighting manufacturers typically produce product families with potentially thousands of variations and SKU combinations

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[1] Recent PNNL survey looking at PEP EcoPassport ® EPD database and Sustainable Minds Transparency Catalogue (EPDs)

Sustainability and LCA Alignment and Impact

Streamlining, simplifying, and standardizing the sustainability reporting process (EPDs) for North American geographic scope supports rapid decarbonization of U.S. building stock, and supports EERE/BTO's vision for a net-zero U.S. building sector by 2050

Identify and reduce barriers for LIGHTING and electrical products to achieve high-quality reporting

- Reduce the cost of decarbonizing whole buildings
- Track flow of benefits and track equity and justice through life cycle assessments

Data is needed to reduce emissions

You can't mitigate what you can't measure!

Build Energy Equity and Justice metrics into the LCA

Greenhouse gas emissions reductions

50-52% reduction by 2030 vs. 2005 levels

Net-zero emissions economy by 2050

Power system decarbonization

100% carbon pollution-free electricity by 2035

Energy justice

40% of benefits from federal climate and clean energy investments flow to disadvantaged communities

The nation's ambitious climate mitigation goals

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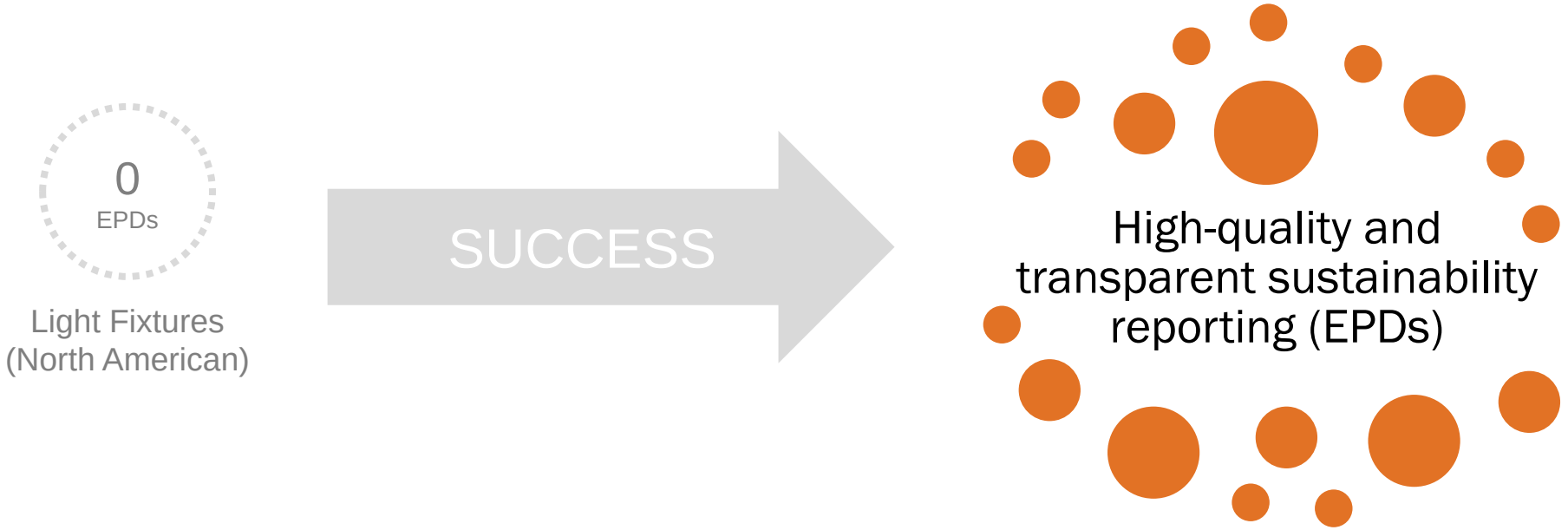
Sustainability and LCA Alignment and Impact

