The Emergence of Disclosure in Green Design

Understanding environmental product declarations

by James L. Hoff, DBA
Photo courtesy Atlas Roofing Company


Many different stakeholders within the building community have been active in the promotion of disclosure, but they all tend to share the same questions. A particular building material may help save operating energy, but how does it impact other equally important environmental concerns? A product may have a high recycled content, but after the effort required for salvage, transportation, and conversion is there still a tangible net environmental benefit? Beyond specific environmental concerns, how does the product affect the safety, health, and well-being of building occupants? Unfortunately, many of these questions cannot be answered effectively using current tools such as energy calculators and one-dimensional green product certifications.

Each of these questions is related to common concerns held not only by green building advocates but also the entire building design community: Do we have the kind of information about building products to make informed decisions? Do simplistic claims or categories of greenness help or hinder our analysis? Do current manufacturer data sheets and
reports provide adequate information? Finally, do we understand exactly what goes into the building materials we use and how these ingredients may affect the well-being of building occupants?

**EPDs and standardized processes**

One of the newest tools to be integrated into the selection of sustainable building materials is the environmental product declaration (EPD). While almost everyone associated with the building envelope industry has become aware of this new tool, few industry stakeholders have had the opportunity to learn about the specifics of how they are developed and how they may be used.

EPDs have been around the longest of all the new product disclosure tools, and the current procedures to develop EPDs have been in place for over a decade. However, the fact even the best-established disclosure tool is still relatively new attests to how quickly the concept of disclosure has entered the construction market. At the same time, the current EPD process has been built on a solid, science-based approach that examines total environmental impact over the entire life cycle of a product. There are many excellent definitions of EPDs, but for this article’s purposes, the EPD may best be described as a standardized process to disclose environmental impacts and other factors over the lifecycle of a product using quantifiable measures as applied to a common functional unit for similar products. This definition should be especially useful when broken down into its key elements.

As the environmental assessment of products has evolved, international standards have been developed to help ensure these practices are conducted in a consistent and reliable manner worldwide. In almost all cases, these procedures are based on standards adopted and maintained by the International Standards Organization (ISO). Standards related to the underlying practice of lifecycle assessment (LCA) are contained in ISO 14040, *Environmental Management–Lifecycle Assessment: Principles and Framework*, and ISO 14045, *Environmental Management–Eco-efficiency Assessment of Product Systems: Principles, Requirements and Guidelines*, which cover the key principles and framework as well as more detailed requirements and guidelines for completing the LCA process.

ISO standards related to the specific structure of EPDs are in ISO 14025, which covers the basic principles for applying EPDs to all kinds of products.
Figure 2

<table>
<thead>
<tr>
<th>Impact Category / Environmental Indicator</th>
<th>Measure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming Potential (GWP)*</td>
<td>Kilograms (kg) of carbon dioxide (CO₂) or equivalent</td>
</tr>
<tr>
<td>Ozone Depletion Potential (ODP)*</td>
<td>Kilograms (kg) of Freon (R11) or equivalent</td>
</tr>
<tr>
<td>Eutrophication Potential*</td>
<td>Kilograms (kg) of nitrogen (N) or equivalent</td>
</tr>
<tr>
<td>Smog Creation Potential*</td>
<td>Kilograms (kg) of ozone (O₃) or equivalent</td>
</tr>
<tr>
<td>Acidification Potential*</td>
<td>Moles of positive ions (H⁺) or equivalent</td>
</tr>
<tr>
<td>Primary Energy Consumption</td>
<td>Megajoules (MJ) of energy consumed</td>
</tr>
<tr>
<td>Resource Depletion</td>
<td>Equivalent megajoules (MJ) of resources consumed</td>
</tr>
<tr>
<td>Water Consumption</td>
<td>Liters (L) or kilograms (kg) of water consumed</td>
</tr>
<tr>
<td>Waste Generation</td>
<td>Kilograms (kg) of solid waste produced</td>
</tr>
</tbody>
</table>

Typical EPD impact measures (an asterisk denotes TRACI as the source).

