Environmental Product Declarations (EPD): Uncertainty
A Technical Review

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EPD are a type of environmental label which provide quantitative information about the environmental impacts associated with making and using a construction product, then managing it after use. EPD are produced according to set rules, using a standardised life cycle assessment (LCA) methodology and reporting format. Nevertheless, there is some uncertainty associated with the numerical values in EPD, as there is with all quantitative information about products. This uncertainty, along with other factors such as local differences between the rules for EPD production, influences the comparability of EPD.

This Briefing Paper describes key sources of uncertainty in the environmental indicator values provided in EPD and other factors which can influence the variability of results provided in an EPD. A separate, but related, Briefing Paper, *Environmental Product Declarations: Comparing EPD,* provides guidance on making comparisons using EPD.

Uncertainty in EPD

The numerical values provided in an Environmental Product Declaration (EPD) are calculated using Life Cycle Assessment (LCA) – at the heart of which are models of production-consumption chains.

LCA uses data characterising a wide range of activities such as raw materials manufacture, factory operations, goods transport, power generation and transmission; it uses information about the configuration of supply networks and markets; and the indicator values quoted in EPD are derived by applying cause-effect models for individual environmental themes. Within such an assessment there are a number of themes where uncertainty may arise, these are explained in this Briefing Paper.

Most of the data we feed into LCA calculations has natural variability. The single values we use are almost all values within a distribution that will have a mean and standard deviation, even though those statistical parameters are seldom known to the LCA practitioner. These different elements are subject to both "natural" data variability and other types of uncertainty with the result that a single indicator value in any EPD is one point in a distribution of possible values. Some possible – albeit imaginary – cases are shown in the figures below, where 'x' represents an indicator value in an EPD for a particular product and the area under the curve all the possible values for that indicator for that product (and module).

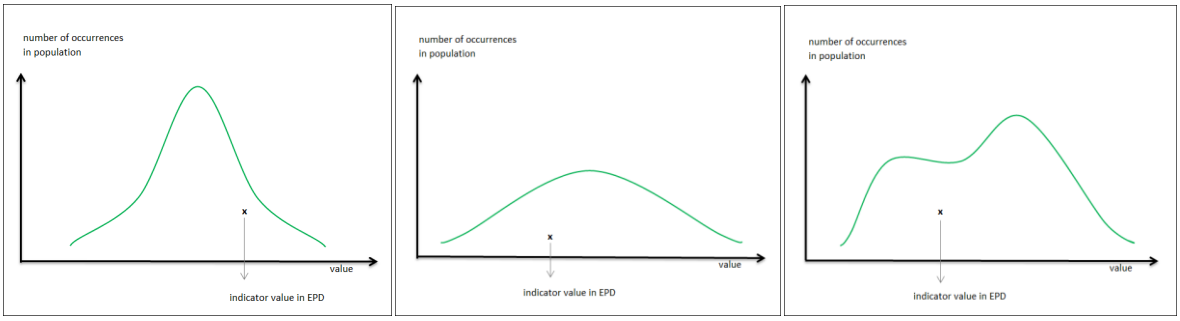

Figure 1

We can't obtain the means and /or standard deviation for these distributions in reality, but an understanding of the different uncertainties can help EPD users to evaluate the extent to which different values may be more or less certain, and thus to make more robust decisions using them.

In the sub-sections below, the different types of uncertainty are introduced and their relevance to different modules or uses of EPD are discussed.

Data uncertainty

At the heart of LCA calculations are data about manufacturing operations, transport activities, energy consumption, etc. All these data have natural variability; some examples of the sources of variability are:

- Measured gas consumption is based on meters whose accuracy is at best typically +/- 1.5%
- Point source emissions from factories are normally based on sample measurements - taken maybe once per year or once per month - scaled up to a full year of operation
- The compositions and calorific values of basic resources like hard coal, crude oil, and natural gas vary
- The mix of electricity generating technologies (power stations) feeding electricity grids normally varies hour by hour as well as year by year. Annual emissions factors for the UK grid for example show how changes in electricity generation, such as the move away from coal fired generation and the introduction of more offshore wind, have changed carbon emissions per kWh, but there are short-term fluctuations behind these annual averages
- Energy consumption of an energy-using product will vary with both external conditions and its age

Some of these are well-understood and the variability is within relatively narrow ranges.

