Architect: Christiansen Andersen
Photograph: Hampus Berndtson

REPORT

IMPLEMENTING THE PARIS AGREEMENT AND REDUCING GREENHOUSE GAS EMISSIONS THROUGHOUT THE LIFE CYCLE OF BUILDINGS:

EUROPEAN PUBLIC POLICIES, TOOLS AND MARKET INITIATIVES

Authors: Rutger Broer, Jelena Simjanovic, Zsolt Toth (BPIE)
Reviewed by: Lucas Rosse Caldas, Fernanda Belizário, Vanderley John

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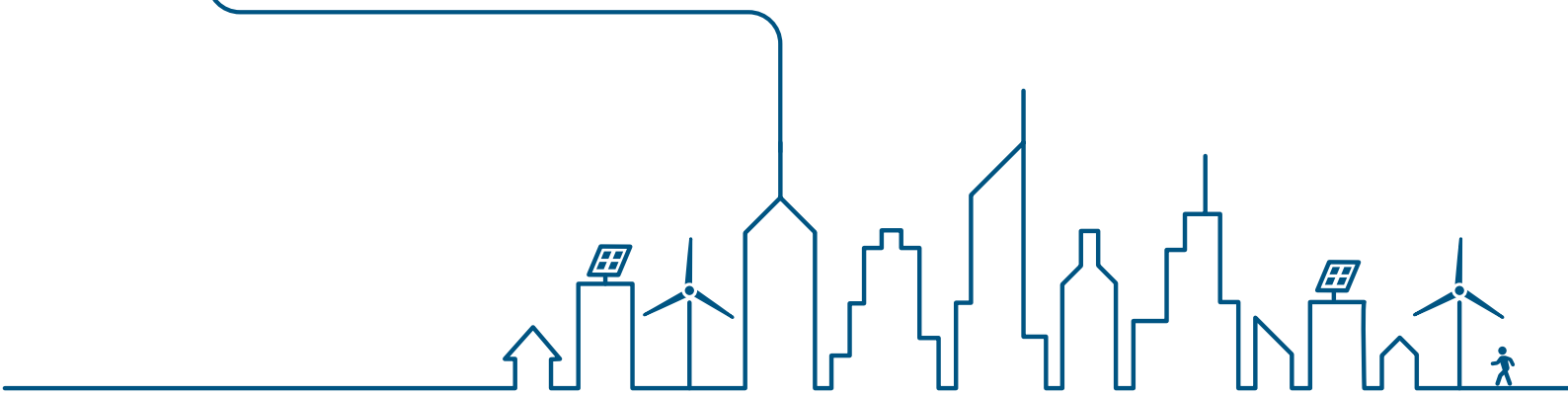
CONTENTS



EXECUTIVE SUMMARY

The European Union as a signatory to the Paris Agreement has set ambitious goals of becoming a carbon-neutral continent by 2050. To fulfil its obligations and achieve climate targets, Europe needs deep emissions reductions across industries, including the buildings sector, which contributes to around a third of all Europe's emissions.

Until today, emissions reductions in the sector have focused on the building's operational phase – improving energy efficiency to reduce operational carbon emissions. While these are necessary efforts, they do not cover all building sector-related emissions that need to and can be reduced. The existing building stock needs to be renovated, while new buildings need to be built with low-carbon materials, and according to the most climate-friendly practices. This process of renovation and construction of new buildings and infrastructure carries its own emissions. Accounting for these emissions requires robust and verifiable measurement, and reliable datasets.

Thus far, low-carbon construction practices have mostly been voluntary, market-driven efforts. As with many initiatives, the initial lack of regulation and official guidelines has resulted in a patchwork of practices, methodologies, standards and certification systems. Despite some laudable efforts, the ongoing policy and market initiatives will need to be made more 'mainstream' – easier to understand, accessible and made in a way that encourages greater engagement and market uptake. The building-level practices must be well coordinated and aligned with upstream policy actions on raw materials and construction products, and with the downstream policies addressing waste and end-of-life practices.

Manufacturers of construction products have started publishing life-cycle assessment (LCA) data on their products. They often do this by using so-called environmental product declarations (EPDs), according to international standards. EPDs are becoming a recognised resource for calculating and documenting the embodied carbon and environmental footprint of products and buildings, although they are not yet mandatory.

The Construction Products Regulation, which provides the EU's regulatory framework in this area, is undergoing revision to put greater emphasis on embodied environmental impacts. Technical specifications will measure, test and verify performance in product-specific regulations in conjunction with harmonised standards across the EU. These EU standards are of a high quality and prescribe transparency, certain core assessment rules and a clear format for LCA studies. Further harmonisation of LCA methodologies is, however, necessary to enhance comparability.

LCA studies and whole-life carbon (WLC) accounting assess the impact of a construction product or building over its complete life cycle, beyond its operational 'use phase'. WLC focuses primarily on carbon emissions; LCAs also evaluate other environmental impacts. The main barrier to considering the whole-life carbon impacts of buildings relates to value chain fragmentation, lack of a comprehensive policy framework and availability of reliable data. The use of digital building logbooks and material passports (files storing information about construction materials and products that are part of a building) is one way to make carbon data in buildings more easily accessible, even though these instruments are not yet widely adopted within the EU. Information tools like these will play an important role in increasing the availability of reliable life-cycle data by making it easier to store and share data.