ADDITIONAL RESOURCES

For a look at how the data disclosed through environmental product declarations (EPDs) will be used in lifecycle databases, whole-building lifecycle assessments (LCAs), product manufacturing improvements, and green guidelines and codes, visit www.constructionspecifier.com/more-on-epds to read a feature by this article’s author.

For the reader looking for additional information about EPDs, the following resources may be very helpful:

- EPD and LCA practitioners: www.pe-international.com and www.scsglobalservices.com;
- EPD program operators: www.nsf.org/services/by-industry/sustainability-environment and www.industries.ui.com/environment; and

Additionally, ISO 21930, Sustainability in Building Construction—Environmental Declaration of Building Products, contains additional principles for applying EPDs to building products.

The use of well-established procedures helps ensure the information disclosed in an EPD has been developed in an objective and scientific manner. In fact, the type of EPD required by LEED and other green building guidelines must be based on ISO standards and requires a final third-party review to validate the disclosure for accuracy and reliability.

Understanding environmental impacts and quantifiable measures

In North America, the environmental impacts reported by EPDs are based on a listing of impact categories established by the U. S. Environmental Protection Agency (EPA). This listing, called the Tool for the Reduction and Assessment of Chemical and other Environmental Impacts (TRACI), categorizes a number of key environmental impacts related to the release of various chemicals into the atmosphere, ground, and water. Currently, five of the impacts are included in the data provided by most EPDs.

In addition to these primary environmental impact categories, EPDs also include an analysis of the energy consumed during the product’s lifecycle, and classify this energy into renewable and nonrenewable sources. Further, EPDs include data regarding energy, water, and other resource consumption, as well as information about hazardous and nonhazardous waste generated over the product lifecycle. Figure 1 (page 25) provides a listing of the typical impact categories and other environmental indicators found in EPDs, along with a brief description of their effects.

All the data reported in an EPD are also quantified to allow for comparison of environmental impacts among similar products. In the case of the five TRACI impact categories, these measures are based on chemical or molecular values that can be added to the impacts of other products to help establish an overall environmental ‘footprint’ for a combination of products, such as a building or major building component. For other environmental indicators, the metrics are based on common measures for energy, volume, or mass. Figure 2 provides a listing of the specific metrics associated with each typical impact category and environmental indicator.

With TRACI impacts, the specific chemical selected is used as a common denominator for similar chemicals yielding a similar result. As an example, although carbon dioxide (CO₂) is the most-recognized greenhouse gas, TRACI allows for the conversion of other gasses such as methane (CH₄) and ozone (O₃) into the equivalent amount of CO₂ that would cause the same effect.

Since TRACI measures accommodate the range of chemicals associated with environmental impact, they can be added to the impacts of other products to establish an overall environmental footprint for a whole building constructed from these products. This additive nature of EPD data is very important in the development of calculators such as the Athena Impact Estimator, used to assess the environmental impacts of whole buildings or major sub-systems.

Although the measures used in product declarations are quantifiable, it is important that one recognizes EPDs only provide an estimate or prediction of the
While almost everyone that is associated with the building envelope industry has become aware of EPDs, few industry stakeholders have had the opportunity to learn about the specifics of how they are developed and how they may be used.

Figure 3

**INPUTS:**
- Raw Materials
- Energy
- Water

**STAGES:**
- Raw Material Acquisition
- Manufacturing
- Transport & Handling
- Installation / Assembly
- Operation / Maintenance
- Disposal / Recycling

**OUTPUTS:**
- Atmospheric Emissions
- Waterborne Waste
- Solid Waste
- Co-Products
- Other Releases

An example of a product lifecycle diagram.

magnitude of these impacts. Since lifecycle assessment is a modeling tool, it cannot provide exact values of any impact. However, when conducted in accordance with recognized procedures, it can provide reasonable and comparable values useful for evaluating the overall sustainability of products.

