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TOWARDS STANDARDISED ENVIRONMENTAL PRODUCT DATA INTEGRATION IN IFC

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Abstract

Whole Building Life Cycle Assessments are currently hindered by manual, labour-intensive workflows and fragmented BIM and LCA data, making iterative use impractical. Existing automated workflows often lack adherence to standards, undermine data quality, or introduce data migration burdens. This study investigates integrating WBLCA data within IFC, focusing on the Danish context, by formalising Danish LCA requirements on bSDD. We propose a data model for implementing EPDs as PDTs, according to ISO 22057, in IFC using the `IfcProjectLibrary` exchange format defined in ISO 17549-2 and ISO 16757-5. A prototype implementation of PDT-to-IFC conversion tool demonstrates and evaluates the data model's feasibility.

Introduction

Life Cycle Assessment

Life Cycle Assessment (LCA), standardised through the ISO 14000 series, is the established methodology for quantifying the environmental impacts. It evaluates multiple environmental indicators across the life cycle, from raw material extraction to end of life, and is essential for avoiding burden shifting from one environmental problem to another. LCA applied to buildings is referred to as Whole Building Life Cycle Assessment (WBLCA). A WBLCA aggregates the impacts of construction products and combines them with impacts from the operational phase.

Product-level results in building LCAs are typically communicated through Environmental Product Declarations (EPDs), defined by ISO 14025 and harmonised in the construction sector through the Product Category Rules (PCRs) standard EN 15804. Product LCA data may be product-specific or generic, e.g. the ÖKOBAUDAT, which is based on representative assumptions rather than individual products. At building level, EN 15978 provides the assessment framework.

While EPDs are still mainly published as PDFs, machine-readable formats are gaining importance. In Europe, ILCD+EPD is widely used, alongside newer approaches like ISO 22057, which defines EPDs as product data templates (PDTs) for direct integration into BIM workflows.

Current WBLCA Workflow

Today, performing a WBLCA is complex and labour-intensive, relying heavily on manual processes such as extracting quantities from models, mapping materials to appropriate EPDs, and coordinating inputs across disciplines. Interdisciplinary communication relies on disconnected tools, while required environmental data is frequently incomplete or unavailable in digital formats. These steps introduce additional workloads, are error-prone, and limit the feasibility of iterative assessments.

Long-term data storage is a further challenge. Although buildings last for decades, LCA results and their underlying assumptions are often difficult to access or reuse after only a few years, reducing transparency and leading to information loss.

Existing automated workflows offer some improvements, but often lack alignment with standards, compromise data quality, or depend on data transfers between systems that require additional mapping and validation. There is clear potential to improve WBLCA by reducing manual effort, enabling earlier and more iterative assessments. Such workflows should align with data standards, maintain scientific rigour, and ensure that models remain transparent and self-documenting over time.

Background

Strategies for Storing and Sharing EPD Data

Addressing these issues requires tighter integration of LCA data into BIM-based workflows (Klumbyte et al. (2023), Bari et al. (2019), Safari and AzariJafari (2021)), with a focus on open standards, such as IFC, and vendor-neutral, collaborative processes like openBIM, to ensure interoperability and long-term data accessibility.

Initial attempts to integrate LCA data into IFC rely on the property sets `PSet_EnvironmentalImpactIndicators` and `PSet_EnvironmentalImpactValues`. These property sets store environmental indicators per functional unit and calculate scaled results based on element quantities. However, their practical use is currently limited. The main limitation is the inability to represent multiple lifecycle modules for a single element. The `LifeCyclePhase` attribute allows only one phase to be assigned, which prevents full "cradle to grave" representation. In addition, the supported indicators are not fully aligned with EN 15804, agreement on indicator definitions is incomplete, and LCA data cannot be consistently defined at material level or aggregated at building level.

ILCD+EPD and ISO 22057

The ILCD+EPD format, a subset of European Commission's ILCD framework, was an early and significant step in digitising EPDs, using XML to make environmental data machine-readable. Initially developed to meet German governmental requirements, it has since 2022 become the mandatory format for all new European EPDs.

Despite this progress, ILCD+EPD remains limited in its applicability within BIM workflows, particularly for representing construction objects. This limitation motivated the development of ISO 22057, which aims to better integrate EPDs into BIM workflows and support fully machine-interpretable EPDs in the future.

A significant benefit of ISO 22057 lies in its integration within systems already familiar to manufacturers, who will predominantly be responsible for maintaining and publishing EPDs moving forward. The task of digitising EPDs should not fall on architects or LCA practitioners. Additionally, the implementation of EPDs as PDTs presents opportunities for integration with existing systems such as SMART CE, ETIM, and GTIN/GS1. A JSON-based representation of ISO 22057, called DT JSON (Erlandsson et al. (2024)), is also mentioned in the EU Taxonomy and as the potential base-format for Digital Product Passports.

