# TECH BRIEF: ENVIRONMENTAL PRODUCT DECLARATIONS

## Communicating Environmental Impact for Transportation Products

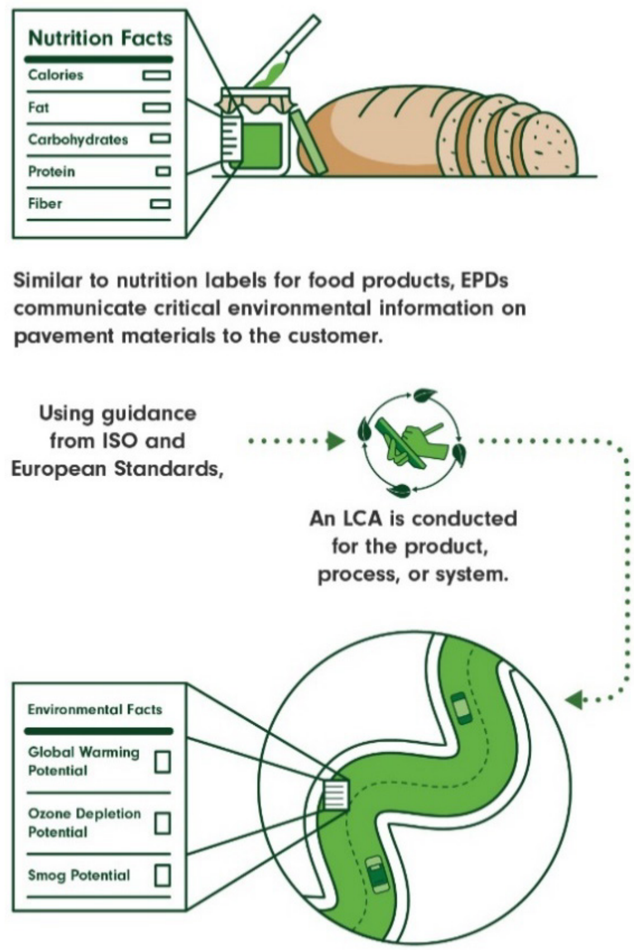
## What Is This Document's Purpose?

Environmental Product Declarations (EPDs) are developed by the producers of construction materials as tools that communicate the environmental impacts of material production. In recent years, State Departments of Transportation (DOTs), as well as other State and local government agencies, have expressed interest in using EPDs. This document is an expanded version of an affiliated document (*Environmental Product Declarations*, FHWA-HIF-19-027-c) and it summarizes the information on to-date developments in the domain of EPDs for pavement materials as well as their potential implementation. The purpose of this document is educational.

## What Are EPDs?

An EPD is a transparent, verified report of the environmental impacts of product manufacturing. Also known as Type III Environmental Declarations, EPDs are product labels developed by industry in accordance with the International Organization for Standardization (ISO) Standard 14025 (ISO 2006). They are developed using life-cycle assessment (LCA) procedures and following the industry consensus methodology described in the governing Product Category Rules (PCR) document. As specified in ISO 14025, EPDs undergo third-party verification before being published. EPD concepts are illustrated in figure 1.

In the domain of pavements, EPDs are being developed for such construction materials as cement, aggregates, asphalt mixtures, concrete mixtures, and steel reinforcement. EPDs and PCRs are not required by Federal statute or regulation.




Source: FHWA

**Figure 1. EPD concepts.**

### What are the Goals of EPD production?

Based on ISO 14025[1], EPDs are produced with the following objectives:

- Provide verifiable and transparent environmental impacts information for materials or products based on LCA,
- Help purchasers to make more informed decisions.

[1] International Organization for Standards (ISO) is a non-government organization involved in creation of a suite of internationally-recognized sustainability standards. These standards are not included in the Federal requirements.

- Encourage industry efficiency and environmental improvement.
- Support the supply and demand of products that produce less stress on environment.
- Provide data for assessment of the products over their full life cycle.

### *How do material manufacturers use EPDs?*

In the United States, EPD programs have been developed mainly as a manufacturer initiative. Material manufacturers are using EPDs mainly as **communication tools**. Motivations for developing EPDs include:

- Marketing purposes.
- Demonstrating environmental stewardship.
- Satisfying customers' requirements (where applicable).
- Internal production improvement.
- Earning environmental credits in green rating systems such as LEED v4 (for building products).

