CEBI
Clean Energy Buyers Institute

An Introduction to Embodied Carbon Analysis

The **Clean Energy Buyers Institute (CEBI)** engages leading organizations in the solar industry to raise awareness about the impact of embodied carbon emissions throughout the solar photovoltaic (PV) supply chain and related clean energy procurement decisions. To support this effort, CEBI has created a suite of educational materials for stakeholders along the solar supply chain. This document introduces key embodied carbon analysis terminology and documentation, along with existing national frameworks that incorporate this information.

CEBI Low-Carbon Solar Resources

Low-carbon Solar Primer

An introduction to solar PV supply chain challenges and the opportunity for energy customers to take action now toward decarbonization

Letter of Intent

A letter for suppliers to signal energy customers' collective intent to prioritize embodied carbon in solar PV procurement

RFP Guidance

An overview of how to integrate low-carbon solar preferences into procurement documents

Embodied Carbon Analysis

An overview of key embodied carbon analysis terminology and documentation, along with existing national frameworks

Reducing embodied carbon emissions is key to unlocking the full potential of solar PV. There are three puzzle pieces that work together to evaluate the full supply chain emissions associated with similar products, such as solar modules, and enable embodied carbon reduction: an environmental product declaration (EPD) based on a life cycle assessment (LCA) according to a product category rule (PCR).

An LCA is a technical framework for conducting a life cycle analysis. The PCR is a common set of rules for a particular product to ensure that everyone conducts their LCAs in the same manner to enable comparability. An EPD is a simplified summary of the results of an LCA done according to a PCR.

LCA

+

PCR

EPD

Data

Life Cycle Assessment

A compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle

Guidelines

Product Category Rules

Rules, requirements, and guidelines for calculating and reporting environmental data across the full life cycle of a product or service so it can be compared to others in the same category.

Summary

Environmental Product Declaration (Type III)

A publicly available, third-party verified document based on an LCA of a product, according to a PCR

ACTION

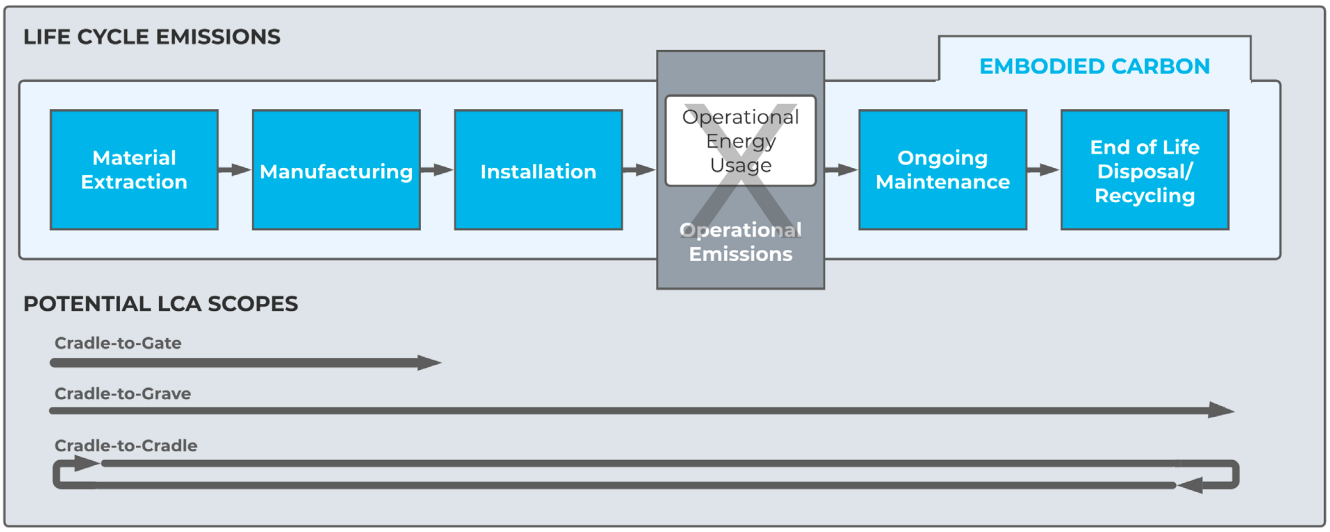
Clean energy customers can make CO_2-informed procurement decisions

For more information, please contact communications@cebi.org.