In manufacturer-specific EPD of some basic materials such as cement and glass, these are the most important sources of variability for Modules A1-A3, and as long as electricity is not a major source of energy for the process, the possible distribution of indicator values is quite narrow, like Figure 2.

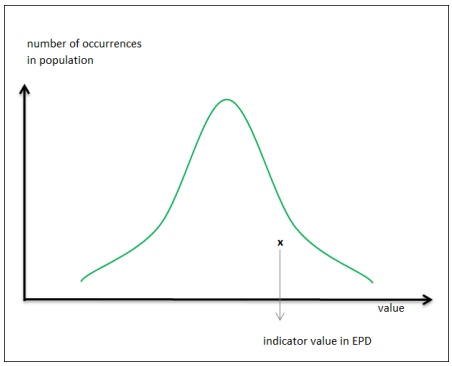

Figure 2

Data uncertainties – generic data

BS EN 15804:2012+A2:2019, the standard describing the methodology for producing an EPD, states that *"specific data derived from specific production processes, or average data derived from specific production processes shall be the first choice as a basis for calculating an EPD"*, and requires that *"An EPD describing a specific product shall be calculated using specific data for at least the processes the producer of the specific product has influence over"*.

Manufacturer-specific EPD seldom use supplier-specific data to characterise suppliers' processes, e.g. manufacture of input materials, not least because even if a supplier's data are available, manufacturers would need to check and reverify their own EPD if they were to change supplier. Furthermore, where manufacturers purchase materials through intermediaries or the materials pass through bulk stockpiles or multiple refining steps, even mapping the complete supply chain may be impossible.

Instead, "generic" data are most commonly used to represent upstream processes; for raw materials, these can be drawn from a sector level average EPD, or from one of the commercial databases such as GaBi or of ecoinvent. While these generic data are critical in LCA, data providers are volunteers, so these data aren't necessarily statistically representative of a whole population of producers. And there are, of course, real differences between producers of any product or material: they may use different technologies, different energy carriers, or differ in the formulation or design or the product. So even if the generic data are a very representative average for the regional sector in a given year, the differences between the various producers in the region can be quite large, so that the data used in the LCA might represent a distribution of performance like that represented by Figure 3

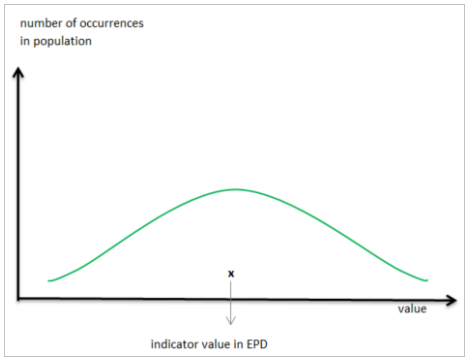

Figure 3

If the same material is made with two technologies, the overall mean across many producers might even represent a more complex distribution, for example like that shown in Figure 4.

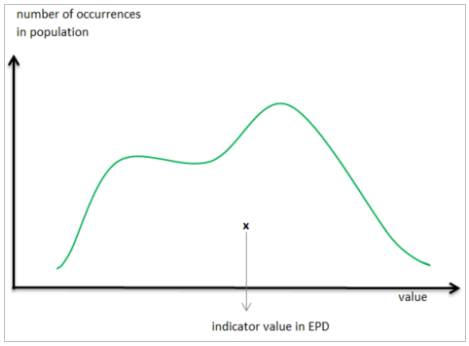

Figure 4

Methodological Uncertainty

Methodological Uncertainty – difference in accounting approaches

For some aspects of an LCA calculation, there are different choices of accounting approach, and different EPD may use different approaches, for example:

- the use of purchased Guarantees of Origin (GoO) to account for the source of electricity and biogas delivered from a national grid
- the way in which burdens are assigned (allocated) to pre-consumer recycled materials, e.g. metals or low-value co-products such as blastfurnace slag
- the use of the mass balance chain of custody credit approach[1].

These differences can significantly affect indicator values, for example, when electricity is a significant source of energy in manufacturing or if products are made with pre-consumer scrap or low-value co-products.