ISO 17549-2 and CODview2

The standard ISO 17549-2 defines an MVD of the IFC schema, named Construction Object Data View 2 - CODview2 for short. The purpose of CODview2 is to store and exchange configurable construction objects and their requirements using the `IfcProjectLibrary` mechanism of IFC. The MVD can be used to exchange both empty PDTs and filled product data sheets (PDSs). CODview2 does not support geometrical representations, but allows for exchanging geometric properties, focusing on complex, dynamic requirement constraints, and product specifications using embedded JavaScript functions. ISO 17549-2 does not define any construction-specific semantic entities or IFC element classes. Instead, it recommends using `IfcBuildingElementProxy` to represent all object types and defines classification through external data dictionaries based on ISO 12006-3:2022, such as the buildingSMART Data Dictionary (bSDD), as the sole sources of construction semantics.

ISO 16757-5 and IFC Catalogues

ISO 16757-5:2025 - *"Data structures for electronic product catalogues for building services - Product catalogue exchange format"* builds on the structure defined in ISO 17549-2 by, among others, introducing means of representing parametric geometry and generation of IFC geometries for selected product variants. The result is an IFC-based product catalogue, dubbed IFC catalogue, bridging the gap between manufacturer's catalogues and BIM project models. ISO 16757-5 keeps the strong connection to data dictionaries, relying on them for definitions of product classes and related properties.

Table 1: Central literature on LCA-IFC integration

Ref	Focus	Link to ÖKOBAU	Custom Pset	UUID Link	Spreadsheet with ERs	MVD	Custom schema
Lambertz, M. et al. (2019)	Analysis of multiple methods; IDM; IFC model architectures; UUID	✓	✓	✓	✓	✓	
Horn et al. (2020)	ifcXML; custom XML schema; DGNB; LCA MVD	(✓)	(✓)		✓	✓	✓
Schmid et al. (2022)	EPDs in IFC using IfcTask & IfcResource; bSDD; ISO 22057		✓		(✓)		
Theißen et al. (2020)	Building services; Revit; LCA MVD (custom Psets)	✓	✓	✓	✓		
Llatas et al. (2022)	SBA (LCA, LCC, S-LCA); custom Dynamo scripts		✓				

Existing Research on LCA and BIM Integrations

Research on BIM–LCA integration is extensive (Bolognesi et al. (2025), Parekh and Trabucco (2024), Potrč Obrecht et al. (2020)). Wastiels and Decuypere (2019) identified five levels of integration. These range from exporting Bills of Quantities (BoQs) and processing them in spreadsheets or dedicated LCA tools, to importing BIM models directly into LCA software, and performing real-time estimations using LCA plug-ins within native BIM software. A further level, relatively new in the LCA context, involves using manufacturer-specific BIM objects enriched with environmental data.

Most research and software implementations do not place IFC or openBIM at the core of the workflow. Studies that do focus on IFC or openBIM, are comparatively few. The main contributions in this area are summarised in Table 1. All of the approaches rely on creating custom IFC property sets. Some avoid embedding EPD data in the model, instead referencing external datasets via unique identifiers (UUIDs). While this reduces model size, it introduces risks related to data persistence, responsibility, and broken links.

The buildingSMART Sustainability Group's "Industry Report on Environmental Impact Indicators" (Schmid et al. (2022)) is the only approach identified that integrates ISO 22057 data into IFC and links to a DD. It defines LCA and EPD modules in the bSDD and maps them into IFC using existing entities such as `IfcTask` and `IfcResource`. However, the resulting structure is highly complex, relying on deep nesting and repurposing IFC concepts beyond their original intent to represent even simple EPD data. This limits software support and may reduce clarity for users. The approach also lacks scenario handling, diverges from ISO 22057 in several respects, is incompatible with the CODview2 MVD, and does not support easy reuse or exchange of EPD data across projects or BIM objects.

