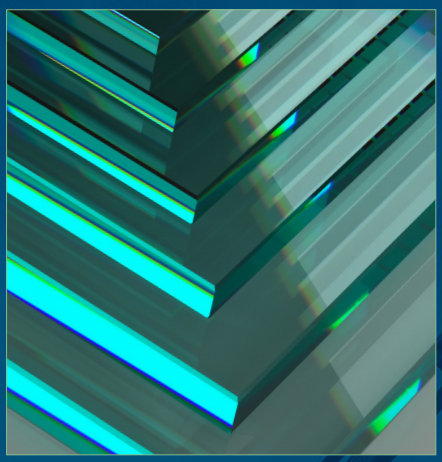

Life Cycle Inventory Data Gap Assessment

Office of Chemical Safety and Pollution Prevention
August 2024

EPA

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Background and Approach

The objective of this assessment is to identify life cycle inventory data gaps in free-to-use and publicly accessible secondary LCI datasets, as relevant to the supply chains of the products and materials identified in the U.S. Environmental Protection Agency's Interim Determination. These include asphalt mix, concrete, steel and glass. The *U.S. EPA Criteria for Product Category Rules (PCRs) to Support the Label Program for Low Embodied Carbon Construction Materials* require that, effective January 1, 2026, PCRs shall prescribe the use of the EPA-designated free-to-use and publicly accessible datasets. Appendix F in EPA's PCR Criteria provides additional reasoning for preference of use of free-to-use and publicly accessible secondary LCI datasets. The overall purpose of this requirement is to ensure underlying data used for the label program are suitable for use for procurement. The purpose of this LCI gap assessment is to support identification of priority secondary dataset development efforts to enhance the quality and quantity of free-to-use and publicly accessible secondary LCI datasets.

The assessment is organized according to the following sections:

1. **Review of Existing PCRs**: Existing PCRs for priority materials—and other materials for which federal staff are involved in PCR committees—were first reviewed. If a PCR recommends or prescribes secondary LCI databases and/or datasets, these were documented. If a PCR lists secondary LCI data gaps, these gaps were also documented.
2. **PCR Committee Insights:** Active PCR committees were also engaged to understand the secondary LCI data gaps and needs from an industry perspective. These engagements also yielded insight from committees on considerations related to future versions of their PCRs. EPA assessed data gaps for PCR committees for material categories where federal staff currently or will participate.
3. **Comparison to Existing Datasets:** These secondary LCI data and data gaps found in PCRs and identified by PCR committee engagement were compared to existing free-to-use and publicly accessible LCI data—for example, data on the Federal LCA Commons and within the National Renewable Energy Laboratory's U.S. Life Cycle Inventory Database, which is a part of the Federal LCA Commons.
4. **Recommendations for Prioritizing Datasets to Develop to Fill Gaps:** Combining the findings from steps 1 through 3, this section makes recommendations on priority secondary LCI datasets to develop for EPA's label program for low embodied carbon construction materials. Recommendations address development of data for materials and processes that may already have free-to-use and publicly accessible datasets, but that also have data quality limitations. Recommendations include input from experts in the LCA field.

This is version 1 of the LCI data gap assessment; EPA may periodically update the document as necessary based on sector-specific stakeholder feedback. Feedback or questions on this LCI data gap assessment can be submitted through the embodiedcarbon@epa.gov email.

Review of Existing PCRs

General Requirements on Secondary Data

In general, PCRs use "shall" language to make certain requirements for the sources of secondary data. Most PCRs refer to Section 7.1.9, "Selection of data and data quality requirements" in ISO 21930:2017 (ISO, 2017) as the secondary data selection guidance. This section's requirements for secondary data selection include:

- **Requirements on the quality of the secondary data.** The standard requires that "datasets used for calculations shall have been updated within the last 10 years."
- **Requirements on the life cycle modules for which generic and proxy data may be used.** The standard states that "generic and proxy data may be used for the processes over which the manufacturer has no influence" and makes specifications for particular life cycle stages:
    - For upstream processes including the production of commodities and raw materials, generic data or EPDs may be used.
- For downstream processes including installation (A4, A5), use processes (B1 to B7), and end-of-life processes (C1 to C4), scenario-based generic data may be used.

In addition to the ISO standard, some PCRs require purchased electricity energy data to include North American Electric Reliability Corporation regions, or similar data, to represent electricity production in the United States and Canada, with a preference for datasets that include transmission and distribution losses. A few of the PCRs require the use of national-level databases such as the Federal LCA Commons (or U.S. Life Cycle Inventory) electricity production data. Geographical and technological representativeness are also required by PCRs. One PCR requires any secondary data source used in the underlying LCI to be complete and representative of the applicable North American region in terms of its geographic and technological coverages and of a recent vintage (i.e., less than 10 years old). Some PCRs also state that priority should be given to publicly available datasets.

Table 1 summarizes these requirements for reviewed PCRs.

Table 1. Secondary Data Requirements from PCRs

	National Databases	Federal LCA Commons—All Secondary Data	Federal LCA Commons—Energy Data Only	Electricity Data Recommendations[a]	Valid EPDs	Free-to-Use and Accessible Datasets	Additional Process-Level Secondary Data Source[b]
Steel Construction Product (UL, 2020)		X[c]					
Asphalt Mixtures (NAPA, 2022)					X	X	X
Flat Glass: UN CPC 3711 (NSF International, 2020a)			X[d]				
Concrete (NSF International, 2024a)					X		X
Cements (NSF International, 2021)				X			
Fenestration Assemblies (NSF International, 2024b)			X[e]	X[e]			
Architectural Coatings[f] (NSF International, 2023b)							
Gypsum Panel Products (NSF International, 2020b)	X						
Clay Brick, Clay Brick Pavers and Structural Clay Tile (NSF International, 2016)	X[g]						

	National Databases	Federal LCA Commons—All Secondary Data	Federal LCA Commons—Energy Data Only	Electricity Data Recommendations[a]	Valid EPDs	Free-to-Use and Accessible Datasets	Additional Process-Level Secondary Data Source[b]
Pressure-Treated Wood (NSF International, 2023a)				X			
Construction Aggregates (NSF International, 2017)	X[g]						

[a] "Purchased electrical energy data shall use NERC regions or similar data to represent electrical energy production for the U.S. and Canada. Preference should be given to datasets that include transmission and distribution losses."
[b] Details are provided in Table 2.
[c] The USLCI and seven other publicly accessible or proprietary databases (such as ecoinvent) are recommended.
[d] The USLCI database is listed as the source of national grid data in the United States.
[e] "Electrical energy data shall use US Federal LCA Commons fuel use and power data, or similar data to represent electrical energy production for the United States. Preference shall be given to datasets that include transmission and distribution losses."
[f] There is no specific secondary data requirement from the PCR.
[g] The USLCI database is listed as an example of national databases.

