Using standards to maximise the benefit of digitisation of construction product Environmental Product Declaration (EPD) to reduce Building Life Cycle Impacts

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Submitted Abstract.
Introduction: Environmental Product Declarations (EPD) provide standardised environmental information about the impact of making, using, and disposing of products – their embodied impacts and many are now provided digitally for use in Building LCA. Recognising the need to significantly reduce the embodied impact of our buildings, ISO/TC59/SC17 WG3 has developed ISO 22057 to standardise the provision of digitised and digitalised EPD and ensure EPD can be used to their full potential, as machine interpretable digitalised data.
Methods: ISO/TC59/SC17 WG3 has developed the standard using for ISO procedures with liaison with those in ISO working on Building Information Modelling (BIM) and building level environmental assessment standards. Using the Vienna Agreement, CEN/TC350 is also participating in the work and should adopt the standard as a European Standard.
Results: ISO 22057 will ensure digitised gate to grave EPD results are accompanied by machine readable and machine interpretable data. By standardising this process using ISO 22057, it will ensure that all building LCA tools and tool developers have access to common digital information in the most appropriate format to use alongside BIM.
Conclusions: ISO 22057 offers the opportunity to provide standardised, machine interpretable EPD and generic data which will enable the rapid digitalisation of building life cycle assessment.

1 Introduction

We need to significantly reduce the embodied impact of our buildings. Over the last 30 years, Life Cycle Assessments (LCA) have been applied in the construction sector as the methodological foundation to evaluate environmental performance of construction works and construction products over the life cycle [1].

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At European level, CEN/TC350 standards have set a framework for the assessment of environmental, economic, and social aspects for both buildings and civil engineering works, and for construction products using Environmental Product Declarations (EPD), which provide standardised environmental information about the impact of making, using, and disposing of products. Using the life cycle stages and modules from the CEN/TC350 standards shown in Figure 1, environmental data for products, provided in EPD, can be used in assessments at building level. Figure 1 shows how data for the Product, Construction and End of life Stage modules (and the Use Stage modules if provided) can be used at building level, though only if the scenarios used in the EPD are appropriate for the building being assessed (for example, data for A4 or C3 can be used if the transport or end of life scenarios from the EPD and for building are the same, shown in Figure 1 by the lighter arrows for these modules, whereas the product stage data will always be applicable at building level). For the Use Stage of the building, for example the replacement of a window in Module B4, impacts can be modelled using data from the Product, Construction and End of life Stages of the window EPD, as shown in Figure 1.

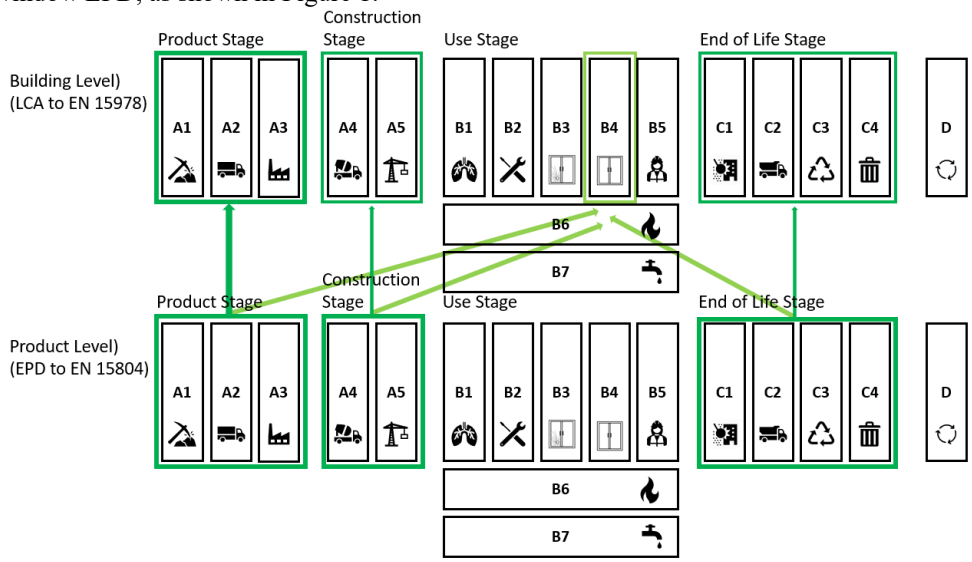

Figure 1 Life cycle stages and modules, and the relationship between product and building level

The increasing use of Building Information Modelling (BIM) makes it easier to quantify the materials used in buildings [2], and digitised EPD provide a source of environmental data allowing assessments to be undertaken directly within BIM or building LCA tools [3]. Although there have been some developments in digitising EPD, further work is needed to tackle machine interpretability of data and link with existing standardisation efforts on the transfer of product information to BIM. Standardisation is important so manufacturers can provide all product data credibly in a consistent way and the availability of the data is maximised for use in BIM and Building LCA tools.