Successful outcome is when our work supports lighting manufacturers in publishing high-quality sustainability reporting (e.g., EPDs) that qualify for North American procurement policies, and contribute to industry sustainability and carbon reporting averages



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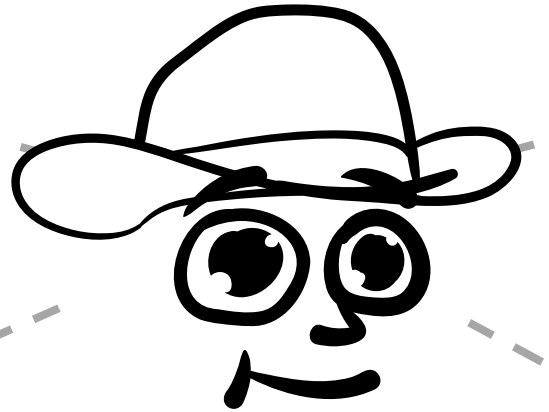
Sustainability and LCA Approach

Enormous push to get high-quality sustainability and carbon reporting (e.g., EPDs) is producing a **"Wild West" in development**, causing a lack of standardization and comparability

Life Cycle Assessment (LCA) sustainability reporting is a comprehensive, standardized, and third-party verified methodology, but there is still room for improvement

The few existing rules (PCRs) that standardize LCA approaches for lighting products are European-based. Limitations in geographic scope can lead to lack of comparability in EPDs across products.



Collecting LCA data can be labor intensive and intimidating, and certain components can be very difficult to get information for, causing a roadblock

The cost ($) of getting an LCA and resulting report (EPD) are very high

The existing European-based LCA rules (PCRs) for lighting products may not meet new federal sustainability reporting quality requirements

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Sustainability and LCA Approach

Develop a free and transparent (open vs “black box”) Life Cycle Assessment data inventory template that aligns with North American-centered LCA rules (e.g., PCRs) for lighting products

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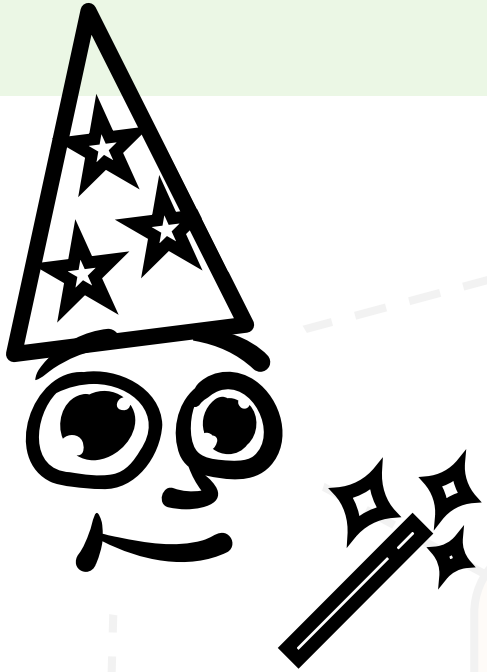

Life Cycle Assessment data inventory TEMPLATE

Support development of NA-aligned LCA rules (e.g., PCRs) for lighting products

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Sustainability and LCA Approach

To support the use of LCAs in North America, Product Category Rules (PCRs) for lighting products are needed that adhere to ISO standards, and align with NA background data

Support development of NA-aligned LCA rules (e.g., PCRs) for lighting products

BEST: A North American (NA) program operator creates new (NA or Global) LCA rules (e.g., PCRs) for lighting products, adhering to ISO standards (open and free for all to use)

BETTER: The existing European-based LCA rules (e.g., PCRs) for lighting products may create a North American addendum (may have additional costs and limitations associated)

GOOD: In lieu of North American-aligned LCA rules (e.g., PCRs) for lighting products, PNNL has developed LCA guidance for manufacturers and LCA practitioners to aid in standardizing background data approaches