Process-Level Requirements

The Asphalt Mixture and Concrete PCRs provide more specific requirements on the secondary datasets to be used in their annexes/appendices. These PCRs list processes and their required secondary inventories. These inventories are from various data sources including reports published by industry associations, national databases such as the Federal LCA Commons, and proprietary databases such as ecoinvent.[1] The detailed secondary data listed in the Concrete and Asphalt Mixture PCRs are shown in Table 2.

[1] The ecoinvent database is available at https://ecoinvent.org/database/.

Table 2. Process-Level Secondary Data Requirements from PCRs

Category	Source	Process Flow Name	Temporal Scope	PCR Name
Transportation	USLCI database	Transportation by barge, diesel powered	2000	Asphalt Mixtures
Transportation	USLCI database	Transportation by ocean freighter, diesel powered	2000	Asphalt Mixtures
Transportation	USLCI database	Transportation by pipeline, natural gas powered	2002–2008	Asphalt Mixtures
Transportation	USLCI database	Transportation by train, diesel powered	2000	Asphalt Mixtures
Transportation	USLCI database	Transportation by combination truck, diesel powered	2000	Asphalt Mixtures
Transportation	USLCI database	Transportation by combination truck, gasoline powered	2000	Asphalt Mixtures
Transportation	USLCI database	Transportation by refuse truck, diesel powered	2009	Asphalt Mixtures
Transportation	USLCI database	Transportation by refuse truck, gasoline powered	2009	Asphalt Mixtures
Energy	Miller, 2008	Soy biodiesel, production, at plant with combustion emissions data	2008	Asphalt Mixtures
Energy	USLCI database	Anthracite coal, combusted in industrial boiler	1997–2003	Asphalt Mixtures
Energy	USLCI database	Bituminous coal, combusted in industrial boiler	1996–2002	Asphalt Mixtures
Energy	USLCI database	Lignite coal, combusted in industrial boiler	1996–2002	Asphalt Mixtures
Energy	USLCI database	Diesel, combusted in industrial boiler	1997–2000	Asphalt Mixtures
Energy	USLCI database	Natural gas, combusted in industrial boiler	1997–2000	Asphalt Mixtures

Category	Source	Process Flow Name	Temporal Scope	PCR Name
Energy	Mukherjee, 2021[a]	Recycled fuel oil, combusted in industrial boiler	2021	Asphalt Mixtures
Energy	USLCI database	Residual fuel oil, combusted in industrial boiler	1997–2002	Asphalt Mixtures
Energy	USLCI database	Compressed natural gas equipment operation, industry average, >56 kW and <560 kW	2015	Asphalt Mixtures
Energy	USLCI database	Compressed natural gas equipment operation, industry average, >19 kW and <56 kW	2015	Asphalt Mixtures
Energy	USLCI database	Diesel, combusted in industrial equipment	1998	Asphalt Mixtures
Energy	USLCI database	Gasoline, combusted in industrial equipment	1995–2002	Asphalt Mixtures
Energy	USLCI database	Natural gas, combusted in industrial equipment	1998–2002	Asphalt Mixtures
Energy	USLCI database	Liquefied petroleum gas, combusted in industrial boiler	2000	Asphalt Mixtures
Energy	USLCI database	Electricity	Various	Flat Glass
Transportation	USLCI database	Transport, combination truck, long-haul, diesel powered/tkm/RNA	2009	Concrete v2.3
Transportation	USLCI database	Transport, combination truck, short-haul, diesel powered/tkm/RNA	2009	Concrete v2.3
Transportation	USLCI database	Transport, combination truck, short-haul, gasoline powered/tkm/RNA	2009	Concrete v2.3

Category	Source	Process Flow Name	Temporal Scope	PCR Name
Transportation	USLCI database	Transport, single unit truck, long-haul, diesel powered/tkm/RNA	2009	Concrete v2.3
Transportation	USLCI database	Transport, single unit truck, long-haul, gasoline powered/tkm/RNA	2009	Concrete v2.3
Transportation	USLCI database	Transport, single unit truck, short-haul, diesel powered/tkm/RNA	2009	Concrete v2.3
Transportation	USLCI database	Transport, single unit truck, short-haul, gasoline powered/tkm/RNA	2009	Concrete v2.3
Transportation	USLCI database	Transport, train, diesel powered/tkm/U.S.	2000	Concrete v2.3
Transportation	USLCI database	Transport, ocean freighter, average fuel mix/tkm/U.S.	2000	Concrete v2.3
Transportation	USLCI database	Transport, barge, average fuel mix	2000	Concrete v2.3
Transportation	USLCI database	Transport, barge, diesel powered	2000	Concrete v2.3
Energy	USLCI database	Natural gas, combusted in industrial boiler	1997–2000	Concrete v2.3
Energy	USLCI database	Residual fuel oil, combusted in industrial boiler	1997–2000	Concrete v2.3
Energy	USLCI database	Diesel, combusted in industrial equipment	1998	Concrete v2.3
Energy	USLCI database	Gasoline, combusted in industrial equipment	1995–2002	Concrete v2.3
Material	ecoinvent 3.4	Tap water (ROW) market for | Cut off	2012–2021	Concrete v2.3