## What are the current EPD programs for construction materials?

In the U.S., several organizations initiated EPD programs for construction materials, as listed in the following table.

| Material | Source |
|---|---|
| **Blended Cement** | ASTM<br>Slag Cement Association |
| **Portland Cement** | Portland Cement Association / ASTM |
| **Steel** | Concrete Reinforcing Steel Institute |
| **Hot Mix Asphalt** | National Asphalt Pavement Association |
| **Concrete** | National Ready Mixed Concrete Association |
| **Aggregates** | ASTM |

**Table 1. Example of a hypothetical EPD for an asphalt mix design** (courtesy of National Asphalt Pavement Association).[2]

| TRACI Impact Indicator | Unit | Materials | Transport | Production |
|---|---|---|---|---|
| **Global Warming Potential** | kg $CO_2$-Equiv. | 83.4 | 11.8 | 168 |
| **Ozone Depletion** | kg CFC-11-Equiv. | 1.81e-08 | 5e-10 | 8.55e-11 |
| **Acidification** | kg $SO_2$-Equiv. | 0.486 | 0.0577 | 1.08 |
| **Eutrophication** | kg N-Equiv. | 0.0263 | 0.00373 | 0.0207 |
| **Smog Air** | kg $O_3$-Equiv. | 8.23 | 1.81 | 13.3 |

Note: Impacts for Test Mix 1, a dense-graded Superpave asphalt mixture, categorized as a hot-mix asphalt mixture, produced within a temperature range of 100 to 250°F.

Because of the increased interest in EPDs, producers of other supporting constituents also may start developing programs.

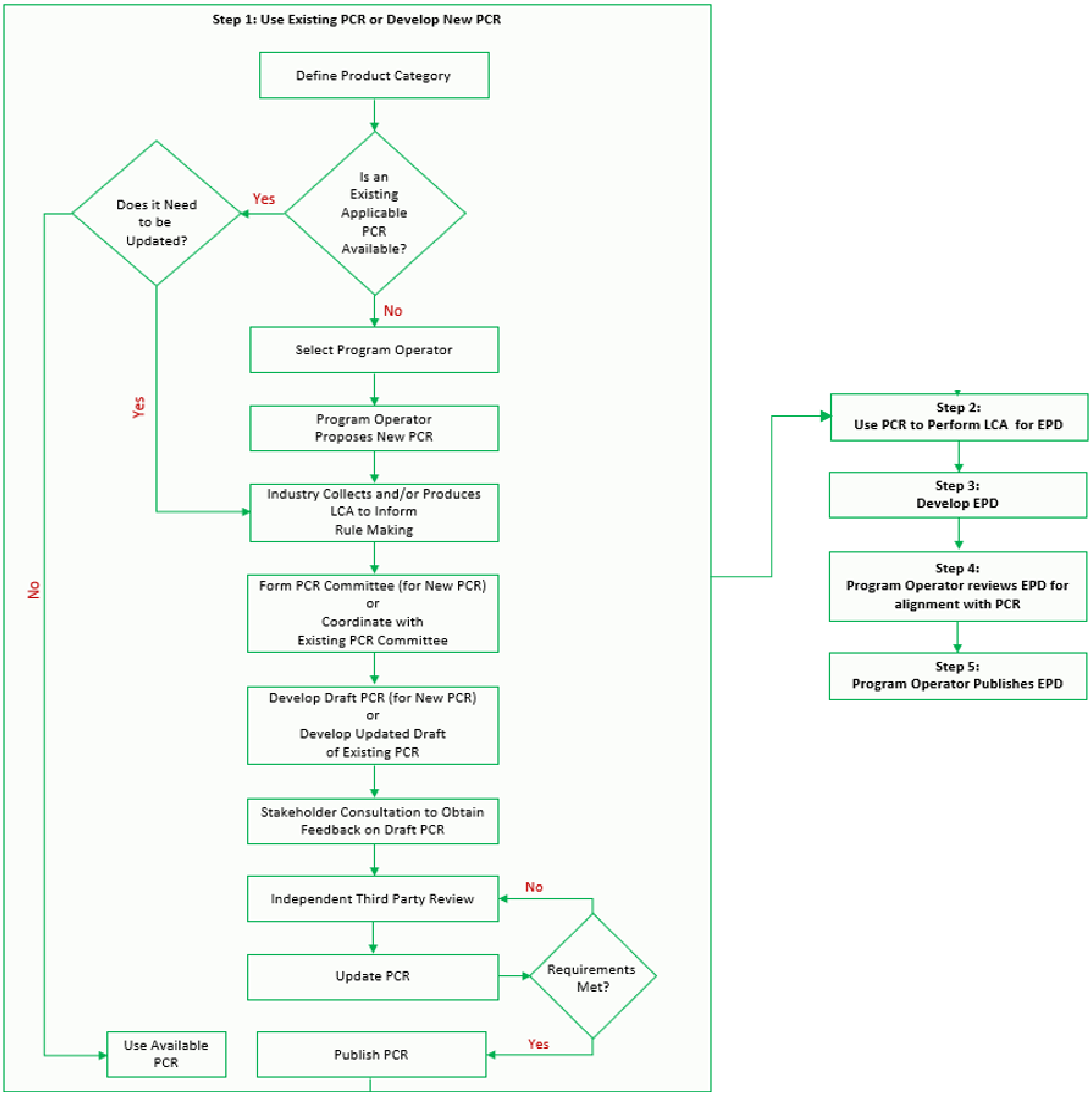
## How Are EPDs Produced?