ECO Platform is the association of EPD Programmes for construction products. It provides additional calculation rules to EN 15804 to try to increase consistency and transparency across EPD programmes. All ECO Platform member programmes have to follow the ECO Platform requirements and use a common approach to verification. Differences may still arise[2], but newer EPD should at least be more transparent about the approaches taken.

Model uncertainty – supply networks

As noted earlier, supply chains or networks are difficult, even impossible, to map completely; for example we cannot know from which oil well the crude oil used to make a particular batch of plastic came. A cradle-to-gate LCA of a product represents a simplified snapshot of a supply network in a certain configuration. Supply networks are also dynamic, although some change more quickly than others and some changes are more environmentally-significant than others. The more complex the supply network for a particular product, the more some simplification is essential for an LCA to be practicable, and therefore the less the configuration embedded in the LCA is likely to match "reality". The omissions and simplifications should be recorded in the LCA reports underpinning EPD, and significant ones reported in the EPD itself.

For products that use materials purchased through intermediaries, bulk stockpiles or multiple refining steps, complete knowledge of that reality may be impossible to obtain in any case. This aspect of uncertainty is more significant for EPD of assembled products (for example windows or air conditioning units), for which the production of basic materials by upstream actors often accounts for most of the A1-A3 indicator value found in an EPD. For fossil- and mineral-derived basic materials themselves, the manufacturer's own processes are often the main driver of the indicator value, and this uncertainty about the upstream supply network is less significant.

[1] This is where a manufacturer uses, for example, 5% biobased content across all their production, but sells 5% of their production as having 100% biobased content.
[2] for example a few ECO Platform EPD programmes do not allow the use of Guarantee of Origin (GoO) for electricity or biogas, whilst most allow GoO but require the use of residual electricity mix if GoO have not been used

Model uncertainty – granularity of manufacturer-specific data

A manufacturer-specific EPD may be specific for one product, for a representative product or the average of a group of products, and could be specific for one site, for several sites or all the manufacturer's sites. The more granular the product and site disaggregation, the more closely the indicators represent the output defined in the EPD, particularly where manufacturing (module A3) is the main driver of the impact potentials.

However, if EPD are produced on a very disaggregated level, each EPD represents only a small part of a manufacturer's total production, and this extra granularity is only useful if the product on the market is identified in a way that matches the disaggregation applied in the EPD (for example, if site-specific EPD are produced, then buyers or users will need to be able to identify the site from which the product originated to make use of those EPD).

An EPD that is an average over several sites will be a better representation of the manufacturer's total output, but also the average of a broader distribution: more like Fig. 3 than Figure 2. This difference is particularly relevant to consider if comparing EPD, for example the EPD for a specific product from one site, with an EPD for an average product from several sites, as the granularity of the data is very different.

Model uncertainty – indicators

Different cause-effect chains link emissions to air or water, or the use of particular materials, to different categories of environmental change such as climate change, acidification of water bodies, or the degradation of ecosystems and the natural resource base. The models of these cause-effect chains used to derive the indicator values in EPD are stronger for some environmental categories than for others. For some categories, certain models suit certain regions better than others. The globally-applicable models used for climate change and ozone depletion are considered robust, but nevertheless the global warming potentials of certain greenhouse gases (for example methane, nitrous oxide) have been adjusted by small amounts in successive reports from The Intergovernmental Panel on Climate Change (IPCC).

Considering all of these factors, it is important not to over-interpret environmental indicator values from EPD. Although they're quoted to 3 significant figures in many EPD (for example 12.3 or 1.23E+01), the last digit would best be disregarded in most instances. As a rule-of-thumb, the minimum uncertainty in any A1-A3 carbon footprint (GWP-total) is probably ±10%, although a few producer-specific values from basic material manufacturers will have lower uncertainty.

Further reading:

- BS EN ISO 14025:2010 – Environmental labels and declarations – Type III environmental declarations – Principles and procedures
- BS EN 15804:2012+A2:2019. Sustainability of construction works. Environmental product declarations. Core rules for the product category of construction products
- ISO 21930:2017 – Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services
- EN 15941:2024 Sustainability of construction works — Data quality for environmental assessment of products and construction work — Selection and use of data
- RICS Professional Statement on Whole Life Carbon for the Built Environment
- ECO Platform Calculation Rules + ECO Platform Verification Guidelines

- Tackling uncertainty in life cycle assessments for the built environment: A review. 2023 Bath University

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V1 –August 2024