Category	Source	Process Flow Name	Temporal Scope	PCR Name
Energy	ecoinvent 3.4	Electricity generation (ecoinvent 3.4 processes by region)	2014–2021	Concrete v2.3
Material	Wildnauer et al., 2019[b]	Asphalt binder, no additives, consumption mix, at terminal, from crude oil	2019	Asphalt Mixtures
Material	Wildnauer et al., 2019[b]	Asphalt binder, 0.5% polyphosphoric acid (by weight of asphalt binder), consumption mix, at terminal, from crude oil	2019	Asphalt Mixtures
Material	Wildnauer et al., 2019[b]	Asphalt binder, 3.5% styrene-butadiene-styrene (by weight of asphalt binder), consumption mix, at terminal, from crude oil.	2019	Asphalt Mixtures
Material	Wildnauer et al., 2019[b]	Asphalt binder, 8% ground tire rubber (by weight of asphalt binder), consumption mix, at terminal, from crude oil	2019	Asphalt Mixtures
Material	Marceau et al., 2007	Coarse aggregate from crushed stone	2007	Asphalt Mixtures
Material	Mukherjee, 2021[a]	Crushed stone, sand and gravel	2021	Asphalt Mixtures
Material	USLCI database	Quicklime, at plant	1991–2001	Asphalt Mixtures
Material	EPDs from Portland Cement Association	Portland cement, at plant	2021	Concrete v2.3
Material	EPDs from Slag Cement Association	Slag cement	2020[c]	Concrete v2.3
Process	Mukherjee, 2021[a]	Reclaimed asphalt pavement processing	2021	Asphalt Mixtures
Process	Mukherjee, 2021[a]	Recycled asphalt shingles processing	2021	Asphalt Mixtures

Category	Source	Process Flow Name	Temporal Scope	PCR Name
Waste	EPA Waste Reduction Model version 15; Mukherjee, 2021[a]	Municipal solid waste, landfilling of asphalt concrete	2021 (Mukherjee), 2020 (EPA WARM)	Asphalt Mixtures
Material	EPDs from Portland Cement Association	Portland limestone cement	2021[c]	Concrete v2.3
Material	EPDs from Portland Cement Association	Blended hydraulic cement	2021[c]	Concrete v2.3
Material	ecoinvent 3.4	Gravel, crushed (ROW) | production | Alloc Rec	2011–2021	Concrete v2.3
Material	ecoinvent 3.4	Gravel, round (ROW) | gravel and sand quarry operation | Alloc Rec	1997–2021	Concrete v2.3
Material	ecoinvent 3.4	Expanded clay (ROW) | production | Alloc Rec	1995–2021	Concrete v2.3
Material	EPDs from Slag Cement Association	Ground granulated blast furnace slag cement	2020[c]	Concrete v2.3
Material	EPDs from European Federation of Concrete Admixtures Associations	Chemical admixtures	Various	Concrete v2.3
Material	EPDs from European Federation of Concrete Admixtures Associations	Chemical admixture—plasticizer	2021[c]	Concrete v2.3

Category	Source	Process Flow Name	Temporal Scope	PCR Name
Material	EPDs from European Federation of Concrete Admixtures Associations	Chemical admixture—coloring	Various	Concrete v2.3

[a] Original data from Tables 10, 11, 26, 32, 33, 34, 41 and 42 in Geyer et al., 2013.
[b] Note that these data are available on the Federal LCA Commons (USLCI) as a rolled-up systems process with embedded secondary proprietary data.
[c] The original EPD was updated after the PCR's publication.

Data Gaps in PCRs

The Asphalt Mixtures PCR listed data that are not currently available. This includes data on some types of asphalt (e.g., bio-based asphalt binder and emulsified asphalt), some additives (e.g., binder modifiers), and natural and synthetic fibers such as cellulose and polyester. The PCR's annex will be updated with new data when available to fill existing data gaps. These data gaps are also crosswalked with available public LCI data in the "Comparison to Existing Datasets" section.

PCR Committee Insights

In May 2024, EPA interviewed representatives from various PCR committees of interest. These include:[2]

- Asphalt Binder
- Asphalt Mixtures
- Cement
- Concrete
- Construction Aggregates
- Fenestration Assemblies
- Lightweight Aggregates
- Steel
- Structural and Architectural Wood Products

Key Categories Identified

Most of the PCR committees engaged reported that consistent secondary data would be particularly valuable in a few categories that are nearly universal in LCA modeling. Firstly, in the context of the electricity grid, having consistent data is crucial. This includes guidance on appropriate geographical resolution (such as NERC, EPA eGRID region or Balancing Authority Area), having an accurate consumption mix for that resolution, and having methods to assess the "residual mix" that discounts any renewable energy certificates already claimed within the LCA. Secondly, transportation data are essential for informed decision-making. This includes various classes of vehicles that are not represented in most datasets (e.g., freshwater barges, rail freight) as well as the production and combustion of alternative transportation fuels (e.g., compressed natural gas, renewable diesel, biofuels). Last is the need for data related to primary fuel consumption mixes and combustion for on-site heat or power generation (e.g., propane, CNG, liquified natural gas).

Prescribing Data

While prescribed secondary data cover many aspects, there are areas where it is challenging to use standard data due to unique upstream supply chains. For instance, PCR committees noted that products like specific chemicals, additives and coatings may have unique processes that require targeted data collection efforts. This is the case for industry-specific processes as well, including highly specialized modes of transportation such as overloaded asphalt trucks, internationally flagged asphalt barges, and concrete trucks with power take-off. Additionally, there is some concern that existing federal datasets may be old or inaccurate. (Mentioned by name were freshwater barges, rail freight and concrete.) PCR committees also noted that current public LCI data exchange formats are a barrier to using those data in commonly used commercial LCA software.

[2] EPA may engage with additional PCR committees in subsequent versions of this document.