The production of an EPD follows four basic steps defined by the ISO 14025[1] standard and shown in figure 2.

### *Step 1: Developing the PCR*

PCRs define the details of the LCA procedure that underlies the EPDs. PCRs are developed by a committee of stakeholders convened by a ***Program Operator***, which can be a company or a group of companies, industry sector, or a trade association. In the United States, most program operators are the accredited certification bodies or industry organizations for a given product (e.g., National Ready Mix Concrete Association, National Asphalt Pavement Association). Many stakeholders are involved at various stages of this process, including involvement in the PCR committee, submission of the comments, and third-party review. This can include:

[2] An example of a concrete EPD can be found in the affiliated document *Environmental Product Declarations*, FHWA-HIF-19-027-c.




Source: FHWA

**Figure 2. Steps in the development of EPDs.**

- Industry stakeholders.
- Related industries.
- LCA practitioners.
- Subject matter experts, often from academia.
- Government agencies.
- Non-governmental organizations.
- Customers.

A third-party independent review panel, typically with at least three members and including both LCA experts and subject matter experts, reviews the PCR for logic and compliance with ISO 14025.

The PCR describes these methodological components relevant to the EPD:

- **Product** function, technical performance, and use.
- **Goal and scope**, including the functional and declared unit for a product, system boundaries, description of data, completeness criteria for inclusion of inputs and outputs, and data quality reporting.
- **Data aspects**, such as methods of data collection, calculation procedures, and allocation of material and energy flows and releases.
- **Environmental impacts** featuring the category selection and impact calculation rules.
- **Reporting**, including the method for presenting and formatting the results.

### *Step 2: Developing the LCA for the EPD*

To produce an EPD, an LCA is developed based on the PCR for the product or group of products. The manufacturer collects the relevant production parameters (e.g., fuel use, electricity consumption, raw material sources) to be used as LCA inputs. These parameters are known as foreground data. The parameters that the manufacturer does not have control over (e.g., electricity at grid) are typically modeled using LCA databases. These parameters are known as background data. More information on different data types can be found in a companion FHWA Tech Brief (Meijer and Harvey 2020). If the types of foreground data to be collected as well as the background data sources are prescribed in the PCR, the resulting EPDs have the potential for higher comparability and consistency (see section on *Use of EPDs in bidding to ensure environmental improvements*).

The LCA for EPDs can be done with the assistance of an LCA consultant. Alternatively, manufacturers can use software tools to streamline the EPD production. Software tools, which can facilitate and reduce costs of EPD development, can be developed by manufacturers or Program Operators. Tools can also include various calculation checks, which can facilitate EPD verification.

### *Step 3: Developing the EPD*

The third step is to use the developed LCA and report its results in the format defined in the PCR. The PCR is also followed for any additional environmental information, the inclusion of materials and substances to be declared, and a period of validity. As of now, EPDs are mainly static documents. However, PCRs and EPDs can be integrated with other software tools, design tools, and databases. This can enable automation, facilitate implementation, and inform decision-making (Ingwersen et al. 2013). Using EPDs as dynamic documents can aid the use of EPDs as a data source (see section on *EPDs as a data source for pavement LCA*).