The product lifecycle

The assessment and measurement of the environmental impacts reported in an EPD are structured to include all aspects of a product’s lifecycle, from the initial acquisition of raw materials to the eventual removal and disposal of the product. This lifecycle typically is described in an EPD using a diagram similar to Figure 3.

The concept of the product lifecycle has been refined and expanded to include a number of important elements. It begins with inputs such as raw materials and energy before moving these inputs through a series of processes from initial material acquisition all the way to eventual disposal and recycling. In moving through these processes, one produces many different outputs in the form of emissions and wastes that impact the environment.

Another important element in this lifecycle chart is the system boundary. Essentially, it is a way to admit the user may not always capture every impact on the environment, but still needs to clearly state where the assessment begins and ends. Additionally, the system boundary is critical to ensure consistency and comparability among products.

To gain a clear understanding of the concept of environmental impact over the product lifecycle, it may be helpful to view the EPD as an estimated measure of net product impacts over time. Every product starts with a design concept, which may have little or no impact. However, as we acquire the raw materials, manufacture and ship the product, install and maintain it, and eventually remove and dispose of it, the air, water, and land are impacted in numerous ways.

Service life is also a vital factor. The longer a product’s useful service life is extended, the more its overall impact is reduced. An illustration of the concept of environmental impact over time is shown in Figure 4 (page 30).

**Common functional unit**

As the standardized ISO foundation is so critical to EPDs, it is important to note the purpose or function of these tools is, according to ISO 14025, to enable comparison between similar products. This means the impact data of a particular product should be comparable to impact data for a similar product with the same function. To accomplish this, a functional unit most relevant to the impacts associated with a group of similar products must be identified. Frequently, the basic functional unit identified within the ISO process is a measure of mass or area, such as kilograms or square meters. Finally, the functional unit also involves a timeframe, typically related to the product’s service life.

There is the question of how exactly one gets quantified information that can enable comparison among similar products. A product category rule (PCR) is intended to ensure products with similar functions may be assessed in the same way using comparable measures. PCRs are developed in accordance with ISO standards, which call for the formation of a consensus body backed by third-party validation to develop each PCR.
To answer the critical issues of product comparison, the PCR establishes several key elements of how every LCA for a particular class of product should be conducted, including:

- the functional unit, including the time frame for the product;
- the system boundary; and
- the impact categories to be assessed.

By doing this, the PCR helps to ensure meaningful comparisons may be made among similar products.

An example of a PCR relevant to the construction specifier was developed recently by a broad coalition of insulation manufacturers under UL’s third-party stewardship. This PCR covers all building envelope thermal insulation, including fiberglass, mineral wool, expanded polystyrene (EPS), extruded polystyrene (XPS), and polyisocyanurate (polyiso).

This thermal insulation PCR uniquely defines the functional unit as a square meter of insulation with a metric RSI value of ‘1.’ This is very important because the thickness required to obtain this RSI value varies significantly between different insulations. In many cases, we really do not care about the exact thickness of the insulation because the material’s critical function is related to the ability to resist heat transfer, as measured in R-value. The PCR also identifies the service life to be 60 years—the current standard for typical building service life in the new International Green Construction Code (IgCC).

Unless damaged by unforeseen forces, most thermal insulations have a service life of 60 years or more when protected within a wall, ceiling, or roof. Finally, the thermal insulation PCR establishes the system boundary to be cradle-to-grave, which includes all processes leading up to the delivery of the insulation to the jobsite, its installation during construction, and its maintenance over the service life, along with its removal, disposal, and possible recycling at the end of its service life.

A thermal insulation example

Due to the structure provided by underlying ISO standards and a relevant PCR, most EPDs follow a similar format. The basic requirements for a typical EPD for a building material can generally be met in a relatively short document—perhaps three or four pages. However, because current standards provide a number of options in regard to supplemental information that may be provided in an EPD, some product declarations can be much longer and contain a wide variety of graphics and pictures.