Secondary data can be systematically assigned through PCRs or exist as inventories embedded within EPD generator tools. The PCR committees acknowledged that the use of prescribed data ensures uniformity across EPDs and sometimes different product categories, allowing for a standardized approach to essential upstream activities for which data may not be accessible to the parties drafting the LCAs and EPDs. Prescribing data simplifies the process by identifying a vetted, reliable inventory that can be readily applied, making it easier for manufacturers to comply with standards and for customers to interpret the environmental implications of their choices. Additionally, some PCR committee members feel that prescribed data facilitate comparative analysis, enabling stakeholders to benchmark products against one another based on their environmental performance, decreasing the variance that would occur if each EPD developer were left to pick and choose secondary datasets based solely on availability or benefits that the data carry through to the results.

However, some committee members stated that using prescribed secondary datasets comes with its own set of challenges. One significant drawback is that such data may be less representative of the actual environmental impact of a product, especially if they do not account for specific manufacturing processes or regional variations. Within the committees, there is a divergence of opinion on the prescriptive approach to secondary datasets. Some view it as beneficial, while others are actively trying to avoid it.

When datasets are assigned or a PCR establishes a data preference hierarchy, PCR committees have used several approaches:

- An annex approach, in which prescribed databases are provided in a separate supporting document.
- Deferring to program operator guidelines that specify appropriate databases.
- Developing a PCR in support of an EPD generator tool that uses specific datasets in the underlying model.

The annex approach used for Concrete and Asphalt Mixtures allows for more frequent updates as new data become available, ensuring that the most representative datasets are used. Some of the annexes EPA reviewed specify a particular version of a dataset while also stating that any newer versions are acceptable. This ensures that users are always working with the latest information without the need for constant updates by the PCR committees.

In some instances, EPA found that the program operator detailed specific datasets and the PCR committee referenced the program operator's documentation. This level of specificity at the program operator level may ensure that EPDs developed under all the PCRs one operator supports are using the same datasets; this may make EPD results more broadly comparable. Specifying the datasets in a centralized document may reduce discrepancies that could arise from EPD developers using different versions or types of data either by happenstance or to improve their relative performance.

In some cases, particularly where an industry trade group is serving a large share of many manufacturers, a PCR is developed in support of a specific EPD generator tool. This is currently the case for both the concrete (and cement) and asphalt industries. While the PCR may be very flexible with regard to the datasets implemented, the generator tools may be updated more often than the PCR, which may be another way to ensure more current, representative data are used. Additionally, manufacturers using the tool may have the opportunity to input more specific data (e.g., upstream

supplier EPDs) if available, allowing some specificity in tools that may otherwise create relatively generic EPDs.

EPA's Approach to Prescribing Secondary Data

While the *U.S. EPA Criteria for Product Category Rules (PCRs) to Support the Label Program for Low Embodied Carbon Construction Materials* do require prescribing secondary data, they prefer specific data (i.e., from upstream EPDs) that are representative of the raw material supply chain to be used where possible. Where specific data are not possible, EPA's PCR Criteria require PCRs to prescribe free-to-use and publicly accessible secondary datasets. Additional plans for improvement in secondary datasets to support prescription of secondary data in PCRs are provided in EPA's *Vision and Plan to Improve Secondary Life Cycle Assessment Data Used in Environmental Product Declarations*.

PCR Committee LCA Experience

PCR committees are pivotal in shaping the standards for EPDs, including the methodologies applied in the supporting LCAs. Industry representatives bring invaluable insights into the manufacturing nuances of their industries. Also important for PCR committees is the inclusion of more LCA-focused professionals to enhance the robustness of PCR development. This is because LCA experts can help ensure that the environmental impacts of products are assessed through well-developed methods. Moreover, program operators, who oversee the PCR process, may not necessarily be LCA specialists. A committee member emphasized that review of PCRs through both a technical competency lens (ensuring conformance with established standards) and a verification lens (validating the accuracy and reliability of the data) is essential. Another stated that well-crafted PCRs avoid redundancy and potential contradictions, presenting clear and unambiguous guidelines that reflect both technical precision and industry-specific expertise.

More information on EPA's recommended PCR reviewer qualifications can be found in Appendix E of the *U.S. EPA's Criteria for Product Category Rules (PCRs) to Support the Label Program for Low Embodied Carbon Construction Materials*.

Data in the Pipeline

This section documents some insights from the PCR committees on industry data currently under development.

The Asphalt Binder PCR is crafted to support an EPD generator tool, which incorporates industry average data from the Asphalt Institute. Collaboration is underway to establish comprehensive secondary data, which are highly specific to asphalt products. Efforts are being made to create a template that will help meet the data quality objectives.

For wood products, the PCR is being renewed by American Wood Council, with input from groups such as CORRIM and the USDA Forest Products Laboratory. The secondary LCI data, which are publicly accessible, are largely planned to be included in the Federal LCA Commons and are specific to North America. The upstream forestry data being developed consider ecological regions and their primary timber species to provide representative data.

The Construction Aggregates PCR is based on an underlying LCA that encompasses data from about 50 locations. The industry trade association played an essential role in accessing producer data, ensuring that the underlying LCA represents various manufacturing pathways. Although that was a significant

data collection effort, it does not equate to an industry average. Future plans include the development of regional averages to provide high-quality regional inventories.

Leveraging the Lightweight Aggregates PCR, the Expanded Shale, Clay, and Slate Institute is producing EPDs for the life cycle of finished products that incorporate their materials. This is because the lightweight aggregates offer advantages during the use phases, such as lighter materials, longer service life and insulating properties, and they noted the need to provide these assessments publicly to support informed decision-making.

The Concrete PCR is on track for a revision release in August. There is an initiative to enhance the modeling of imports.

Lastly, the Steel PCR will use industry average LCI data provided by the American Iron and Steel Institute and potentially other steel organizations.

Notes on Global Considerations by PCR Committees

Generally speaking, the large construction materials industries have complex international supply chains and markets that need to be considered during dataset selection. PCR committees are actively working to address these complexities. The Aggregates PCR Committee has highlighted the necessity for incorporating Canadian electricity mixes to reflect the energy sources used in aggregate production. The Asphalt Binder PCR Committee faces challenges due to the EPA program's U.S.-centric focus, raising concerns about the exclusion of secondary databases, which sit behind paywalls, especially when the quality of the government-supplied data may not be sufficient. The cement EPD generator tool offers both North American and global versions to cater to different modeling needs. The Steel PCR Committee handles imported materials by using World Steel data. Meanwhile, the Wood Products PCR Committee, which is specific to products from North American forests, is coordinating with international forestry associations to address cross-border movement of raw logs. They are also paralleling Canadian efforts to develop regional-resolution data, acknowledging that about 20 percent of lumber consumed in the United States is sourced from Canada.