### *Step 4: Verification and publishing*

A neutral third party or the Program Operator verifies the compliance of the EPD to the PCR. While ISO 14025 has defined specific requirements for the PCR review and EPD verification, ISO itself does not review the credentials of critical reviewers or enforce any standards. The Program Operator will issue the EPD after the successful completion of the review process. The name of the verifier and the validity period are specified on the final EPD. These processes are not governed by Federal statute or regulation.

PCRs commonly are valid for up to 5 years. The validity period of the EPD is defined in the PCR. Some PCRs specify that EPDs also have a 5-year validity period (e.g., NSF International 2019). When the updated PCR is issued, there is a chance that EPDs produced under different PCR versions are valid concurrently, which may preclude any comparisons. Other PCRs resolve this issue by limiting the validity period of EPDs until the expiration of the PCR (e.g., NAPA 2017).

## How Do EPDs Differ?

EPDs can differ in scope, primarily in the life-cycle phases that are characterized. Additionally, EPDs can differ in terms of product specificity.

### *Scope of an EPD*

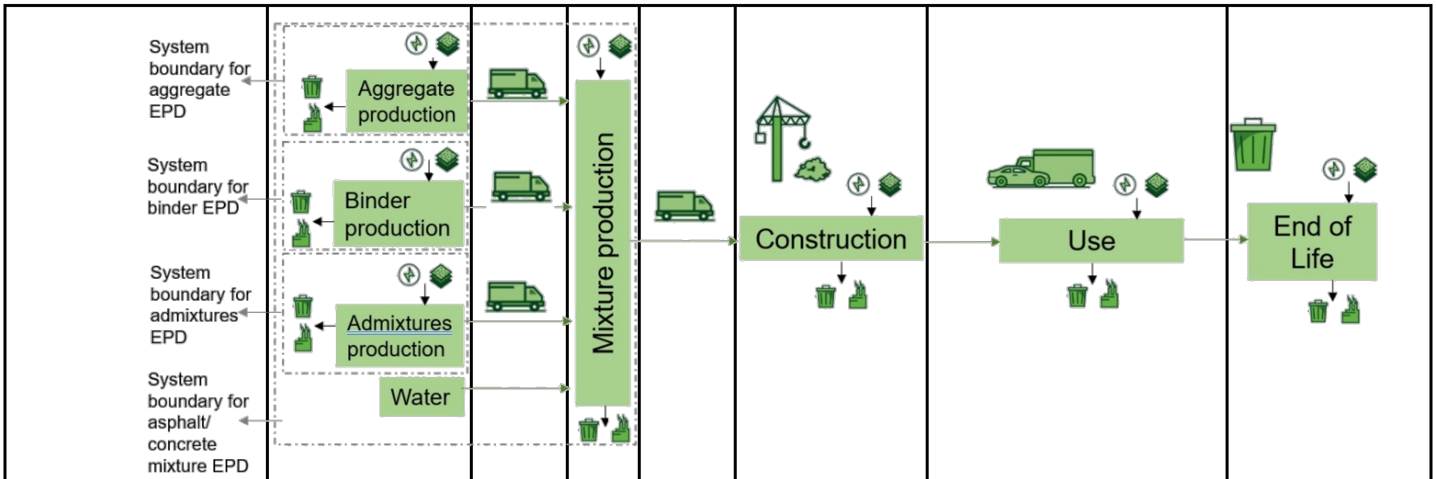
Based on the included life-cycle phases, EPDs can be differentiated in terms of representing the following aspects:

- **Cradle-to-Gate**: Includes the impacts calculated from initial material production (e.g., oil exploration and extraction, mining of rock) up to the gate of the manufacturing site (EN 15804 modules A1-A3 in table 2) (EN 2012). This type of EPD is most applicable in design-bid-build (DBB) projects.
- **Cradle-to-Site**: Includes the impacts of cradle-to-gate plus the transportation to the paving site, and the construction operation of paving (EN 15804 modules A1-A5 in table 2) (EN 2012). This type of EPD is most applicable in design-build (DB) projects.
- **Cradle-to-Grave**: Includes the impacts of cradle-to-site, plus the use stage processes (e.g., vehicle operation, stormwater, noise) and maintenance and rehabilitation just before the first reconstruction (EN 15804 modules A1-A5, B1-B7, and C1-C4 in table 2) (EN 2012). This type of EPD is most applicable in design-build-maintain (DBM) projects.