Notably, Kremer et al. (2025) recently demonstrated an implementation of IFC product catalogues with dynamic requirements, defined in ISO 16757-5, using a heat pump as

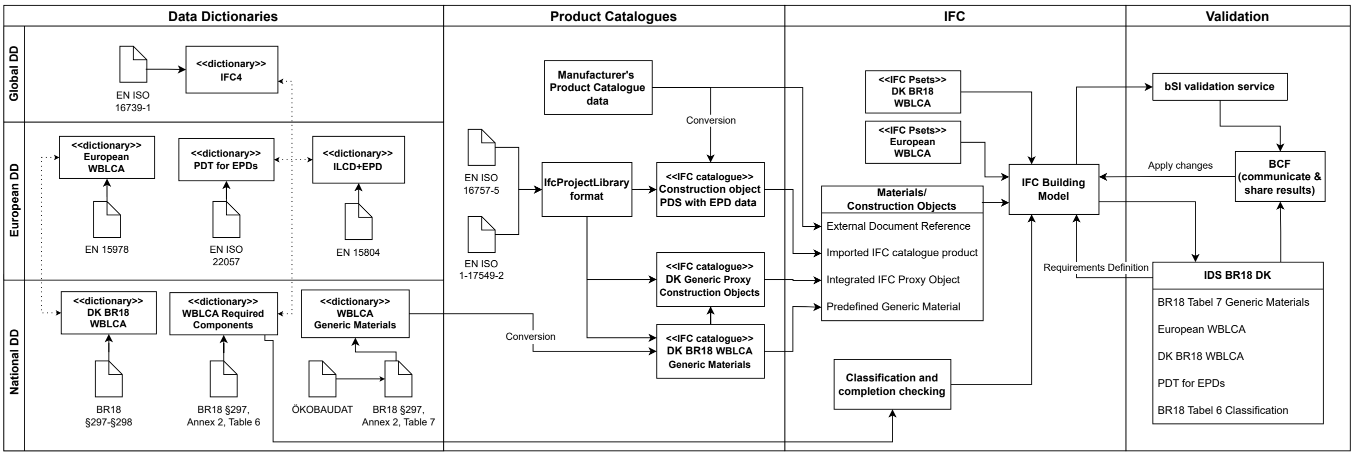

Figure 1: Data flow diagram of storing LCA information in an IFC context.

a case study.

None of the identified research investigates the implementation and enrichment of IFC catalogues, based on ISO 17549-2 and ISO 16757-5, with EPD data aligned with ISO 22057 as a means to enable transparent environmental data exchange and support automated WBLCA. Addressing this gap constitutes the primary focus and contribution of this study.

Danish Regulatory Context

In 2023, Denmark introduced new energy and climate regulations (§297–298), requiring WBLCAs. All new buildings, except unheated constructions under 50 m², need to comply with Global Warming Potential (GWP) limits ranging from 4 to 8 kg CO_2-eq/m²/year depending on function and size.

To define a consistent and practicable LCA scope, Annex 2, Table 6 of BR18 §297 specifies which building elements must be included and which may be excluded. Rather than requiring full material coverage, Table 6 focuses on elements that account for most of a building's climate impact, balancing analytical accuracy with feasibility and ensuring comparability across projects.

According to BR18, the environmental impact of included elements must be calculated using either product-specific EPDs or generic data defined in Annex 2, Table 7. Table 7 provides standardised generic values based on average data from the ÖKOBAUDAT database. No other generic datasets may be used, and any more detailed assessments must rely on third-party verified EPDs.

Methodology

This study proposes a method for integrating data needed to support a WBLCA process in a BIM context, with a specific focus on the Danish regulatory framework. The main objective is to enable practical integration of product-level EPD data into IFC models, with minimal manual input, clear data traceability, and long-term usability. Building-level LCA integration is addressed at a conceptual level.

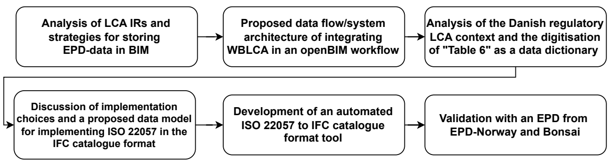

Figure 2: Summary of the methodological approach.

Figure 2 summarises the methodological approach. Firstly, existing approaches for storing, sharing, and reusing product data in IFC-based BIM workflows are then reviewed, alongside relevant sources and schemas for machine-readable, product-level LCA information.

Based on this analysis, an openBIM data model and workflow for WBLCA integration is proposed, linking IFC models with products stored in IFC catalogues, data dictionaries (DD), and national information requirements specified using Information Delivery Specification (IDS). Potential DD architectures are explored to support building-level, product-level, and Danish national requirements. As part of this work, BR18 §297, Annex 2, Table 6, is formalised, mapped to IFC classes, and digitised as a DD in the bSDD.

Implementation choices are then discussed and a data model for implementing ISO 22057 in the IFC catalogue format is proposed. This includes the handling of information modules, alternative scenarios and sub-scenarios, and the representation of EPDs at different modelling levels. Finally, a proof-of-concept automated conversion tool from ISO 22057 to the IFC catalogue format is developed using the IfcOpenShell library and validated with a real EPD from EPD-Norway using the Bonsai software.