A working group within the ISO Technical Committee for Sustainable Construction, ISO/TC59/SC17 WG3, has therefore developed a standard to be published as 'ISO 22057:2022 Sustainability in buildings and civil engineering works – Data templates for the use of EPD for construction products in BIM'. The standard is developed through the Vienna Agreement [4], with an ISO lead and CEN participation, and CEN can it as a European Standard, ISO EN 22057.

2 Use of EPD within Building LCA

2.1 Levels of digitisation

Figure 2 illustrates the various levels of digitisation that can be applied to EPD, drawing on the concept of SMART standards used by ISO to show the various stages of digitisation [5].

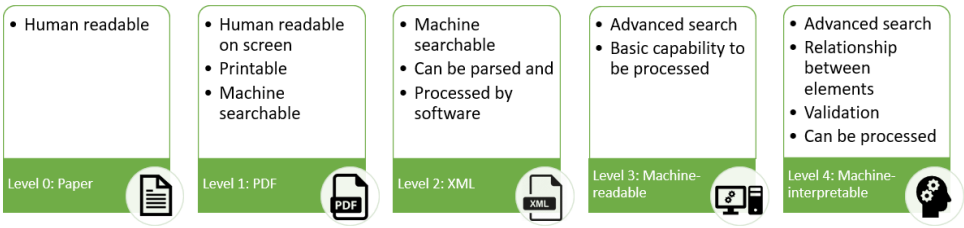

Figure 2 Levels of Digitisation, drawing on the SMART Standard concept

The first construction product EPD were developed by the Nordic EPD programme in 1997 [1]. Initially EPD were published as paper documents (Level 0) for circulation by manufacturers and EPD programmes at events, but providing them for download as pdf files (Level 1) followed shortly after as internet use became common around this time. This pattern was followed by the BRE Environmental Profiles EPD programme which launched in 1999 with paper copies of the generic EPD issued with the Methodology at the launch [6], but in parallel, EPD were also made available to download as pdf files by registered users through a website. To incorporate EPD data within LCA tools, such as the Green Guide to Specification [7], BRE manually entered data from EPD into MS Excel spreadsheets and MS Access databases which were used as the "engines" for these tools [8].

In March 2017, ISO/TC59/SC17 WG3 held a workshop in Paris to explore the use of EPD within building life cycle assessment and BIM. The workshop found that digitisation of EPD was a central part of strategies to use EPD in building LCA. This included its use in proposals for regulatory approaches to building assessment in Germany, France, and Sweden and in voluntary approaches in the UK and Norway.

2.1.1 ILCD+EPD

The ILCD+EPD format was the first example of EPD being provided via XML format (Level 2) and is considered machine readable (Level 3). ILCD+EPD draws on the International Life Cycle Database (ILCD) format [9] developed by the European Commission for use in life cycle assessment, but allows the environmental indicator results to be provided rather than the inventory flows used by ILCD. The format was initially developed for the German Government [10] to allow the provision of EPD data within the oekobaudat database for use in the Assessment System for Sustainable Building (BNB), and the German Sustainable Building Council (DGNB). Its subsequent development was taken on by InData, a group of European EPD programmes and other interested parties, as described by Brockmann [10].

In the short term, the use of the ILCD+EPD format proposed by the InData initiative, and endorsed by ECO Platform, appears to be the most commonly used format currently used to digitise EPD in Europe. From the start of 2022, ECO Platform EPD Programme members will have to make all new EPD available in both a digitised form using the ILCD+EPD format, and as pdf via the ECO Platform EPD Portal [11].

2.1.2 OpenEPD

In the United States, Building Transparency has developed a format called OpenEPD for use in their EC3 tool, based on the JSON format (Level 2) which is again considered machine readable (Level 3) and is claimed to be an improvement on ILCD+EPD, as it "enforces a key set of guarantees for interoperable data processing", including uniqueness of data for organizations, precision regarding PCR references and version control. [12] Additionally, it includes digital information on the technical performance of the product (though this does not comply with the Smart CE marking approach proposed in Europe) which allows digital EPD to be selected on the basis of both environmental and technical performance.