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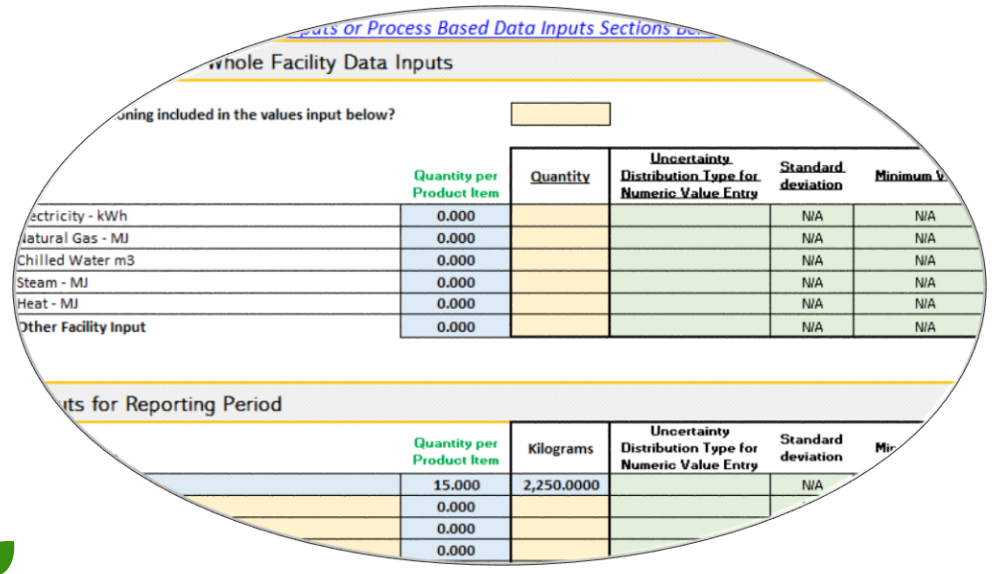
Sustainability and LCA Approach

Develop a free and transparent (open vs “black box”) Life Cycle Assessment data inventory template that aligns with North American-centered LCA rules (e.g., PCRs) for lighting products

Life Cycle Assessment data inventory TEMPLATE



Template aligns with current guidelines and standards:

- Streamline and simplify the LCA process
- Improve comparability, transparency, and options for open access
- Integrate North American Center for LCA ‘Open Standard’
- Align with BuyClean and other upcoming clean procurement regulations
- Connect to open-source data sets to promote digitization and open access

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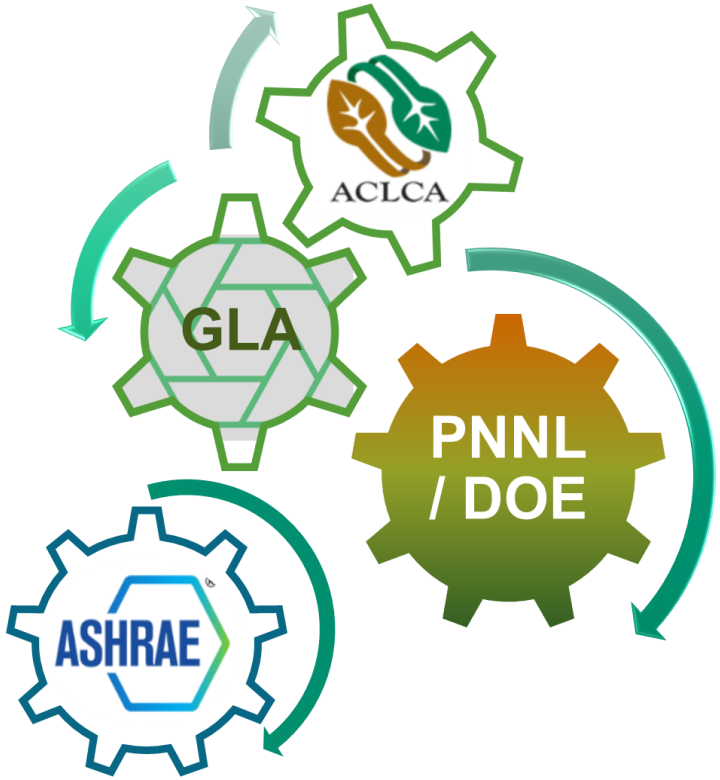
Sustainability and LCA Approach