As mentioned, EPDs may be either generic or proprietary in scope. In the former, data is disclosed relating to a common product produced by multiple manufacturers, and the impacts are based on a weighted average of their combined production. Proprietary EPDs, on the other hand, disclose data relating to a single product produced by a single manufacturer, and the impacts disclosed are based on that manufacturer’s total production.

Due to the expense that is associated with the development of EPDs, many in the initial wave were generic rather than proprietary. By joining together to develop a common EPD for functionally similar products, individual manufacturers can pool their resources and achieve economies of scale. (Additionally, end users are provided with a useful ‘baseline’ for
Published generic EPDs for thermal insulation.

**Figure 5**

<table>
<thead>
<tr>
<th>Product(s) Covered</th>
<th>Issued To</th>
<th>Program Operator</th>
<th>Date Issued</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sprayed Polyurethane Foam (SPF) for Insulation and Roofing Systems</td>
<td>Spray Polyurethane Foam Alliance (SPFA)</td>
<td>UL Environment (<a href="http://www.ulenvironment.com">www.ulenvironment.com</a>)</td>
<td>October 10, 2013</td>
</tr>
<tr>
<td>Polyiso Roof Insulation</td>
<td>Polyisocyanurate Insulation Manufacturers Association (PIMA)</td>
<td>NSF (<a href="http://www.nsf.org">www.nsf.org</a>)</td>
<td>January 1, 2015</td>
</tr>
<tr>
<td>Polyiso Wall Insulation</td>
<td>Polyisocyanurate Insulation Manufacturers Association (PIMA)</td>
<td>NSF (<a href="http://www.nsf.org">www.nsf.org</a>)</td>
<td>January 1, 2015</td>
</tr>
</tbody>
</table>

With data from the Polyisocyanurate Insulation Manufacturers Association (PIMA), this is a typical summary impact table for a thermal insulation EPD.

PCR used to develop the EPD and the organization that performed the basis LCA.

Inside each EPD is a lifecycle diagram showing all the processes, inputs, and outputs included within the required system boundary. Further, the EPD contains additional charts and figures to help explain the makeup and function of the product, including illustrations, manufacturing process flows, and typical construction details. EPDs also may include a broad range of additional information that may be helpful to the end user. These include:

- references to relevant product technical standards;
- key performance information (e.g., fire resistance and moisture resistance);
- other environmental benefits (e.g., energy payback and recycled content); and
- information regarding product use toward achieving LEED credits.

Each thermal insulation EPD also specifically identifies the functional unit used to measure all environmental impacts. As discussed, the functional unit for thermal insulation is a square meter of insulation with a metric RSI value of 1. Frequently, the EPD provides additional information to help the end-user better understand the functional unit. As an example, a thermal insulation EPD may discuss exactly how R-value is measured for the product as well as how to convert RSI values into the ‘inch-pound’ R-values.

Finally, each EPD contains a summary table of impacts—undoubtedly, the most important part of the disclosure document. Figure 6 provides an example of a summary impact table taken from the EPD for generic polyiso roof insulation previously referenced in Figure 5.

A number of important elements may be identified in this typical impact table. First, the table identifies the specific impact categories/environmental indicators for which impacts are reported. As an example, the first impact category shown in the table is global warming potential (GWP). Next, the
table identifies the impact units for each impact category. In this case, the impact unit for GWP is kilograms of CO₂, or carbon dioxide equivalents. Additionally, the table identifies the specific impact measure, which is 2.32 kg of CO₂ equivalents. Finally, the table identifies the functional unit used to determine each impact measure, which is a square meter of insulation with an RSI value of ‘1.’

This typical impact table also illustrates a very important feature of many EPDs that may be problematic for the less mathematically inclined reader. As many of the unit impacts identified in the EPD are relatively small for the given functional unit, scientific notation frequently is use to express the measurement. As an example, ‘eutrophication potential’ in the summary table shown in Figure 6 (page 32) is stated as 1.28E-03 in scientific notation. In decimals, this would be 0.00128, or 1.28 thousandths.