2.2 Digitalisation using machine interpretable EPD (Level 4)

In this context, digitalisation is defined as the full integration and application of "machine interpretable" EPD in Building Information Modelling (BIM) and building assessment, for example through the use of Application Programming Interfaces (APIs) to select EPD and the use of parameterised information from digitised EPD to evaluate specific scenarios for a given building.

Although both ILCD+EPD and OpenEPD use digital formats and provide machine readable EPD, they have limitations in relation terms of both their scope, and the extent to which the data provided can be considered to be machine interpretable. It is to address these concerns that ISO TC59 SC17 WG3 has developed ISO 22057, with a view to both standardising the digitisation of EPD and ensuring that digitised EPD data can be machine interpretable in the future. Below, we describe one limitation of existing digitisation approaches, and explain how ISO 22057 will address this to ensure EPD can be machine interpretable in future.

2.2.1 Supporting Information for Scenarios

OpenEPD currently only digitises the cradle to gate data (A1-A3) from EPD, ignoring any scenario data provided in the EPD. Although ILCD+EPD digitises the environmental indicators from all scenarios included in the EPD, it has no additional placeholders for supporting information for the scenarios. Without this information, the digital EPD cannot be checked to understand whether, for example, the A4 scenario data provided (which might represent 100 km of road transport, or transport from the factory in Poland to Berlin) are suitable for use at the building level, or whether they can be adapted to model a different transport scenario, for example 250 km of road transport. The only way to check this is for a human to access the pdf version of the EPD, which provides this information and read the relevant section of the EPD describing the scenarios. Thus, although the ILCD+EPD format is machine readable, it is not machine interpretable.

ISO 22057 looks to address this limitation by specifying how to provide standardised digital data for all life cycle modules, including a standardised approach to describing the underlying scenarios modelled in the EPD, in addition to the scenario results. It additionally allows the standardised reporting of multiple scenarios (e.g., transport to Norway and to Germany) and the ability to break scenarios down into sub-scenarios. for example, the A4 scenario for transport to Norway could be broken down into a sub-scenario for road transport from the factory to the local port, and the shipping to Oslo, with each sub-scenario including the data on which it is based, for example the distances. This will allow the impacts in A4 data to be automatically adjusted and scaled for a different building location.

2.3 Maximising the benefit of digitising EPD

ISO/TC59/SC17 WG3 has brought together experts from both the realm of EPD and the realm of BIM, with extensive knowledge of the real-life use of these concepts and of the underlying ISO and CEN standards they rely on. ISO 22057 has been developed using formal ISO procedures including enquiry with National Standards Bodies and interested parties, and ISO/TC59/SC17 WG3 has formal liaison with ISO/TC59/SC13 (BIM) and ISO/TC59/ SC17 WG1 (environmental performance of buildings). CEN/TC350 is also participating in the work to ensure the standard is suitable for use in Europe as EN ISO 22057.

ISO 22057 uses data templates as described by the BIM standard, ISO 23387:2020 [13], Data templates are sets of digital concepts, logically connected to each other, describing a product and its relevant characteristics of all kinds – technical, environmental, geometric, operation & maintenance etc. The logic set by the connections between concepts ensures product information interpretability by a software application, and thus, relieves humans of the processing of information otherwise held in formats like PDF that normally require manual interpretation. For example, tools will be able to automatically calculate transport impact in A4 based on a manufacturing location and scenario data, and to check if end of life scenario data in EPD are suitable for use at building level. Data templates have also been adopted for Smart CE Marking [14], so that standardised technical performance information for products and their EPD can be digitised using the same process, allowing the data to be used in parallel, for example to find product EPD that meet a given performance specification.

EPD data digitised according to ISO 22057 can be used in BIM for direct calculation of environmental impacts, and in standalone Building LCA/embodied carbon tools, e.g., using API to extract data from digitised databases. The ISO 22057 data template can also be used to digitise generic LCA data required for these calculation tools, as shown in Figure 3.