This project involves **leading lighting manufacturers**, external LCA experts and a core team of lighting and Life Cycle Assessment experts within PNNL who participate in our ongoing RD&D, providing feedback and supporting the research and development of approaches.



Lighting Manufacturers: Testing the LCA template and providing data and feedback for continuous improvements

GreenLight Alliance LCA Incubator: Supporting international dialogue on transparency and standardization in the lighting industry

American Center for Life Cycle Assessment: PCR Open Standard for standardized, consistent, and reliable PCRs and EPDs

ASHRAE: Developing a North American version of CIBSE TM65 embodied carbon estimation tool and a WBLCA Embodied Carbon Guide

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Image by MidJourney

Sustainability and LCA Progress

Address barriers to achieve high-quality reporting

Barrier identified by this project	Approach to address barriers	Complete? Addresses quality / quantity?
Collecting LCA data can be labor and cost intensive and intimidating	Custom free and transparent LCA data inventory template that is aligned with North American-aligned LCA rules (e.g., PCRs) for lighting products • **May 2023 release BETA version of template** and kick-off new "Focus Group" to provide feedback	
Certain components can be very difficult to get information for, causing a roadblock	Collect data on drivers and small electronics, conduct LCAs, and suggest approaches to streamline lighting fixture LCA data collection	
Research on lighting End-of-Life outcomes, and reporting in Behind-the-Meter Batteries	Scoping work to identify how the LCA methodology could be used to gather data for these areas	
European-based LCA rules (e.g., PCRs) for lighting products have multiple limitations including cost, accessibility and misaligned geographic scope	Develop LCA guidance for manufacturers and LCA practitioners to aid in standardizing background data approaches. Support NA program operators in creation of a new (NA or Global) PCR for lighting products	

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Sustainability and LCA Future Work

	Deepen	Expand
FY23 Continued	• Collect feedback from “Focus Group” of manufacturers on BETA version of template • Collect data on drivers and small electronics, conduct LCAs, and suggest approaches to streamline lighting fixture LCA data collection • Support NA program operators in creation of a new (NA or Global) PCR for lighting products	

FY24 Proposed	• Develop a lifecycle footprint LCA “template” cloud solution, with privacy-preserving computation
	• Use the LCA template to assess End-of-Life stage scenarios, identify benefits and impacts from various End-of-Life strategies
		• The LCA template is scalable to many other products or industries. Our team has identified some specific products that could greatly benefit from the LCA template:
		  • Certain HVAC products
		  • Behind-the-Meter batteries
		  • Drivers and small electronics

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Thank You

Questions?

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Kate Hickcox, Energy + Environment Research Scientist
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REFERENCE SLIDES

Project Execution

	FY2022				FY2023				FY2024			
Planned budget	100K				356K				tbd			
Spent budget	100K				186K (Q2)				tbd			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Past Work												
Q2 Milestone: Mid-Year Update Report		◆										
Q4 Milestone: Final Summary Report				◆								
Q4 Milestone: Go/No-Go Decision				◆								
Q2 Milestone: Mid-Year Update Report						◆						
Current/Future Work												
Q2 Milestone: BETA release of LCI Template							◆					
Q4 Milestone: Final Summary Report								◆				
Q4 Milestone: Go/No-Go Decision								◆				
Q2 Milestone: Mid-Year Update Report										◆		
Q4 Milestone: Final Summary Report												◆

◆ Milestone/Deliverable (Originally Planned) use for missed
◆ Milestone/Deliverable (Actual) use when met on time