Proposed Data Flow of LCA-IFC Integration

Figure 1 presents the proposed data model and its associated data flow. It illustrates the DDs required to support WBLCAs, structured across three levels: global, European, and national. In practice, an additional layer may be introduced for company- or project-specific data. Each dictionary is linked to the relevant standards that define its content. An implementation of ISO 22057 as a DD (shown as "PDT for EPDs") can build on existing initiatives, such as the buildingSMART Sustainability Group's "LCA Indicators and Modules" dictionary (Schmid et al. (2022)) discussed earlier.

Manufacturer's product catalogues provide input to construction objects shared through an IFC catalogue in the `IfcProjectLibrary` format, as defined in ISO 16757-5 and ISO 17549-2. The Danish context is represented through national data dictionaries and potential generic construction objects and materials in accordance with BR18 §297, Annex 2, Table 7.

An IDS tailored to Danish LCA requirements is used both to define information requirements and to validate the completed model. Final verification is carried out using the buildingSMART validation service, with results communicated via the BIM Collaboration Format (BCF), either externally or returned to the model for correction.

Implementation Analysis and Discussion

BR18 §298, Annex2, Table 6 as a Data Dictionary

A key part of the presented WBLCA workflow in the Danish context, is ensuring that it includes the required building components (part of inventory scope) defined in Table 6, Annex 2 of BR18 §298. Table 6 is provided by BR18 as an Excel sheet with nested categories of building elements, boolean specifying inclusion or omission, comments, and examples. To minimise oversights, support the integrated modelling process and be able to use the BIM model as a single source of truth (SSoT) in reporting and long-term archiving, Table 6 was formalised as a classification system to be used in IFC.

Using properties or classification systems defined in the bSDD has become one of the main recommended ways of extending IFC by buildingSMART. With the provision to avoid duplication of existing definitions, this approach presents a semi-standardised alternative to the many national and project-specific property sets that otherwise characterise the BIM landscape. Many BIM software today also provide direct integration with the bSDD API.

In line with this philosophy, we implemented the required elements from Table 6 as classification system on the bSDD[1]. Firstly, we made an English translation and numerical categories to organise the hierarchy. All required elements were then mapped to a corresponding IFC class. While this mapping should not be seen as a mandatory assignment to specific IFC classes, it serves as guidance for BIM practitioners during modelling and could be used in BIM software to recommend a classification assignment to the user. Figure 3 shows how an `IfcWallType` would be classified as a masonry wall ("Opmurede vægge") through nested `IfcClassificationReference` entities when using Table 6 as a DD.

Implementation of ISO 22057 in IFC

In this paper we present an integration of the ISO 22057 standard and its Annex A Excel workbook into the IFC schema using the IFC catalogue format defined in ISO 16757-5 and ISO 17549-2. In general, the IFC implementation adheres as closely to the standard as possible, preserving property names, descriptions, units, and other salient details unchanged.

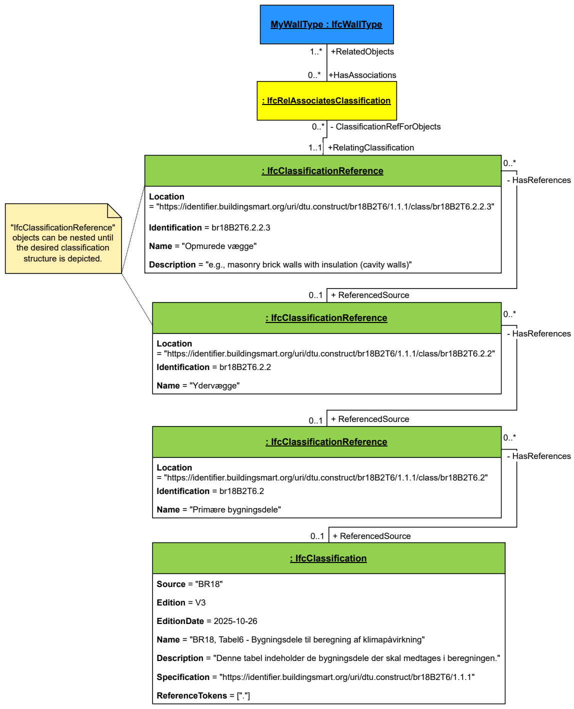

Figure 3: Example object diagram of association of BR18 Table 6 — "Masonry Walls" on the bSDD as a classification in IFC.

