Building Decarbonization: How LCA and EPDs Fit in

Life-cycle assessment and environmental product declarations reveal embodied carbon and other impacts, but it's important to know their limits.

by Elizabeth Waters

As part of its economy-wide decarbonization plan, the U.S. government is targeting a building-sector emission cut of 90% from 2005 levels by 2050—and a crucial component of that is reducing the embodied greenhouse gas emissions from building materials and construction.

To achieve this, we need better information about the carbon impacts of product and material manufacturing. Life-cycle assessments (LCAs) and environmental product declarations (EPDs) set out to do this while measuring myriad other impacts. And while both are becoming increasingly robust and useful, limitations remain.

Life-cycle assessment (LCA)

LCA is a scientific method used to quantify the environmental impacts of a product from raw material extraction through manufacture ("cradle to gate"), or disposal ("cradle to grave"). LCAs typically contain:

- the goal and scope of the assessment
- the product's functional unit
- an inventory of the system's inputs and outputs
- an impact assessment across a set of environmental impact categories
- a consideration of the data's limitations

Product category rule (PCR)

To help ensure that similar products are assessed in comparable ways, product category rules (PCRs) tell users how to conduct LCAs for different product types.

PCRs are commonly commissioned by product manufacturers or industry associations but must be developed with oversight from a program operator. A program operator is an independent third party (such as UL or SCS Global Services).

Before it's finalized, a PCR is reviewed by an expert review panel to ensure it meets the International Organization for Standardization (ISO) technical standards governing LCA and EPD development, which—for the most part—align well with European (EN) standards covering the same topics. Additionally, stakeholder feedback on the PCR is solicited during a 30-day public comment period.

Type III environmental product declaration (EPD)

An EPD is a summary of a product's LCA. EPDs can be product specific or an industry average of similar products made by different manufacturers. EPDs are disclosure documents—they don't draw conclusions about whether a product is good or bad—and commonly contain:

- a cover page summarizing the PCR followed, ISO compliance, and effective dates

- an explanation of what the LCA measures
- a list of the materials and components of the product
- the product's manufacturing process
- the product's environmental impact data

EPDs are usually valid for five years. It's important to check their expiration dates and watch for changing information.

What do product LCAs and EPDs measure?

In North America, LCA practitioners conduct life-cycle impact assessments using the U.S. Environmental Protection

International & European Standards for LCA & EPDs

STANDARD	WHAT IT GOVERNS	OTHER INFO	RELEVANT LEED CREDITS
International Organization for Standardization			
ISO 14040, 14044	Life-cycle assessment (LCA) principles, methodologies, and requirements	–	BD+C v4 & v4.1 Building Life-Cycle Impact Reduction, Option 4 Environmental Product Declarations, Option 1
			ID+C v4.1 Building Interiors Life-Cycle Assessment, Option 3
ISO 14025	Type III environmental product declaration (EPD) development and presentation	Aligns with ISO 14040/44	BD+C v4 & v4.1 ID+C v4 & v4.1 Environmental Product Declarations (must also meet EN 15804+A1)
ISO 14027	Product category rule (PCR) development (not construction-specific)	Aligns with ISO 14040/44/25	–
ISO 21930	EPD development for construction-related products and services	Mirrors EN 15804+A1 Not fully compatible with 15804+A2	BD+C v4 & v4.1 ID+C v4 & v4.1 Environmental Product Declarations
European Committee for Standardization			
EN 15978	Building-level LCA; Building lifecycle stages A–D	Aligns with ISO 14040/44	Europe ACP only BD+C v4 & v4.1 Building Life-Cycle Impact Reduction, Option 4
EN 15804+A1	PCRs for construction-related EPDs	Includes seven environmental impact categories Aligns with ISO 14040/44/25 and 21930	BD+C v4 & v4.1 ID+C v4 & v4.1 Environmental Product Declarations (must also meet ISO 14025)
EN 15804+A2	2019 amendment to EN 15804 that supersedes A1 in the European Union	Compared with the A1 version, the more recent standard: No longer fully compatible with ISO 21930 Changes include: Triple the number of impact categories A new approach to biogenic carbon emissions and storage Expanded scope that includes a product's end-of-life impacts	–

Source: BuildingGreen, Inc.