Because the cradle-to-gate part of the life cycle is controlled by the material producer and DBB projects are the most common, it is expected that EPDs for cradle-to-gate will be by far the most prevalent EPD type. Additionally, current PCR programs in the U.S. are set up for cradle-to-gate EPDs. Therefore, the manufacturers can quantify the environmental parameters of their production in the form of cradle-to-gate EPDs and make them available to other practitioners who have more information on the use of the product and subsequent life-cycle stages.

In the case of infrastructure projects, the stakeholders that utilize the construction materials are the state departments of transportation (DOTs) and contractors performing construction (see table 2). Accordingly, their input is helpful in accounting for the life-cycle phases beyond production.

**Table 2. Life-cycle stages included in EPDs or pavement LCA with different scope, based on EN 15804 (EN 2012). Note: “X” indicates life-cycle stages included.**




| Modules | | A1: Raw material supply | A2: Transport | A3: Mixture production | A4: Transport | A5: Construction | B1: Use<br>B2: Maintenance<br>B3: Repair<br>B4: Replacement<br>B5: Refurbishment<br>B6: Operational energy use<br>B7: Operational water use | C1: Demolition<br>C2: Transport<br>C3: Wastage processing<br>C4: Disposal |
|---|---|---|---|---|---|---|---|---|
| Key stakeholder/data owner | | Material manufacturers | | | State agencies and contractors | | | |
| Scope | Cradle-to-gate EPD of materials (DBB) | X | X | X | - | - | - | - |
| | Cradle-to-built EPD or LCA of pavement (DB) | X | X | X | X | X | - | - |
| | Cradle-to-grave EPD or LCA of pavement (DBM) | X | X | X | X | X | X | X |

- n/a

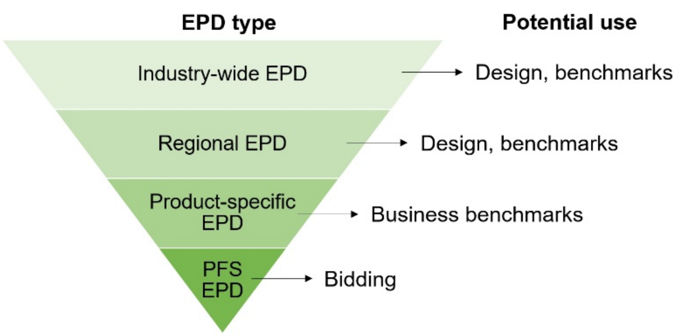
Source: FHWA

## Specificity

EPDs typically report product-specific environmental impacts. Some PCRs also provide instructions on how to perform averaging and develop a more general EPD.

- **Product- and facility-specific EPD.** This EPD type reports the environmental profile of a specific product (e.g., a specific asphalt mixture produced at a specific facility) and typically has the highest resolution. Each facility (e.g., asphalt plant or concrete plant) typically produces multiple types of products and can therefore develop multiple product-specific EPDs. Product-specific EPDs could potentially be used in bidding.
- **Product-specific EPD.** A producer could develop product-specific EPDs based on the weighted average production from multiple facilities using the PCR’s averaging rules (see, for example, Carbon Leadership Forum 2013). This type of EPD could be used as a business benchmark.

- **Regional EPD or industry-wide EPD.** For a more general assessment, an industry group can perform an LCA that describes the material production in a region or on an industry level following the PCR (see NSF International 2019 as an example). The foreground data that describes production parameters are collected from the key industry stakeholders to develop an EPD. Regional or industry-wide EPDs can assist producers in evaluating their environmental performance against the average regional or industry average ("Benchmarks" indicated in figure 3). Additionally, the information from the regional or industry-wide EPDs could be used as a data source for pavement LCA that could be considered in evaluating pavement structural designs.