Identified Data Gaps

Table 3 lists free-to-use and publicly accessible secondary data source gaps identified by the engaged PCR committees.

Table 3. Secondary Data Gaps Identified Through PCR Committee Engagement

	PCR Committees:	Asphalt Binder	Asphalt Mix	Cement[a]	Concrete	Construction Aggregates	Fenestration Assemblies	Lightweight Aggregates	Steel	Wood Products[b]
Raw Materials and Extraction	Aggregates				X					
	Iron ore								X	
	Manganese wear parts					X				
	Hydrated lime		X							
	Steel slag		X							
	Tires					X				
Chemicals and Additives	Chemicals		X							
	Concrete admixtures				X					
	Explosives					X				
	Flocculants					X				
	Ancillary materials							X		
Transportation	Asphalt tankers (international)		X							
	Freight, barge		X							
	Freight, train		X							
	Overloaded asphalt trucks		X							

	PCR Committees:	Asphalt Binder	Asphalt Mix	Cement[a]	Concrete	Construction Aggregates	Fenestration Assemblies	Lightweight Aggregates	Steel	Wood Products[b]
Fuels (Consumption Mixes)	Biofuels				X	X		X		
	CNG		X			X				
	Electric vehicles		X			X				
	Hydrogen		X			X				
	LNG		X			X				
	Propane		X			X				
	Renewable diesel		X			X				
	Recycled fuels							X		
Building Materials	Glazing/novel coatings						X			
	Vinyl window framing						X			
	Window hardware						X			
Energy and Resources	Crude oil extraction	X								
	Electricity mixes		X				X		X	
	REC methods		X						X	
Packaging	Cardboards						X			
	Plastics (more options)						X			

[a] Did not note gaps. PCR is not prescriptive, but data embedded in the global cement EPD generator tool rely heavily on ecoinvent and some USLCI transport.
[b] Did not note gaps. Primary data were created with CORRIM and Forest Products Laboratory and made public; transport and process fuels are modeled using USLCI.

Comparison to Existing Datasets

The data gaps provided in the PCRs and provided by the stakeholders from the committee engagement were mapped to processes on the Federal LCA Commons (as of May 2024) and Argonne National Laboratory's GREET model (v. 2023rev1).[3] The mapping results show that:

- Some of the data gaps (e.g., for sulfur and polyethylene) can be filled with data from the Federal LCA Commons.
- Some processes can be mapped to similar processes. For example, stakeholders mentioned CNG trucks as a data gap; in the Federal LCA Commons, the "Operation of Compressed Natural Gas Equipment" processes could be used as a proxy to fill this data gap.
- Data to fill a few gaps are not available at the Federal LCA Commons but can be found in the GREET model. Examples include ammonium nitrate and bio-based oils.

The full results of the crosswalk are provided in Table 4. This table may be updated in future versions of this document as additional data sources are reviewed.

Note that GREET also reports a limited set of elementary flows: primarily greenhouse gases, criteria air pollutants and water usage. GREET is useful for the priority GHG indicator, but does not address eutrophication and ozone depletion potential required in Table 5 of ISO 21930:2017.

[3] Argonne National Laboratory's GREET model is available at https://greet.anl.gov/.

Table 4. Data Gap Crosswalk to Free-to-Use and Publicly Accessible Secondary Data Sources

Material Name	Source[a]	Federal LCA Commons Processes	Federal LCA Commons Repository	GREET Processes
Bio-based asphalt binder	PCR	NA	NA	NA
Emulsified asphalt	PCR	NA	NA	NA
Cutback asphalt	PCR	NA	NA	NA
Liquid antistrips	PCR	NA	NA	NA
Amidoamines	PCR	NA	NA	NA
Imidazolines	PCR	NA	NA	NA
Organo-silanes	PCR	NA	NA	NA
Polyamines	PCR	NA	NA	NA
Biopolymers	PCR	Polylactide (PLA), biopolymer resin, at plant	USLCI	NA
Natural rubber	PCR	NA	NA	NA
Polychloroprene latex	PCR	NA	NA	NA
Reactive ethylene terpolymers	PCR	NA	NA	NA

Material Name	Source[a]	Federal LCA Commons Processes	Federal LCA Commons Repository	GREET Processes
Bio-based oils	PCR	NA	NA	Production of bio-based palm-based fatty alcohol
Lignin	PCR	NA	NA	NA
Petroleum oils	PCR	NA	NA	NA
Re-refined engine oil bottom (REOB), a.k.a. vacuum tower asphalt extender (VTAE)	PCR	NA	NA	NA
Sulfur	PCR	Sulfur, at plant	USLCI	Sulfur for cobalt production
Gilsonite	PCR	NA	NA	NA
Trinidad Lake asphalt	PCR	NA	NA	NA
Biochar	PCR	NA	NA	• Biochar to soil (40 miles) • Biochar to soil (80 miles) • Charcoal production from wood
Ethylene acrylate copolymer	PCR	NA	NA	NA
Ethylene propylene copolymers (EPM)	PCR	NA	NA	NA
Ethylene propylene diene (EPDM)	PCR	NA	NA	NA

Material Name	Source[a]	Federal LCA Commons Processes	Federal LCA Commons Repository	GREET Processes
Ethylene-vinyl acetate (EVA)	PCR	NA	NA	NA
Polyethylene	PCR	• Polyethylene, high-density (HDPE), virgin resin, at plant • Polyethylene, low-density (LDPE), virgin resin, at plant • Recycled postconsumer HDPE, pellet	USLCI	• LDPE resin production • HDPE resin production
Polyolefins	PCR	• Polypropylene (PP), virgin resin, at plant • HDPE, virgin resin, at plant • LDPE, virgin resin, at plant • Recycled postconsumer HDPE, pellet	USLCI	• LDPE resin production • HDPE resin production • PP resin production
Polypropylene	PCR	Polypropylene, PP, virgin resin, at plant	USLCI	PP resin production
Recycled plastics	PCR	• Recycled postconsumer polyethylene terephthalate (PET), pellet • Recycled postconsumer PET, flake • Recycled postconsumer HDPE, pellet	USLCI	• Production of recycled PET via enzymatic hydrolysis • Production of recycled PET via mechanical extrusion