- **Go/no-go decision points:** FY23 Improve access and ability for equipment manufacturers to complete LCAs - Decision on continuing work in FY24 on improving access, scalability, and adoption of LCI template in support of high-quality LCAs
- No slipped milestones or slips in schedule

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Sustainability and Life Cycle Assessment of Electrical Products Team

Rebe Feraldi

LCA & Biomimicry Scientist, Environmental Engineer

Dr. Scott Unger

Environmental Engineer

Kasey Johnston

Post Masters RA

Dr Peter Christensen

Industry Partnerships Advisor

Dr. Tyler M Harris

Sustainability Engineer

Corey Strachan

Post Bachelors RA

Gabe Arnold

Senior Systems Engineer

Kate Hickcox

Energy + Environment Research Scientist (PI)

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Sustainability and Life Cycle Assessment of Electrical Products

External Partners

GreenLight Alliance

- Leela Shanker (Flint Collective) *,
- James Salazar (Athena Sustainable Materials Institute)

FINELITE Better Lighting

- Aaron Smith,
- Bernhard Goesman

AcuityBrands

- Scott Roos,
- Dirk Zylstra,
- Chris Sorensen

eldoLED

- Gilles Abrahamse,
- Ranjit Jayabalan,
- Bharath Kodali,
- Russell Porter

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Life Cycle Assessment Terminology

- **American Center for Life Cycle Assessment (ACLCA)** - is a nonprofit membership organization providing education, awareness, advocacy, and communications to build capacity and knowledge of environmental LCA.
- **Embodied Carbon (EC):** greenhouse gas emissions arising from the manufacturing, transportation, installation, maintenance, and disposal of material or service products – (SOURCE: Carbon Leadership Forum – Embodied Carbon 101)
- **Environmental Product Declaration (EPD)** – a.k.a., Type III environmental declaration; providing quantified environmental data using predetermined parameters [based on ISO 14040 and ISO 14044] and, where relevant, additional [quantitative or qualitative] environmental information (SOURCE: ISO 14025:2006, 3.1)
- **Life Cycle Assessment (LCA)** - compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle (SOURCE: ISO 14044:2006, 3.2)
- **Life Cycle Impact Assessment (LCIA)** - phase of life cycle assessment aimed at understanding and evaluating the magnitude and significance of the potential environmental impacts for a product system throughout the life cycle of the product (SOURCE: ISO 14044:2006, 3.4)
- **Life Cycle Inventory (LCI)** - phase of life cycle assessment involving the compilation and quantification of inputs and outputs for a product throughout its life cycle (SOURCE: ISO 14044:2006, 3.3)
- **Mechanical, electrical, and plumbing (MEP)** - These three technical disciplines encompass the systems that make building interiors suitable for human occupancy (SOURCE: Ashwin Mathew)
- **Product Category Rule (PCR)** - set of specific rules, requirements, and guidelines for developing Type III environmental declarations and footprint communications for one or more product categories (SOURCE: ISO 14027:2017, 3.1)
- **Whole Building Life Cycle Assessment (WBLCA):** compilation and evaluation of the inputs, outputs, and the potential environmental impacts of a whole building system throughout its life cycle