Source: FHWA

**Figure 3. EPD types based on specificity.**
Note: PFS EPD = product- and facility-specific EPD.

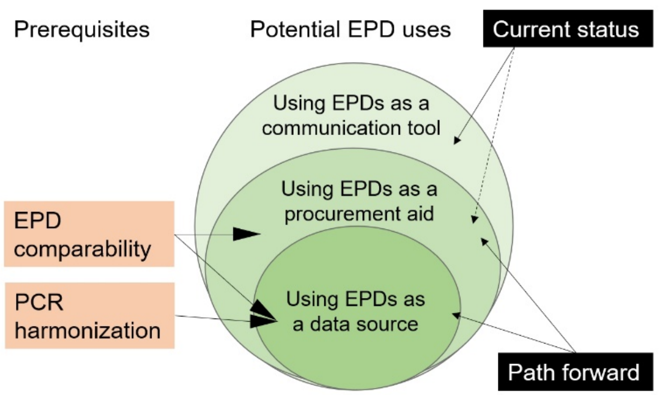
## Why are agencies interested in EPDs?

Multiple transportation agencies in the U.S. (e.g., Caltrans, NYSDOT, WSDOT) have established environmental goals. The current practices for quantifying environmental performance generally consist of measuring tailpipe emissions of vehicles (Chester et al. 2014; Kendall et al. 2018). The inclusion of materials production into the quantification of environmental impacts could provide more opportunities for savings and involvement of different stakeholders in pursuit of the established environmental goals (Kendall et al. 2018; Rangelov et al. 2020a). To that end, EPDs are identified as tools that can help facilitate those efforts.

### How Are Agencies Encouraging EPDs?

- The California Department of Transportation, started requesting EPDs for eligible materials in 2019 and requiring EPDs for those materials beginning in January 2020 as part of the Buy Clean California Act (California Legislative Organization 2017).
- Similar legislation requiring EPDs for public procurement has been proposed in several States, including Oregon, Minnesota, and Washington (Rangelov et al. 2020b). Although the legislation has not been enacted in any state other than California yet, new iterations of legislations are being introduced.
- The Oregon Department of Environmental Quality has a voluntary program to help concrete mix manufacturers produce EPDs aiming to reduce the environmental impact of concrete consumed in Oregon (OCAPA and Oregon DEQ 2016).
- In March 2018, the Washington State Legislature authorized the University of Washington to conduct a study to investigate Buy Clean policy options based on Buy Clean California and to propose potential implementation routes for Buy Clean Washington policy. The study outlines potential implementation routes, along with costs, opportunities for environmental savings, and challenges (Carbon Leadership Forum 2019).

Figure 4 shows three implementation options in the order of increasing complexity and more technical qualifications. As mentioned in the previous section *How do material manufacturers use EPDs?*, EPDs are currently used as communication tools, mainly by material producers. This is the broadest category and the simplest to use. In recent years, however, agencies have also expressed an increased interest in the use of EPDs as a procurement aid, as well as a tool to help evaluate the environmental impacts associated with various pavement designs.




Source: FHWA

**Figure 4: Potential uses of EPDs.**

## Potential use of EPDs in bidding

Agencies purchase significant amounts of construction materials for their projects. Therefore, state DOTs have recognized that leveraging **EPDs as a procurement aid** can be a feasible strategy to support the pursuit of environmental goals.

### *EPDs as a procurement aid*

EPDs can be collected as part of the procurement. This practice has the potential to encourage environmental disclosure, promote healthy competition, and incentivize sustainable material production practices. If EPDs are requested and incentivized through procurement, it is likely that their production will be increased. Additionally, EPDs can be used to inform material selection; however, the comparisons can be made only if the performance of the compared materials beyond the gate is expected to be equal. In this context, the product- and facility-specific EPDs (figure 3) are the most applicable.

For instance, Caltrans is collecting EPDs through the procurement and using them to develop benchmarks; that is, threshold environmental profiles of local material production. However, the development of benchmarks should consider that:

- A sufficient percentage of the producers can comply with the benchmark.
- Small producers are not disadvantaged.
- EPDs used to develop a benchmark are consistent and comparable.

Regional or industry-wide EPDs (figure 3) also can be used to set benchmarks. In this case, consistency and comparability of product-specific EPDs with the selected benchmark EPD should be confirmed before making comparative assertions.

### *Use of EPDs in bidding to ensure environmental improvements*

The consistency and comparability of EPDs produced under the same PCR will be confirmed before the EPDs may be used in procurement comparisons and in the development of nonfederal benchmarks. The consistency and comparability of EPDs are contingent on the PCR quality. The prescriptiveness of the PCR was identified in the literature as a key to ensure EPD consistency and comparability (Subramanian et al. 2012; Ingwersen et al. 2013). The key advantage of a prescriptive PCR is that the differences in the environmental profile reported on EPDs stem from actual differences in production rather than inconsistencies in methodology, data collection, and data sources (Minkov et al. 2015).