Minor, IFC-specific implementation choices include; converting property names into PascalCase to align with the IFC naming conventions, prefacing property sets with `LCAPset_` to differentiate custom property sets from official `IfcPropertySets` beginning with "`Pset_`", mapping "Data type" fields to the appropriate `IfcValue` type. In case of enumerations, the property type was sat to `IfcPropertyEnumeration` and individual enumeration values were assigned to appropriate data types as indicated in the standard. More substantial modifications, or implementation choices, are described in the following sections.

Omitting Enumerations with Boolean Values

ISO 22057 defines several properties with "yes" and "no" enumerations, seen defined in Tables 9 and 10 in the standard. Representing these binary states as enumerations is redundant where a boolean data type such as `IfcBoolean` is available. Using `IfcBoolean` directly simplifies the data model and reduces unnecessary complexity.

Flattening the Nested Structure

ISO 22057 defines a deeply nested data template, organised into property groups with three levels of nesting in some cases (Figure 4). Annex D of the standard ("EPD in Smart CE Marking Declarations") describes how this structure is mapped to the smart CE XML format, which supports only two levels of nesting; "Property Level 1"

[1]A preview version of the Table 6 DD can be found here.

groupings and “Property Level 2” individual properties. ISO 22057 introduces additional tags (e.g. <EPDGeneralInformation>) to represent higher-level categories (shown in blue on Figure 4).

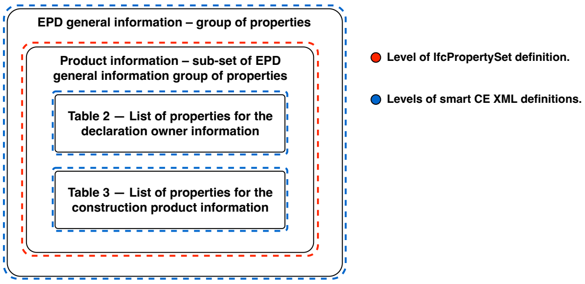

Figure 4: EN ISO 22057 nested structure adjusted for IFC and smart CE XML.

As IFC supports only a single level of property grouping, the intermediate groupings are implemented as `IfcPropertySets`. For example, the grouping highlighted in red in Figure 4 is represented as the property set `"LCAPset_ProductInformation"`. This balances the trade-off between restricting the number of properties in a single property set and minimising the overall number of property sets.

Implementing Information Modules and Scenarios

Representing EPD results for a single indicator, such as GWP limited to modules A1–A3, as commonly found in EPDs aligned with EN 15804+A1, is relatively simple and can be achieved with a single property (e.g. “`GWP_A1toA3`”). However, comprehensive assessment requires support for multiple indicators and life cycle modules, which substantially increases data model complexity. In ISO 22057, life cycle phases are defined through the “information module” property in the EPD methodological framework (Table 9, ISO 22057). This property links environmental indicators, waste categories, and output flows to specific modules. Complexity is further increased by the use of scenarios, which allow multiple declared values for the same indicator under different assumptions.

Several alternative approaches were considered for representing life cycle modules and scenarios in IFC, including dependent properties, repeated property sets following the ISO 22057 Smart CE XML implementation from Annex D, `IfcPropertyTableValue` properties, and the use of `IfcTask` and `IfcResource` entities (Schmid et al. (2022)). These approaches were rejected due to excessive property duplication, reliance on naming conventions, poor alignment with CODview2, increased model complexity, or limited software support.

The chosen approach represents environmental indicator results using `IfcTable`, referenced from a property via `IfcPropertyReferenceValue`. This enables a compact and structured representation closely aligned with the tabular format commonly used in EPDs, with indicators listed as rows and life cycle modules as columns. Unlike `IfcPropertyTableValue`, `IfcTable` allows an arbitrary number of columns and richer column definitions, supporting clearer semantics and better scalability as the number of indicators and modules increases. Units can be assigned at column level, improving machine interpretability while avoiding the repetition of properties for each module or scenario.

The `IfcTable` is composed of `IfcTableRow` and `IfcTableColumn` objects, with the former containing a list of values in their respective data types. `IfcTableColumn` enables the specification of an “identifier” attribute, allowing it to be referenced across multiple tables. It also supports the definition of “description”, “unit”, and a “reference path” that links to the object and attribute targeted by the column’s data via the `IfcReference` entity. The nesting capability of `IfcReference` entities further allows for direct linkage of an `IfcTableColumn` to a particular property within a property set of a specific object.

Given that `IfcTableColumns` can define units while `IfcTableRows` cannot, an alternative approach involves transposing the table, positioning indicators as columns and modules as rows. Unlike modules, indicators require unit definitions, and assigning them proper IFC units enhances computational interpretability, compared to listing them as IfcLabels in an additional column. However, this approach would complicate the direct referencing of modules to their defining property sets, and it may be more user-friendly to adhere to the conventional table format familiar from PDF EPDs.