Material Name	Source[a]	Federal LCA Commons Processes	Federal LCA Commons Repository	GREET Processes
Aromatic extracts	PCR	NA	NA	NA
Paraffinic oils	PCR	NA	NA	NA
Tall-oil-based products	PCR	NA	NA	NA
Vegetable-oil-based products	PCR	NA	NA	NA
Cellulose fibers	PCR	Cellulosic fiberboard, uncoated, at plant	USLCI	NA
Mineral wool	PCR	NA	NA	NA
Rock wool	PCR	NA	NA	NA
Aramid fibers	PCR	NA	NA	Aromatic polyamide
Fiberglass	PCR	NA	NA	Glass fiber reinforced plastic production mix
Polyester fibers	PCR	NA	NA	NA
Polypropylene fibers	PCR	NA	NA	NA
Iron oxide pigment	PCR	NA	NA	NA
Titanium dioxide pigment	PCR	NA	NA	NA

Material Name	Source[a]	Federal LCA Commons Processes	Federal LCA Commons Repository	GREET Processes
Recycled plastic, dry method	PCR	NA	NA	• Production of recycled PET via enzymatic hydrolysis • Production of recycled PET via mechanical extrusion
Amine surfactants, emulsifiers and other chemical additives	PCR	NA	NA	NA
Waxes and fatty acid amides	PCR	Slack wax, at plant, U.S. Southeast	USLCI	Palm fatty acid distillate
Zeolites (aluminosilicates)	PCR	NA	NA	NA
Hybrid chemical/water-based technologies	PCR	NA	NA	NA
Slag aggregate	PCR	NA	NA	NA
Chemical admixtures	PCR2	NA	NA	NA
Iron ore	Com	NA	NA	Iron ore production
Plastics	Com	Various plastic processes are available	USLCI	Various plastic processes are available
Cardboards	Com	Containerboard, average production, at mill	USLCI	NA

Material Name	Source[a]	Federal LCA Commons Processes	Federal LCA Commons Repository	GREET Processes
Packaging	Com			Plastic packaging production—pathway
Explosives for aggregate mining	Com	NA	NA	Ammonium nitrate production
Overloaded asphalt trucks (MI policy)	Com	NA	NA	NA
Concrete admixtures	Com	• Portland cement concrete; Maschmeyer concrete • Portland cement concrete; CalPortland • Portland cement concrete; Argos Ready Mix, South Central • Portland cement concrete; National Ready Mixed Concrete Association industry average • Portland cement concrete; Concrete Supply Company • Portland cement concrete; Advance Ready Mix	Michigan Technological University Asphalt Pavement Framework	• Concrete production • Reinforced concrete

Material Name	Source[a]	Federal LCA Commons Processes	Federal LCA Commons Repository	GREET Processes
Freight transport (ocean)	Com	• Transport, ocean freighter, residual fuel oil powered • Transport, ocean freighter, diesel powered • Transport, ocean freighter, average fuel mix	USLCI	NA
Asphalt tankers (internationally flagged ships)	Com	• Transport, ocean freighter, residual fuel oil powered • Transport, ocean freighter, diesel powered • Transport, ocean freighter, average fuel mix	USLCI	NA
Consumption mix for process fuels: CNG, propane, LNG	Com	• Natural gas, combusted in industrial boiler • Natural gas, combusted in industrial equipment • Natural gas, processed, for energy use, at plant • LPG, combusted in industrial boiler, at pulp and paper mill • Dispensing of CNG, at pump	USLCI	• CNG from flared gas • CNG from non–North American LNG • CNG from North American natural gas • Mix: natural gas and flare gas (transportation) • LNG (as a transportation fuel) from non–North American natural gas • LNG (as a transportation fuel) from North American natural gas • LNG (as a transportation fuel) from flared gas • Mix: natural gas and flared gas (intermediate) • LNG (as an intermediate fuel) from flared gas • LNG (as an intermediate fuel) from non–North American natural gas • Propane from crude oil

Material Name	Source[a]	Federal LCA Commons Processes	Federal LCA Commons Repository	GREET Processes
Vinyl framing on windows	Com	Polyvinyl chloride (PVC), virgin resin; at plant	USLCI	Mix: final PVC product, combined
Glazing/novel materials on windows	Com	NA	NA	NA
Window hardware	Com	NA	NA	NA
Flocculants	Com	NA	NA	NA
Ammonium nitrate	Com	NA	NA	Ammonium nitrate production
Manganese wear parts	Com	NA	NA	NA
Tires	Com	NA	NA	• Medium-/heavy-duty vehicle (MHDV): drive tire replacement—pathway • MHDV: steer tire replacement—pathway • MHDV: trailer tire replacement—pathway • Vehicle tire replacement
Steel slag	Com	NA	NA	NA
Crude oil extraction for asphalt	Com	• Crude oil, extracted • Crude oil, at production	USLCI	Asphalt from crude oil for use in U.S. refineries
REC accounting methods	Com	NA	NA	NA
Quicklime	Com	Quicklime, at plant	USLCI	NA