Key considerations for the quality and prescriptiveness of the PCR (Ingwersen et al. 2013, Mukherjee et al. 2020):

- **Product definition.** The PCR should specify reporting of the performance characteristics of the product such that users can make informed product comparisons (i.e., users can determine which products should be compared and which should not be).
- **Methodological consistency.** The LCA methodology should be clearly defined in the PCR so that the key methodological elements are not subject to a practitioner's interpretation.
- **Foreground vs. background data.** The PCR defines the primary process data that should be collected and the secondary process data that can be estimated (i.e., the foreground and background data). More information on data types can be found in a companion FHWA Tech Brief (Meijer and Harvey 2020).
- **Data consistency.** Background data sources are defined such that every EPD is produced with the same background datasets.
- More information on improved consistency and comparability of EPDs can be found in a report published by FHWA (Mukherjee et al. 2020).

## Potential use of EPDs in pavement design

When it comes to pavement infrastructure, materials production (typically quantified in EPDs) comprises one stage in the life cycle of a pavement. Life-cycle stages beyond material production should also be considered in pavement design. Optimizing only material production for lower environmental impacts can produce tradeoffs in subsequent life-cycle phases. Comparison of pavement design alternatives on a cradle-to-grave basis is therefore more appropriate, however, it is also more demanding in terms of the data collection demands. To that end, **EPDs can potentially be used as a data source** in cradle-to-grave pavement LCA, elaborated in the next section.

### What are the Options for the Background Data?

Background data specified in the PCRs typically come from LCA databases. When deciding on the database, a PCR committee can choose between various proprietary or public databases.

- The advantage of **proprietary databases** is the convenience of its use and the perceived higher level of data quality.
- The advantage of **public data** is the transparency and low cost of the analysis.

In the context of public procurement, transparency and inclusivity of data are important concerns. FHWA is currently collaborating with Federal LCA Commons on development of a web-based data repository with freely available Federal data sets for LCA. Additionally, FHWA is involved in developing a roadmap for background datasets.

### *EPDs as a data source for pavement LCA*

LCA is commonly described as a modular type of analysis, with different products and life-cycle stages contributing to the environmental impacts of an entire product system. In the case of pavements, a cradle-to-gate scope in EPDs can be seen as a subset of a cradle-to-grave scope (see table 2). Accordingly, EPDs can serve as data sources, providing the environmental impacts of the materials production. Since the final material selection is typically not performed as a part of the design on DBB projects, regional or industry-wide EPDs (figure 3) can be used to estimate generic environmental impacts of the materials used in a pavement design.

As shown in figure 4, this use depends on additional conditions, such as mutual harmonization of PCRs. Pavement designs often include more than one material (e.g., concrete pavement with asphalt shoulders), Moreover, to provide for the consistent cradle-to-grave analysis, all methodological and data elements of a pavement LCA and the constituent EPDs should be aligned.

Key considerations for PCR harmonization and harmonization with pavement LCA include the following (Ingwersen et al. 2013; Minkov et al. 2015; Mukherjee et al. 2020; Subramanian et al. 2012):

- **Methodological choices.** As described by FHWA, the example of methodological choices include goal, scope, cutoff criteria, allocation choices, impact assessment method, impact categories, and inventory items (Harvey, Meijer, and Kendall 2014). PCRs are harmonized if the fundamental methodological elements of an LCA defined in all PCRs are aligned. Additionally, the same methodological elements should be consistent with that of the pavement LCA.
- **Data choices.** Similar to PCR prescriptiveness of the background data sources that provides for the comparability of EPDs, PCR harmonization ensures that consistent background data sources are used for all products. Additionally, the same background data sources should be used in the pavement LCA.
- **Stakeholders' consensus.** There are multiple approaches to select methodological components of an LCA and each approach has tradeoffs. It is therefore essential to base those choices on a dialogue and consensus among the key industry stakeholders. This process necessitates identification of all relevant and interested parties and their buy-in by establishing a mutual agreement.