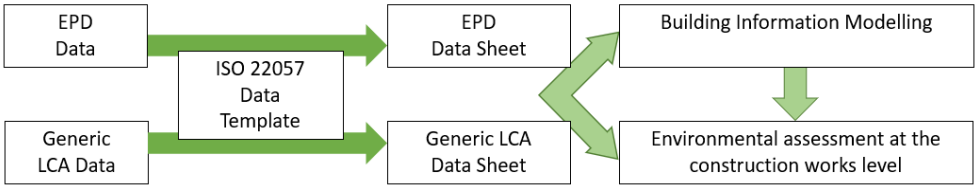

Figure 3 showing the relationship between EPD, Generic Data, Data Templates, Data Sheets, BIM, and Environmental Assessment (Source ISO DIS 22057:2020)

Existing databases, such as oekobaudat, should be able to convert from ILCD+EPD to the ISO 22057 format relatively easily, because many of the fields are common, but it will require accurate digitisation of the scenario descriptions provided in the EPD.

In addition to the approaches described in 2.2.1 to improve the digitisation of EPD scenarios, and the link to the digitisation of technical performance data described above, using the data template approach, ISO 22057 also addresses:

- Provision of product type data
- Provision of location information allowing machine interpretation using GIS
- Inclusion of Dependencies, e.g., EPD data can be associated with different versions of EN 15804, for ISO 21930, and with different national requirements.

3 Conclusion

This paper explains the background to the development of ISO 22057, describing the weakness of existing digitised EPD approaches, which mean, for example, that much of the impact data from EPD scenarios are rarely used. The development of ISO 22057 has used

the expertise of both the LCA and BIM community and existing standardisation efforts for transfer of information in BIM, facilitating the digitalisation of both EPD and generic LCA data using data templates to provide a machine interpretable, digitalised format which will ensure they can be fully utilised both in BIM and standard alone building LCA tools.

Embodied carbon accounts for at least 10% of global energy related CO_2 emissions [15], and there is an increasing interest in regulating and reducing these emissions. Coupled with the rising use of BIM and the benefit BIM brings to the quick evaluation of these impacts, it is clear that there will be a growing demand for digitalised EPD in a standardised format. ISO 22057 is intended to meet that demand and enable the rapid digitalisation of building life cycle assessment.

References

1. A. Rønning, Travels with LCA: the evolution of LCA in the construction sector. Aalborg, (2017). http://vbn.aau.dk/ws/files/267747330/PHD_Anne_Roenning_E_pdf
2. L.Á. Antón, J. Díaz, *Integration of Life Cycle Assessment in a BIM Environment* in Procedia Eng. Jan 1;**85**:26–32 (2014)
3. O. Kusche, C. Düpmeier, A. Braune, T. Brockmann, S. Rössig, *Extending the ILCD Format to Support EPD of Construction Products*, in: Environmental Informatics and Renewable Energies, 27th International Conference on Informatics for Environmental Protection. Aachen, (2013)
4. ISO, CEN, *Agreement on Technical Co-operation between ISO and CEN* (2001)
5. D.A. Czarny, J. Diemer, M. Schacht, G. Bulow, et al. Scenarios for digitizing standardization and standards. Berlin and Frankfurt; DIN & DKE.
6. N. Howard, S. Edwards, J. Anderson, *BRE methodology for environmental profiles of construction materials, components and buildings*, BRE; Watford (1999)
7. J. Anderson, N. Howard, *The Green Guide to Housing Specification*, BRE (2000)
8. J. Anderson, S. Edwards, P. Kapoor, I. Dickie, *Environmental Profiles of Construction Materials, Components and Buildings*, in International Symposium on Integrated Life-Cycle Design of Materials and Structures, Helsinki,308–312 (2000)
9. European Commission – JRC, *International Reference Life Cycle Data System (ILCD) - Documentation of LCA data sets. Version 1.1*. Luxembourg (2011)
10. T. Brockmann, *Digitalization of building LCA and international activities - In the context of German assessment system for sustainable building*. IOP Conf Ser Earth Environ Sci.; **323,** 1 (2019)
11. ECO Platform. *ECO Platform Internal Regulations*: Version May 2021 Brussels (2021) http://www.eco-platform.org
12. Building Transparency. openEPD.pdf. https://www.buildingtransparency.org/openepd/
13. ISO/TC59/SC13. *ISO 23387:2020. Building information modelling (BIM) — Data templates for construction objects used in the life cycle of built assets — Concepts and principles*, ISO; (2020)
14. CEN (2018) *CEN Workshop Agreement 17316:2018 Smart CE marking for construction products*. Brussels. Available from https://www.construction-products.eu/publications/smart-ce-marking-2/
15. UN Environment Programme, *2021 Global Status Report for Buildings and Construction*, Nairobi; (2021)