A potential drawback of this approach is that the `IfcExternalReferenceRelationship`, utilised for linking properties to external definitions such as those in the bSDD, is not applicable to `IfcTableRows`. This constraint implies that while individual indicators would be able to be directly linked to their definitions in a DD, the overarching property could reference a compiled list of indicators.

While current support for visualising `IfcTable` is limited in some software, the data structure itself is robust, extensible, and well suited to automated processing.

Implementation of Alternative Scenarios

ISO 22057 allows two interpretations for handling alternative scenarios; either by defining separate data sheets for each scenario or by consolidating multiple scenarios within a single data sheet (as presented in Annex D).

Both approaches were examined in an IFC context, in the first of which, each scenario is modelled as a separate object definition (for example, alternative `IfcWallTypes`), each containing a complete set of environmental indicator results. Emission values are organised in a table linked to the `EN15804+A2CoreLCIAIndicators` property, under a new property set, `LCAPset_EnvironmentalIndicators`, housing all relevant indicator values (Table 2). Since `IfcTableColumns` can be referenced by multiple tables, the `ReferencePath` attribute, alongside an `IfcReference` object, points to the specific

Table 2: Implementation of modules using IfcPropertyReferenceValue and IfcTable

Pset.Name:	LCAPset_EnvironmentalIndicators					
Property Name	PropertyReference					
	Table.Name: EN15804+A2CoreLCIIndicatorsResults					
	Indicator	Unit	A1	A2	A3	...
EN15804+A2CoreIndicators	GWP_Total	kg CO2-eq				
	GWP_FossilFuels	kg CO2-eq				
	GWP_Biogenic	kg CO2-eq				
	...	...				

property set that corresponds to the module scenario, as outlined for modules A4 to D in the standard. This approach defines only a single scenario per module, suggesting that for alternative scenarios, the entire structure would be duplicated, rather than duplicating individual properties or property sets.

An alternative is to encode multiple scenarios within the same object definition by introducing additional properties and property sets for alternative scenarios and linking them to a base scenario. While this can be advantageous in early design phases, where rapid comparison of alternative assumptions is valuable, it relies on project-specific naming conventions and increases internal object complexity. It also departs from the main-text guidance of ISO 22057 and complicates standardisation through data dictionaries, as only the base scenario can be predefined.

Overall, modelling alternative scenarios as separate construction objects provides a straightforward and schematically clearer method. This approach is particularly suitable for the later stages of design, where the building LCA's primary goals is documentation and long-term storage of product information. However, if LCAs were reimagined as not merely calculations yielding a single numeric results but as comprehensive uncertainty analyses in and of itself resulting in a range of potential outcomes, the second approach could become relevant even in final LCAs. Figure 6 shows the implementation of alternative scenarios as separate construction objects.

Implementation of Sub-scenarios

Sub-scenarios, such as waste handling or transport, introduced in section 8.4.1 of ISO 22057, consist of an intricate data model with nested property dependencies. This complexity, as shown in Annex D for the smart CE XML, could be simplified by repeating all properties relevant to a module scenario. The IFC framework does, however, offer a mechanism for defining nested property sets through `IfcComplexProperty`, which allows grouping several properties under a single entry within an `IfcPropertySet`. Figure 6 details how sub-scenarios can be actualised within the IFC model using `IfcComplexProperty` and `IfcPropertyDependencyRelationship` to establish property dependencies. However, due to inconsistent implementation in BIM software, this mechanism is considered optional, with direct repetition of sub-scenario properties per scenario representing a valid solution.

Representing EPDs at Different Modelling Levels

Construction objects carrying EPD information may exist at different levels of detail and should therefore be definable at multiple levels within a BIM model. Where an EPD represents a complete building element, such as a prefabricated wall or a door, it can be assigned at the element type level. The element type defines LCIA indicator values per declared unit, while the corresponding element instance, with quantities defined through an `IfcQuantitySet`, represents the scaled results. These scaled values may be explicitly stored, for example in `IfcTables` for communication or visualisation, or derived implicitly by storing only a scaling factor and a reference to the type. This approach is exemplified in Figure 5 where an `IfcWallType` specifies $1m^2$ of a prefabricated wall, and the `IfcWall` instance represents the scaled results for $320m^2$ of the wall.

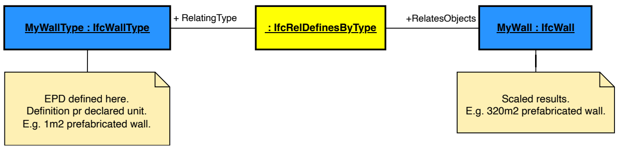

Figure 5: Construction object EPD definition on element level.