Material Name	Source[a]	Federal LCA Commons Processes	Federal LCA Commons Repository	GREET Processes
CNG trucks	Com	• Operation of CNG equipment; industry average; >56 kW and <560 kW • Operation of CNG equipment; industry average; >19kW and <56 kW • Dispensing of CNG, at pump	Heavy equipment operation; Michigan Technological University Asphalt Pavement Framework	NA
Renewable diesel for transportation	Com	Soy biodiesel, production, at plant	USLCI	• Renewable diesel I from soybeans • Algae hydrothermal liquefaction (HTL) for renewable diesel (supply chain sustainability analysis [SCSA]) • Biochemical conversion of sugars to hydrocarbons (via 1,4-butanediol [BDO])—mass-based process allocation • Combined algae processing (CAP) for renewable diesel (SCSA) • Palm fatty acid distillate to renewable diesel II • Renewable diesel from sludge hydrothermal liquefaction with ammonia removal • Renewable diesel from sludge hydrothermal liquefaction with ammonia removal • Renewable diesel from sludge hydrothermal liquefaction with ammonia removal • Renewable diesel from sludge hydrothermal liquefaction with ammonia removal • Renewable diesel from sludge hydrothermal liquefaction without ammonia removal

Material Name	Source[a]	Federal LCA Commons Processes	Federal LCA Commons Repository	GREET Processes
				• Renewable diesel from sludge hydrothermal liquefaction without ammonia removal • Renewable diesel from sludge hydrothermal liquefaction without ammonia removal (2021 SOT) • Renewable diesel from sludge hydrothermal liquefaction without ammonia removal (2022 design) • Renewable diesel from swine manure HTL • Renewable diesel II (marine) from yellow grease • Renewable diesel II (marine) from yellow grease and heavy fuel oil • Renewable diesel II from algae lumped model • Renewable diesel II from corn stover • Renewable diesel II from forest residue via pyrolysis—distributed conventional petroleum refinery (ad hoc) • Renewable diesel II from forest residue via pyrolysis—distributed standalone bio-refinery (ad hoc) • Renewable diesel II from soybeans • Renewable diesel II from used cooking oil • Saline algal biomass HTL pathway with high-protein coproducts • Yellow grease to hydroprocessed esters and fatty acids • Algae HTL for renewable diesel III • CAP for renewable diesel III • Renewable diesel blendstock from integrated biorefineries with co-produced adipic acid • Renewable diesel blendstock from integrated biorefineries with co-produced succinic acid

Material Name	Source[a]	Federal LCA Commons Processes	Federal LCA Commons Repository	GREET Processes
				• Renewable diesel blendstock from standalone integrated biorefineries
Biofuels for transportation	Com	• Ethanol, denatured, corn stover, biochemical • Ethanol, denatured, switchgrass, biochemical • Ethanol, denatured, wheat straw, biochemical • Soy biodiesel, production, at plant	USLCI	• Corn production for biofuel refinery • Corn production for biofuel refinery (animal manure land management) • Corn production for biofuel refinery (rye cover crop land management)
Hydrogen (as a fuel)	Com	Hydrogen, liquid, synthesis gas, at plant	USLCI	• Hydrogen production from proton exchange membrane (PEM) electrolysis—solar (or wind) • Hydrogen production from proton exchange membrane (PEM) electrolysis (hydro) • Hydrogen 2 production from proton exchange membrane (PEM) electrolysis (nuclear light-water reactor) • Hydrogen production from biomass • Hydrogen production from chlorine plants • Hydrogen production from coal • Hydrogen production from coke oven gas • Hydrogen production from dark fermentation and microbial electrolysis cell (energy/hydrogen recovery) • Hydrogen production from electrolysis (high-temperature gas-cooled reactor) • Hydrogen production from high-temperature electrolysis with solid oxide electrolyzer cell

Material Name	Source[a]	Federal LCA Commons Processes	Federal LCA Commons Repository	GREET Processes
				• Hydrogen production from North America natural gas (explicit) • Hydrogen production from natural gas • Hydrogen production from natural gas liquids (NGL) cracker plants • Hydrogen production from nuclear energy (thermo-chemical cracking of water) • Hydrogen production from renewable natural gas

[a] Sources: PCR = PCR of asphalt mixture; PCR2 = PCR of concrete v2.3; Com = PCR committee inputs
NA = not applicable

Recommendations for Prioritizing Datasets to Develop to Fill Gaps

Priority should be given to maintaining and developing higher-quality secondary datasets for processes already recommended in PCRs, listed in PCRs as data gaps, and listed by PCR committees as data gaps (see Table 1 through Table 3). This includes developing new datasets for processes that PCRs list based on a proprietary data source (e.g., ecoinvent). Additionally, the cement EPD generator prescribes industry average LCI, including using ecoinvent global data as the secondary LCI data source. Key EPD generator tools should be further investigated to continue to identify and fill data gaps.

Table 5, below, lists the highest-priority secondary LCI data that need to be maintained/developed across construction material supply chains in the near term, based on the outcomes of this data gap assessment. Lower priority can be given to datasets that are not upstream (A1–A3). Waste management processes are also important to address with public data.

EPA and federal partners are actively working to fill these data gaps, as described further in *EPA's Vision and Plan to Improve Secondary Life Cycle Assessment Data Used in Environmental Product Declarations*.

Table 5. Recommendations for Prioritizing Secondary Data Gaps

Priority Level (1 = Highest Priority)	Process Category	Recommendations Based on Existing PCRs and PCR Committee Engagement
1	Electricity	Electricity was the most acknowledged/requested key dataset needed across supply chains. The current electricity baseline on the Federal LCA Commons (2016) needs to be updated given grid decarbonization. The electricity baseline uses consumption mixes, which PCR committees noted are critical to continue to support. Consistent feedback included the need for the electricity baseline to supply residual mixes. Different geographic levels of resolution were noted as important, including a version at the EPA eGRID level (Hottle and Ghosh, 2021), which does not currently exist on the Federal LCA Commons.