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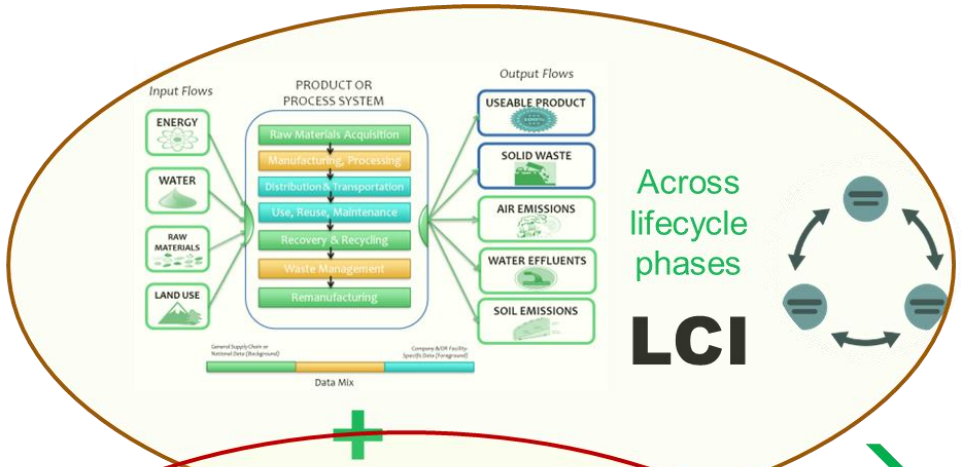
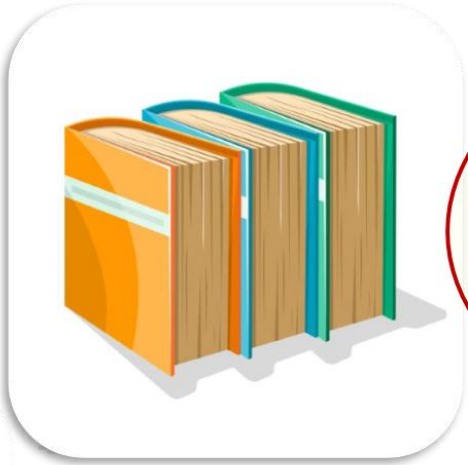
Life Cycle Assessment Stages



Across lifecycle phases

LCI

LCA



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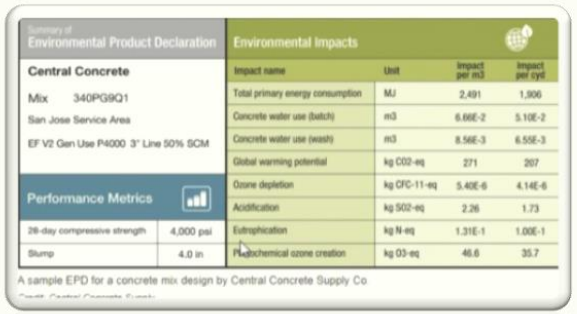
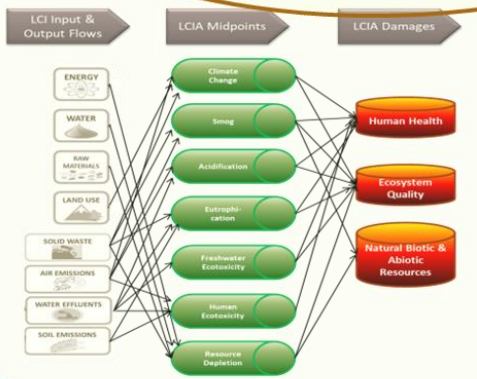
EPD





LCIA

Across impact indicators

According to Relevant Product Category Rule (PCR)

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Legislative and Market LCA Drivers

Legislative and market drivers support increased used of Environmental Product Declarations (EPDs), which disclose embodied life-cycle impacts of products and materials.

Quality

Quantity

EO 14057 Federal Sustainability Plan: Section 303 – Buy Clean Task Force

- EPDs for procurement policies—embodied emissions & pollutants of construction materials
- Increase transparency to help verify accuracy of reported data
- Support manufacturers to report & reduce emissions
- Pilot programs to incentivize consistent Federal GHG accounting for green procurement

Inflation Reduction Act: Section 60112 Environmental Product Declaration Assistance

- $250 million in technical assistance and grants
- Development, transparency, and standardization of EPDs
- To businesses, states, tribes and nonprofits

Inflation Reduction Act: Section 60116 Low Embodied Carbon Labelling for Construction

- $100 million
- Identifying and labelling construction materials with “Substantially lower embodied carbon”
- Across the lifecycle

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