However in some cases, EPDs may describe smaller components or raw materials rather than complete building elements. Here, EPDs can be assigned at the material level, such as to an `IfcMaterialLayer` within a larger assembly, as exemplified on Figure 7. Defining EPDs at the type or material level avoids redundant property sets on individual instances, reducing file size and improving model quality. For materials requiring scaling, typically declared per mass or volume, ISO 22057 introduces reference quantities and scaling factors. In IFC, these can be implemented using attributes such as `LayerThickness` together with user-defined scaling properties, allowing EPDs to be defined once at the `IfcMaterial` level and consistently applied across different material set definitions.

PDT-to-IFC Implementation

The data model presented in the previous sections was evaluated by an implementation in the IFC STEP Physical File format (SPF-IFC), using a custom conversion tool developed with the IfcOpenShell library. The implemen-

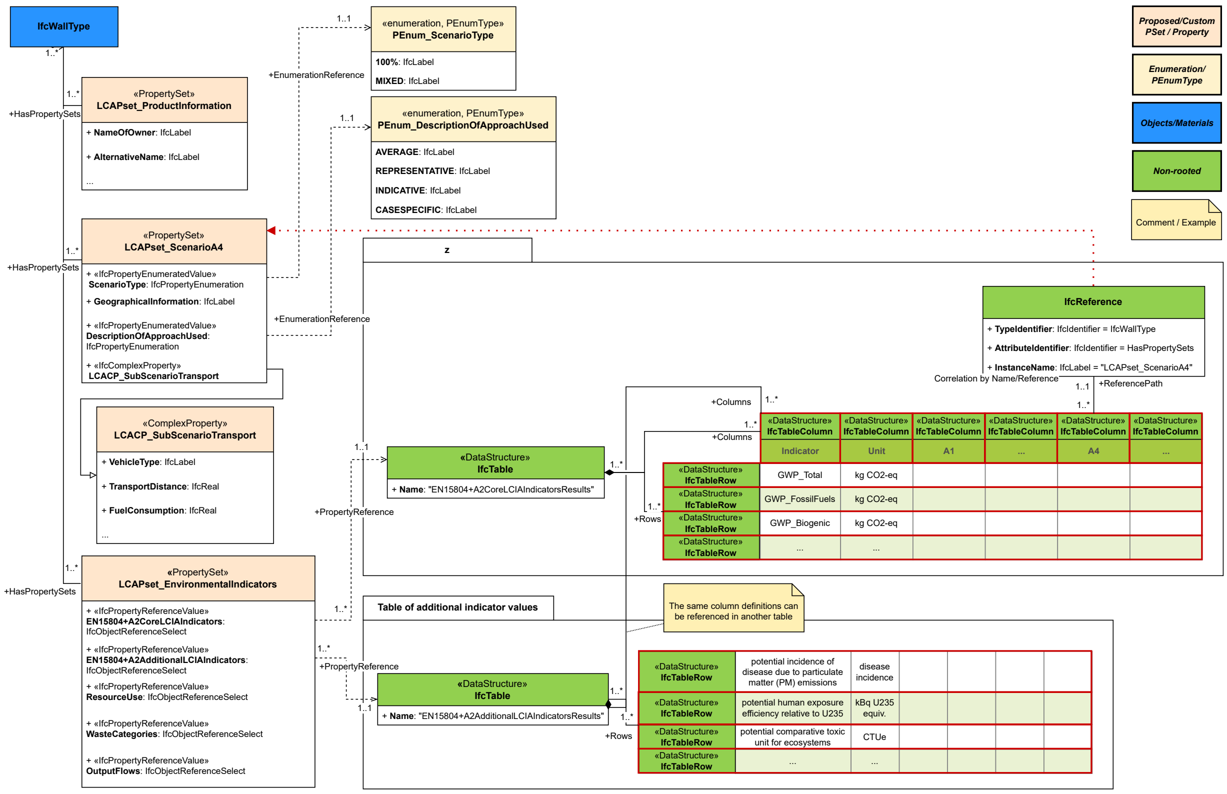

Figure 6: Alternative scenarios defined in different construction objects - with sub-scenarios.

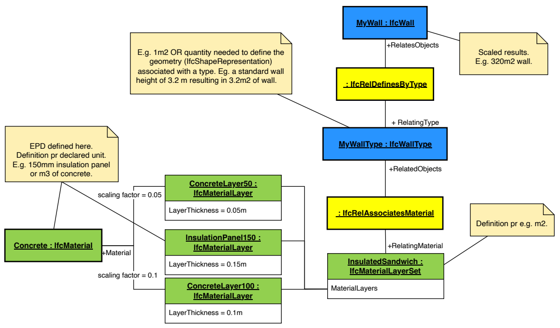

Figure 7: Construction object EPD definition on material level.

tation is based on the CODview2 MVD and the accompanying example IFC files.