Priority Level (1 = Highest Priority)	Process Category	Recommendations Based on Existing PCRs and PCR Committee Engagement
2	Transport and equipment operation	The USLCI is commonly cited for transport data, but several PCR committees noted that the data are outdated.[4] The data should be updated and additional processes added, especially for freight transport. The lack of data for water transport methods was a theme across PCR committee engagement. There is also a need to provide data on electric vehicles and vehicles using other types of fuels (see "Fuels and energy resources" below). EPA's Heavy Equipment Operation repository provides operational information for equipment relevant to construction supply chains, but there is a need for more diversity in the options provided for construction equipment.
2	Fuels and energy resources	Production and combustion of alternative transportation fuels (e.g., CNG, renewable diesel, biofuels) was indicated as an important data need. The need for data related to primary fuel consumption mixes and combustion for on-site heat or power generation (e.g., propane, CNG, LNG) was also identified. A need for more varieties of crude oil assays and development of petroleum refinery datasets more specific to asphalt was also identified. GREET was recognized as a potential source for renewable fuel data, but it lacks consumption mix information and does not cover all indicators in Table 5 of ISO 21930:2017.
3	Raw materials	Key raw materials for construction supply chains are important inputs in the system boundary and play a major part of the final impacts in many products. These materials include iron ore, slag aggregate and hydrated lime. Some of these processes, such as iron ore, are not available on the Federal LCA Commons; others need to be updated.
4	Chemicals and additives	Chemicals and additives account for many of the data gaps identified. These products are very diverse and can vary by material supply chain. For example, in the Asphalt Mixtures PCR, data gaps include specific types of fibers, plastics, mineral fillers and other materials. Priority should be given to processes that contribute to larger impacts, which can be measured based on the quantity of the process used and the impact categories included.

[4] Based on this feedback, non-road transport datasets in the USLCI 2024 summer quarter release were updated.

Priority Level (1 = Highest Priority)	Process Category	Recommendations Based on Existing PCRs and PCR Committee Engagement
4	End-of-life processes	End-of-life processes can include the impacts from recycling or reuse, incineration, landfilling, and others. There is an increasing need to understand how to allocate the end-of-life impacts when module D is involved. There are product-level processes in the Construction and Demolition Debris Management database on the Federal LCA Commons. These processes cover construction materials such as wood, PVC and bricks, and include several end-of-life methods, such as landfilling, reuse and recycling. Priority should be given to updating end-of-life pathways relevant for priority construction materials such as steel.
5	Water treatment	Impacts from water treatment can vary significantly between products. Currently there are no product-specific water treatment processes on the Federal LCA Commons. One PCR (Concrete) requires that a tap water process in ecoinvent be used for water, possibly due to the lack of such a process in publicly accessible databases. U.S. average drinking and wastewater treatment datasets should be developed for the Federal LCA Commons. However, water treatment typically has a low GHG impact (e.g., compared to processes that directly combust fossil fuels), so these are a lower priority.
6	Other	PCRs and PCR committees have identified other processes as data gaps. These are generally related to packaging, such as cardboard (note that the USLCI, on the Federal LCA Commons, has cardboard/corrugated data); the maintenance of vehicles, such as petroleum oil and tires; and additional components, such as window hardware. Lower priority should be given to these processes due to their specialized use. Data development should prioritize secondary (secondary) dataset needs at this time, given the existence of significant data gaps for common processes and materials.

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Terminology

Downstream process: A process that is carried out after the designated process associated with the given PCR. This definition is based on the one in ISO 21930:2017.

End-of-life: The end-of-life stage for a construction material starts when it is replaced, dismantled, or deconstructed from the construction works and does not provide any further functionality. The end-of-life LCA stage includes information modules C1 to C4. This definition is based on the one outlined in ISO 21930:2017.

Environmental product declaration (EPD): An environmental claim providing quantified environmental data using predetermined parameters and, where relevant, additional environmental information. An EPD also includes additional product and company information. This definition is consistent with the one in ISO 14025:2006.

Life cycle assessment (LCA): Refers to the compilation and evaluation of the inputs, outputs, and the potential environmental impacts of a product system throughout its life cycle. This definition is consistent with the one in ISO 14044:2006.

Life cycle inventory (LCI): Phase of life cycle assessment involving the compilation and qualification of inputs and outputs for a product throughout its life cycle. This definition is consistent with the one in ISO 14044:2006.

Product category rules (PCRs): Refers to a set of specific rules, requirements, and guidelines for developing EPDs for one or more product categories. This definition is consistent with the one in ISO 14025:2006.

Product category rule committee (PCR committee): Group of interested parties tasked by the program operator with drafting and finalizing the product category rules. This definition is consistent with the one in ISO/TS 14027:2017.

Program operator: The body or bodies that conduct an EPD program. A program operator can be a company or group of companies, industrial sector or trade association, public authority or agency, or an independent scientific body or other organization. Program operators are typically the organizations that develop PCRs. This definition is based on the one in ISO 14025:2006.

Secondary data: Data indirectly determined through measurement, estimation, or calculation and not based on specific original source measurements. This can include data that is originally developed using primary data sources, but is further aggregated to represent average processes or products. This definition is based on the one in ISO 21930:2017.

Upstream process: A process that is carried out before the designated process associated with the given PCR. This definition is based on the one in ISO 21930:2017.

List of Abbreviations

BDO	1,4-butanediol
CAP	combined algae processing
CNG	compressed natural gas
eGRID	Emissions and Generation Resource Integrated Database
EPA	U.S. Environmental Protection Agency
EPD	environmental product declaration
EVA	ethylene-vinyl acetate
GHG	greenhouse gas
GLO	global
g/cm^3	grams per cubic centimeter
g/mol	grams per mole
GREET	Greenhouse gases, Regulated Emissions, and Energy use in Technologies
HDPE	high-density polyethylene
HTL	hydrothermal liquefaction
ISO	International Organization for Standardization
LCA	life cycle assessment
LCI	life cycle inventory
LDPE	low-density polyethylene
LNG	liquefied natural gas
mg/mL	milligrams per milliliter
MHDV	medium-/heavy-duty vehicle
MJ/kg	megajoules per kilogram
NAPA	National Asphalt Pavement Association
NERC	North American Electric Reliability Corporation
NREL	National Renewable Energy Laboratory
NSF	National Sanitation Foundation
PCR	product category rule
PET	polyethylene terephthalate
PP	polypropylene
PVC	polyvinyl chloride

REC	renewable energy certificate
RNA	North America
ROW	rest of world
SCSA	supply chain sustainability analysis
tkm	tonne-kilometer
USLCI	U.S. Life Cycle Inventory
W/m^2K	watts per square meter per kelvin