An issue of PCR harmonization has been recognized in LCA literature (Ingwersen et al. 2013; Minkov et al. 2015; Subramanian et al. 2012). Increased interest in EPDs has led to the development of multiple disparate EPD programs, which can hinder comparability, compromise the validity of the environmental claims, and create confusion in the market (Subramanian et al. 2012). Harmonization and mutual recognition of PCRs was recognized as a potential pathway to overcome these challenges (Minkov et al. 2015; Subramanian et al. 2012). The need for supplemental instructions for PCR development and best practices was also recognized (Minkov et al. 2015; Subramanian et al. 2012). In the domain of pavement materials, PCR harmonization was discussed in detail by FHWA (Mukherjee 2020).

Agencies can develop internal policies on how to conduct LCA in order to communicate environmental performance\ of pavement designs; best practices for performing a pavement LCA are available from FHWA (Harvey et al. 2016). If EPDs are to be used as a data source for materials, the above-mentioned considerations of PCR harmonization and harmonization with pavement LCA apply. The FHWA is developing a pavement LCA tool that will help agencies get educated on assessing, benchmarking, and communicating environmental impacts of pavement materials and designs.

Achieving all of the necessary qualifications for the technically sound application of EPDs in procurement and pavement design takes time and a joint effort among multiple stakeholders. Technical and organizational challenges to harmonization relevant to pavements are discussed by Mukherjee et al. 2020. Interested agencies can get started with EPDs, help these efforts, and make progress towards sustainability goals.

## How to Get Started with EPDs?

For agencies interested in encouraging EPDs, a potential three-stage implementation plan is summarized below (FHWA 2016):

*Stage 1: Reporting (1 to 2 years)*

- Establish a database with EPDs relevant to pavements.
- Encourage the development and use of EPDs by providing incentives to industries or manufacturers.
- Use pilot projects for requesting EPDs to refine the specification and to help development of tools that use EPDs as inputs.

*Stage 2: Standardization of PCRs (3 to 5 years)*

- Develop procedures and reporting practices for EPDs to support EPD consistency and PCR harmonization. Incentivize compliant EPDs.
- Work with other agencies and industries to participate in harmonization of PCRs, and work to fill gaps in public databases.
- Participate as a stakeholder for creating PCRs (review or committee member) to ensure EPDs are produced in line with the public interests.
- Consider EPDs for materials procurement once harmonization efforts have created a sufficiently level playing field for competition.

*Stage 3: Procurement and design (> 3 years)*

- In design-bid-build projects, consider using EPDs to inform selection between the materials with similar performance. For the important considerations to implement this approach, see the section on *Use of EPDs in bidding to ensure environmental improvements.*
- Consider EPDs for constructed pavement systems, or for longer-term maintenance and rehabilitation of a highway network as follows:
  - EPDs of materials (DBB projects).
  - EPDs of cradle-to-site for the project as opposed to individual materials (DB projects).
  - EPDs of full life cycle for the project (DBM projects).
- Use collected EPDs to quantify agency-averages for various material types and designs to be used as a data source in pavement LCA in support of pavement design.

With sufficient progress on harmonization, data collection, and development of tools, pavement LCA can be integrated into a network-level analysis that can be used to inform policy, programming, planning, and asset (or pavement) management decisions. Agency-average EPDs of materials have the potential to be included in those analyses. As a result, the progress of the agency towards various environmental objectives can be quantified, evaluated, and communicated to the public.

## Where Can I Learn More?

Additional information and resources can be found on the sustainable pavements webpage.

- FHWA Sustainable Pavements Reference Document (FHWA-HIF-15-002).
- FHWA Tech Brief on Pavement Life Cycle Assessment (FHWA-HIF-15-001).
- FHWA Tech Brief on Pavement Sustainability (FHWA-HIF-14-012).
- FHWA Pavement Life-Cycle Assessment Framework (FHWA-HIF-16-014).
- FHWA Tech Brief on Building Blocks of Life-Cycle Thinking (FHWA-HIF-19-027)

- FHWA Insert: Life-Cycle Cost Analysis (FHWA-HIF-19-027-a)
- FHWA Insert: Life-Cycle Assessment (FHWA-HIF-19-027-b)
- FHWA Insert: Environmental Product Declarations (FHWA-HIF-19-027-c)
- FHWA Insert: Product Category Rules (FHWA-HIF-19-027-d)

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