Agency's Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts (TRACI) methodology, which evaluates a product across a set of environmental impact categories. It typically covers:

- depletion of atmospheric ozone
- global warming potential (GWP, roughly equivalent to embodied carbon)
- acidification (harmful lowering of water and soil pH, often from sulfur dioxide and other emissions from burning fossil fuels)
- eutrophication (excessive nitrogen, often from fertilizer runoff)
- formation of ground-level ozone (smog)
- depletion of global fossil fuel resources

Limitations of EPDs

An EPD offers good data, but making effective use of it—and avoiding the pitfalls of overconfidence in its precision—requires an understanding of its limitations and inherent uncertainties. These include:

- **Data reliability**—Data in LCA tools can vary in age, quality, accuracy, and detail, and are often based on proxies and statistical averages that don't reflect the nuances of specific products or materials.
- **Scope of impact assessment**—Social and human health impacts are largely excluded from EPDs, as is ecotoxicity.
- **Wood and agricultural materials**—TRACI's GWP calculation doesn't account for biogenic carbon that's been sequestered by plants during photosynthesis, and then temporarily stored in wood or in products derived from rapidly renewable crops.
- **Ingredient information**—EPDs list some of a product's components but don't typically disclose the full ingredient list or the ingredients' toxicity. Health product declarations, or HPDs, were created to fill this gap.
- **Comparison and alignment**—LCA methodologies and assumptions can vary widely enough to preclude meaningful comparison of products, even when their EPDs are based on the same PCR. With "Buy Clean" policies and even building codes adopting LCA, practitioners and government agencies are working to further standardize methods and to set clearer guidelines on ranking products.

The Carbon Leadership Forum (CLF) at the University of Washington is working to raise awareness of current uncertainties and to further standardize LCA methods and processes. CLF is also one of the convening organizations of ECHO, which stands for Embodied Carbon Harmonization and Optimization. The project's purpose is to align how embodied carbon is measured and reported across the industry. (Disclosure: BuildingGreen, alongside SERA Architects, consulted with CLF and other ECHO participants to facilitate consensus and develop reporting guidelines.)

EPDs and comparative LCA

Cradle-to-gate EPDs correspond with building life-cycle stages A1, A2, and A3: raw material extraction, transport, and product manufacturing, respectively, which make up part of a building's upfront embodied carbon (see diagram). The data from these EPDs can inform whole-building life-cycle assessment (WBLCA) during design. WBLCA software usually relies on other data sources, but advanced tools, some of which integrate with building information modeling (BIM), can pull in product EPDs to inform material selection.

Figure 7: Whole life cycle stages, EN15978 (2011)[10]