**Comparing EPDs**

Given numerous thermal insulation EPDs have now been published, is it possible to make meaningful comparisons among the data they report? The answer must be qualified. As stated, EPDs for similar products must use the same PCR so the scope, methodology, data quality, and specific environmental indicators are equivalent. However, several other important caveats should be noted.

LCA and the development of EPDs is a very young practice, especially in North America. Although there are well-established ISO standards, considerable variations within the actual application of those standards can be found. Additionally, the underlying LCA databases are evolving constantly as new data becomes available. It is possible the newest LCA data may contain different levels of impact—simply due to improvements in measurement precision.

The way similar materials are installed within a building may also affect the validity of comparisons. As an example, insulation may be installed either continuously over the wall framing or roof deck, or it may be installed within wall or roof cavities. When it is installed continuously, the R-value provided is uniform. However, when installed within a cavity wall, the overall R-value is reduced by the lower R-value of the framing materials, such as 2x4s or concrete masonry units (CMUs). This means the functional R-value per square meter of wall or roof area will be lower than the functional unit of the insulation EPD and, as a result, an effective comparison between an insulation product installed continuously and one installed within a cavity is impossible.

Perhaps most importantly, minor differences among small building components may not yield significant impact savings when applied to an entire building. The concept of size versus the effect of any particular impact is very important. In many cases, the measured impact may be so minute that even when you scale up from the functional unit to an entire building, the overall impact remains relatively minor.

The use of scientific notation for very small measures of impacts in EPDs may help to illustrate the issue of impact size and effect. To expand understanding of size and effect, let’s go back to the example of the impact of eutrophication in the generic polyiso roof EPD previously discussed. In the EPD impact table for polyiso roof insulation shown in Figure 6 (page 32), the eutrophication impact of one square meter of polyiso roof insulation at the prescribed functional unit is 1.40E-03 or 1.40 thousandths of a kilogram of nitrogen. If this measure is then extrapolated to a 929-m² (10,000-sf) building with R-20 roof insulation, the net eutrophication potential for the roof insulation would amount to slightly more than 4 kg (8.8 lb) of nitrogen.

Converting this amount of nitrogen into a more tangible example, those 4 kg of nitrogen would be equal to the amount of nitrogen in fertilizer needed to produce approximately four bushels of corn. So, if you were able to find a roof insulation with only half the eutrophication potential as in this example, the net environmental savings over the entire
lifetime of the building would be equal to the net impact of two bushels of corn. This is not to say every bushel of corn is not important, but there are probably many other energy and environmental impacts to consider before making a definitive judgment regarding the use of a particular insulation material based on eutrophication potential alone.

For the construction specifier, it may be important to remember whenever comparisons are available, someone typically will use them to differentiate products in the marketplace. In some cases, comparisons may come from product manufacturers, but it is also likely green building advocates will employ comparisons to promote the use of ‘green materials.’ Consequently, it will be important for every building envelope consultant to fully understand the EPD process so comparisons may be accurately analyzed and interpreted for clients.

**Conclusion**

Based on this brief overview of EPDs, several conclusions may be suggested. First, it is likely the environmental product declaration will become an important tool in sustainable material selection and building design. Additionally, EPDs are obviously destined to play an important role in future building standards and codes. Finally, this review provides considerable support for the proposition that EPDs are being developed under rigorous standards to help assure scientific accuracy and functional comparability. However, there are a number of limitations in comparing EPDs at this time, partly due to the relative infancy of the EPD itself as well as issues involving the significance of differences observed. As a result, the better informed a construction specifier is in regard to EPD processes, the better value the consultant can provide to the end-user.

Given the number of EPDs that will become available within the next year or two, specifiers will likely be able to learn much more about the tool’s usefulness in the near future. In fact, as a building researcher, this author admits he is personally interested in digging deeper into EPD data and providing additional analysis for the consulting community. Based on an initial look at many of these EPDs, there will be real value—and a few surprises—as the industry continues to move to a more quantifiable approach to sustainable material selection.

**Notes**

1 For additional insight into this, see the author’s web feature at www.constructionspecifier.com/more-on-epds.