An Introduction to Embodied Carbon Analysis

Life Cycle Assessments

Emissions are generated at different stages throughout the life of a product, which are collectively called **life cycle emissions.**[1] **Embodied carbon** refers to all emissions excluding operational emissions. Over the entire lifecycle, solar PV has lower emissions than fossil fuel-based energy, but the emissions are concentrated in different stages. While the bulk of fossil fuel emissions are operational, over 70% of solar PV's emissions are from embodied carbon- and much of that is from the electricity required at the manufacturing stage.[2]



The first analysis step necessary for considering embodied carbon is a **life cycle assessment (LCA),** which is a technical method to account for the environmental aspects and potential impacts (e.g., use of resources and the environmental consequences of releases) throughout the life cycle of a product.[3] The company that commissions an LCA determines its scope. Most LCAs cover materials extraction to manufacturing (called "cradle-to-gate"), less cover all the way to end-of-life treatment (called "cradle-to-grave"), and very few cover recycling and reuse (called "cradle-to-cradle"). LCAs use two types of data in their analysis: **supplier specific data**, which collects primary data from the company's actual supply chain, or **industry-wide data**, which collects data from industry averages. Supplier-specific data is preferable due to its accuracy, but it is not always available leaving many LCAs to rely on industry-wide data.

LCAs may not be comparable without set guidelines on scope and type of data, which creates an obstacle for any stakeholder looking to evaluate the environmental attributes of different products. To help ensure comparability, LCAs rely on Product Category Rules (PCRs) to set scope and boundaries.

Product Category Rules

Product Category Rules (PCRs) provide the rules, requirements, and guidelines for calculating and reporting environmental data across the full life cycle of a product or service so it can be compared to others in the same category.[4] The guidelines for building a PCR are determined by the International Organization of Standardization (ISO) standard 14025 or European standard EN 15804. PCRs are developed through an open stakeholder process and approved by a program operator. In North America, common program operators include ASTM, NSF, and UL Environment.

As an example: Italy has developed a PCR for the solar PV system (using a per kilowatt-hour basis) and Norway has built a PCR for the PV module (using a per kilowatt-peak basis).

When an LCA is developed according to a solar PCR, the data can be fed into a Type III Environmental Product Declaration (EPD).

1 Greenhouse Gas Protocol, FAQ. Accessed 15 January 2021.

2 NREL, Life Cycle Greenhouse Gas Emissions from Solar Photovoltaics (Fact Sheet). Accessed 24 August 2021; A. Müller, et al. A comparative life cycle assessment of silicon PV modules: Impact of module design, manufacturing location and inventory (2021). Accessed 24 August 2021; G. Masson, I. Kaizuka, Trends in Photovoltaic Applications IEA Report (2020). Accessed 24 August 2021.

3 14040:2006, Environmental management — Life cycle assessment — Principles and framework. Accessed 2 February 2022.

4 EPA, Guidance for Product Category Rule Development (August 2013). Accessed 15 January 2021.

An Introduction to Embodied Carbon Analysis

Environmental Product Declarations

LCAs often contain highly detailed and sensitive company information. Therefore, a company will likely take the insights derived from their LCA and put it into an **Environmental Product Declaration (EPD)**, which is a type of environmental claim that provides transparent information about a product's life cycle in relation to the environment.[5]

There are different forms of EPDs available. A single product verified EPD, or Type III EPD, is built according to a PCR and enables comparisons between similar products (e.g., two different solar modules). Like PCRs, the guidelines required to build a Type III solar EPD are provided either by ISO standard 14025 or European standard EN 15804. Using a Type III EPD brings an LCA and PCR together and allows clean energy customers to compare the carbon footprint of different products.