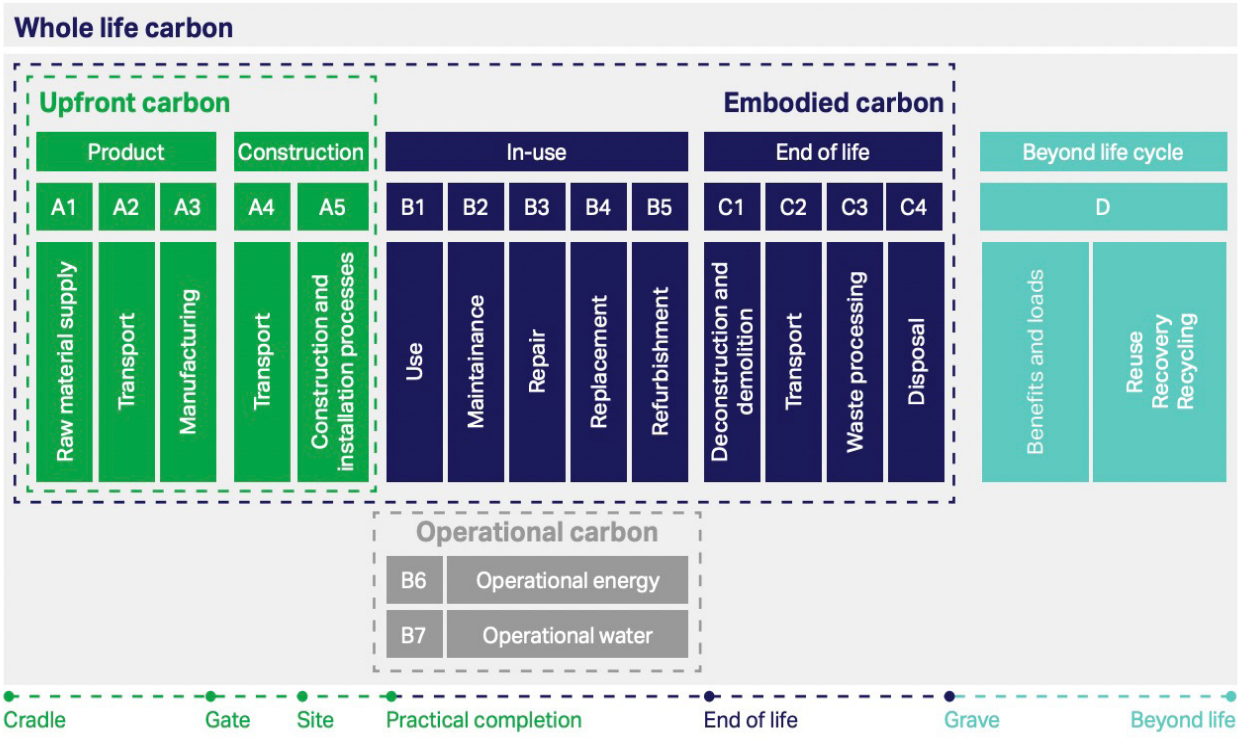

Image: World Business Council for Sustainable Development and Arup

European standard (EN) 15978 breaks down the building life-cycle stages into modules A through D. A product's cradle-to-gate carbon emissions, the scope commonly disclosed in EPDs, fall under modules A1 through A3 and contribute to a building's upfront embodied carbon emissions.

The Embodied Carbon in Construction Calculator (EC3), managed by Building Transparency, is one such tool. With a database of more than 40,000 third-party-verified EPDs, EC3—either on its own or in combination with the Tally Climate Action Tool (tallyCAT)— can be used to estimate and compare the embodied carbon of a range of construction materials during a project's design phase. (EC3 does not display other impacts, like eutrophication or ozone depletion.)

Users should be aware that the data behind EC3 contain uncertainties—which the tool demonstrates with error bars in its results—and should undertake product comparisons with caution. As manufacturers continue to develop EPDs, and LCA data become more robust, the margins of error in EC3 are likely to decrease.

EPDs and green building certifications

EPDs can help projects pursuing rating systems like LEED, the Living Building Challenge, BREEAM, and the Collaborative for High Performance Schools (CHPS) to meet material-related requirements. For example, Option 1 of the Environmental Product Declaration credit in LEED v4.1 requires project teams to submit LCAs or EPDs—which must comply with prescribed ISO and EN standards—for at least 20 permanently installed products from five different manufacturers (certain project types have a lower bar).

Government incentives for EPD development

The U.S. federal government launched the Federal Buy Clean Initiative in 2022,

(CHPS) to meet material-related requirements. For example, Option 1 of the Environmental Product Declaration credit in LEED v4.1 requires project teams to submit LCAs or EPDs—which must comply with prescribed ISO and EN standards—for at least 20 permanently installed products from five different manufacturers (certain project types have a lower bar).

Government incentives for EPD development

The U.S. federal government launched the Federal Buy Clean Initiative in 2022, pledging to prioritize the procurement of lower-embodied-carbon construction materials in federal and federally funded projects, and to support domestic manufacturers in creating EPDs. In 2023, 13 states made a similar pledge for statefunded projects by signing onto the Federal–State Buy Clean Partnership.

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