The workflow begins with the creation of a `IfcProjectLibrary` model, including reference libraries. A user-defined element type is then introduced as the anchor for all subsequent LCA data. Property sets with simple or complex properties are created, including the dedicated `LCAPset_EnvironmentalIndicators`, which stores LCIA indicator results using `IfcTable`. All properties are linked to bSDD definitions via the `Specification` attribute of `IfcProperty`.

The ISO 22057 product catalogue implementation was demonstrated using a real EPD from EPD-Norway. The pilot project "EPD in ISO 22057 format", which provides a JSON-based representation of the standard, was used as input for the conversion. As an example, the EPD for "Massiv betongelement - Vegg, lavkarbonbetong" was selected, with Listing 1 showing a subset of properties from the `LCAPset_ProductInformation` property set.

As the available EPDs did not include scenario data, an extended version with proxy data was created to demonstrate the full implementation, including `IfcPropertyEnumeration`, `IfcPropertyEnumeratedValue`, and `IfcComplexProperty`. The resulting IFC files were validated using the Bonsai add-on. The full source code, generated IFC files, and supporting spreadsheets are available online.

```
#13=IFCPROPERTYSET('3PqJDfAD140QLz7fZhO18q',$,'
    LCAPset_ProductInformation','Document reference:
    ISO 22057 8.2.2 - Table 2 and Table 3',(#14,#15,#
    16,#17,#18,#19,#20,#21));
#14=IFCPROPERTYSINGLEVALUE('NameOfOwner','https://
    identifier.buildingsmart.org/uri/LCA/LCA/3.0/prop/
    nameofowner',IFCLABEL('Jaro AS'),$);
#15=IFCPROPERTYSINGLEVALUE('UniqueIdentifier','https
    ://identifier.buildingsmart.org/uri/LCA/LCA/3.0/
    prop/uniqueidentifier',IFCIDENTIFIER('976 241 053'
    ),$);
#16=IFCPROPERTYSINGLEVALUE('WebDomain','https://
    identifier.buildingsmart.org/uri/LCA/LCA/3.0/prop/
    webdomain',IFCURIREFERENCE('https://jaro.no/'),$);
#17=IFCPROPERTYSINGLEVALUE('ProductName','https://
    identifier.buildingsmart.org/uri/LCA/LCA/3.0/prop/
    productname',IFCLABEL(' Massiv betongelement -
    Vegg, lavkarbonbetong'),$);
```

Listing 1: Fragment of the "Massiv betongelement - Vegg lavkarbonbetong" EPD from EPD-Norge in IFC

Conclusions

This study contributes to the integration of product-level LCA data into IFC-based openBIM workflows. It reviews existing methods for storing, sharing, and reusing product data in BIM, together with available schemas for machine-readable LCA data. ISO 22057 is identified as the most suitable standard for product-level LCA information, while the IFC catalogue format based on `IfcProjectLibrary`, as defined in ISO 17549-2 and ISO 16757-5, is selected as the main mechanism for integrating this data into IFC.

We propose an openBIM workflow for WBLCA that improves data longevity, traceability, documentation, and regulatory compliance, while reducing manual work for LCA practitioners. The approach relies on coordinated data dictionaries at national, European, and global levels. As a concrete implementation, BR18 §297, Annex 2, Table 6 is formalised, mapped to IFC classes, and digitised as a data dictionary in the bSDD.

A detailed IFC data model for integrating ISO 22057 into the IFC catalogue format is developed. Key modelling choices are discussed, including the handling of information modules, alternative scenarios, sub-scenarios, and different levels of EPD representation. These concepts are tested through a proof-of-concept tool that converts EPDs from the ISO 22057 JSON format to IFC-SPF. The approach is demonstrated using a real EPD from EPD-Norway and validated with Bonsai.

The proposed solution also has some limitations. Although it can be implemented in IFC-SPF today, many of the more advanced IFC features used, such as complex property structures beyond `IfcPropertySingleValue`, are not yet supported by most BIM software. This is a tooling limitation rather than a conceptual one and should be addressable if demand increases.

In addition, while ISO 22057 represents a significant step towards machine-interpretable EPDs, recent work has highlighted the remaining challenges that require further refinement of the standard Aragón et al. (2025).

This study focuses on product-level LCA data. Future research should extend the approach to building-level information, including a systematic analysis of information requirements and their implementation within IFC-based workflows.

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