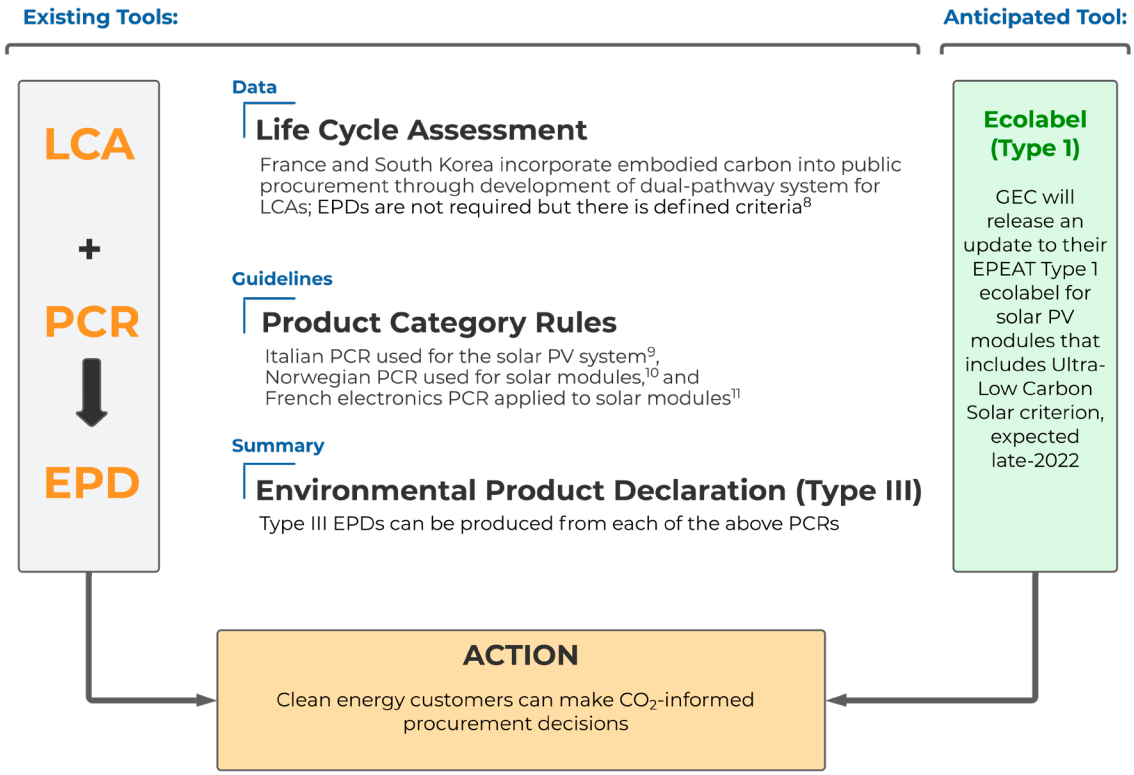
Ecolabels

Ecolabels, which are awarded to products or services that meet a specific environmental criterion, are another tool for companies to communicate the environmental attributes of their products.[6] Similar to EPDs, there are different types of ecolabels, and a Type 1 ecolabel is like a Type III EPD in that it is based on defined criteria, third-party verified, and can be used to compare products. Type I ecolabels are also based on an ISO standard 14024 and may establish thresholds for performance to qualify for the ecolabel.[7]

As an example, the Global Electronics Council is expected to release an update to their EPEAT Type 1 ecolabel that includes criterion for Ultra-Low Carbon solar in late-2022.

Trends in Low-Carbon Solar Procurement Practices

As countries around the world turn their focus to decarbonizing the solar supply chain, an evolving landscape of policies is emerging that incorporates the documents described above. As examples, the European Union is updating its Green Public Procurement requirements to include embodied carbon disclosures for solar PV module production and France and South Korea already favor low-carbon solar PV in public procurement. The graphic below shows how all these available frameworks fit together:



5 The Institution of Structural Engineers, How to calculate embodied carbon (2020). Accessed 15 January 2022.
6 Introduction to Ecolabels and Standards for Greener Products. EPA. Accessed 17 February 2022.
7 Environmental Labels. ISO. Accessed 17 February 2022.
8 Ultra-Low Carbon Solar Alliance, South Korea is implementing Carbon Footprint Assessment regulations for the PV market 2021). Accessed 15 January 2022.
9 EPD Italy, PCR for PV Module (2020). Accessed 15 January 2022.
10 The Norwegian EPD Foundation, "PCR – Part B for photovoltaic modules used in the building and construction industry, including production of cell, wafer, ingot block and solar grade silicon" Product Category Rules. EN 15804: NPCR 029 Version 1.0.11 (2020). Accessed 15 January 2022.
11 PEP Ecopassport, Product Category Rules for Electrical, Electronic, and HVAC-R Products (2015) accessed on January 15, 2022. PEP EcoPassport (2015). "Product Category Rules for Electrical, Electronic and HVAC-R Products". PEP-PCR-ed3-EN-2015 04 02. P.E.P. Association. 02 April 2015.