In addition to these new tools and requirements, some countries in Europe have started introducing legal frameworks to regulate embedded emissions, setting up building codes and requiring LCA caps in new buildings. For example, the Netherlands has introduced CO_2 limits for all new residential and non-residential buildings, Denmark for buildings over 1000m2 and France for all new buildings, while Sweden and Finland have plans to do so. The UK, Germany and Switzerland have established LCA requirements for public buildings. Setting up national environmental databases to facilitate collection of EPDs and as a source for building benchmarks is key to facilitate the measurement of WLC and compliance with these targets. Providing access to all building sector stakeholders could make data more transparent, verifiable and easy to use and make EPDs more comparable. This could provide an important basis for developing low-carbon building practices in Europe.

The report begins with a review of the EU and policy landscape and underlines the urgency of tackling WLC emissions in the building sector. It also identifies frontrunning EU countries that have already adopted regulations targeting upfront emissions in addition to the operational carbon footprint. The report discusses the importance of product and building level assessments (green building rating tools), as well as the central role of information tools, such as logbooks, material passports and building information modelling, which can provide granular data that such environmental assessments require. Finally, the report looks at a number of national environmental databases and their business models to showcase best practice examples that can guide the design and implementation of similar schemes beyond Europe.

THE REPORT CONCLUDES THAT:

- Measuring and effectively reducing building related greenhouse gas emissions beyond the operational phase is necessary and possible. It requires a comprehensive policy framework and access to verifiable environmental data.
- Data needs to be collected, stored and managed in a systematic and transparent way; data should be made available to all parties, both private and public stakeholders.
- Third-party verification of data is essential to ensure its accuracy, giving certainty to investors, developers and clients about the product properties and future performance.
- Outlining product- and project-specific accounting methodologies, together with the system boundaries, is essential for creating a system that enables products and project level comparisons and benchmarking.
- Data management, accounting methodologies and third-party, independent certification schemes also need to be aligned with global industry standards. This would make materials and processes comparable across jurisdictions, as well as reduce costs for producers and developers.
- A common EU policy on WLC is still in the making. So far, three European countries (the Netherlands, Denmark and France) have introduced CO_2 limits for a large share of new buildings, and two others (Sweden and Finland) have plans to do so.
- A choice of a business model for environmental databases will depend on local circumstances. There are different private and public database financing models. The model will depend on many variables – type of data collected, number of participants, level of WLC importance in national policymaking, etc.

ABOUT THE INITIATIVE

The Paris Climate Agreement in 2015 recognised climate change as a global challenge that requires a decisive response. The European Union is committed to sustaining cooperation and building partnerships and alliances to achieve the climate objectives, by promoting cooperation between the EU and non-European major economies. In this context, the EU has established a Strategic Partnership for the Implementation of the Paris Agreement (SPIPA) to promote bilateral dialogues and cooperation in the field of climate action between the EU and 15 other major economies, favouring concrete interventions in line with the global ambition level set by the Paris Agreement.

SPIPA's objectives are threefold:

1. Facilitate the exchange of climate policy options and good practices between the EU and non-European major economies with a view to enable policy changes.
2. Advance bilateral cooperation and investment in the pursuit of the goals of the Paris Agreement (and of nationally determined contributions).
3. Contribute to improving public awareness, including by the business community, of challenges and opportunities associated with the implementation of the Paris Agreement.

The partnership encourages exchange and collaboration across all levels of governance and stakeholders from business, academia and civil society channelling economic and political relations to drive the implementation of the Paris Agreement.

Being responsible for 38% of total global energy-related CO_2 emissions, the built environment plays a vital role in delivering the Paris Agreement[1]. Achieving climate neutrality by 2050 requires a fundamental transformation of the construction and buildings sectors. Residential, commercial and public buildings in Brazil are responsible for about 40% of electricity consumption. The built environment offers significant carbon mitigation potential: decisive policy action will not only address the ongoing climate emergency we are facing, but will also directly reduce energy costs and improve security of supply, and has the potential to create widespread business opportunities and significant numbers of new, local jobs.

Based on this context, the study presented in this report was developed at the request of the Brazilian Ministry of Mines and Energy (MME) within the scope of the SPIPA programme.

[1] Global Alliance for Buildings and Construction. 2020. Global Status Report for Buildings and Construction

ABOUT THIS REPORT

This report discusses policies, tools and market initiatives aimed at reducing upfront emissions – that is, the embodied carbon associated with building construction, including the extraction and processing of materials. It intends to:

- Discuss concepts such as whole-life carbon (WLC) assessment and life-cycle assessment (LCA) to Brazilian policymakers and construction sector stakeholders
- Provide a brief overview of the EU policy landscape targeting energy efficiency and carbon reductions in the built environment
- Showcase relevant market practices and trends
- Highlight lessons learned from existing and forthcoming initiatives and present best practice examples that can guide the design and implementation of similar schemes in Brazil.

ABBREVIATIONS

EPD Environmental product declarations
EED Energy Efficiency Directive
EPBD European Performance of Buildings Directive
EU European Union
ISO International Organization for Standardization
LCA Life-cycle assessment
RED Renewable Energy Directive
WLC Whole-life carbon assessment

1.

SETTING THE SCENE – THE EU CLIMATE AMBITIONS AND THE IMPORTANCE OF THE BUILT ENVIRONMENT

The EU will have to decarbonise its entire economy by 2050 to fulfil its obligation under the Paris Agreement. Almost half of the EU's emissions come from the buildings sector, with energy-related emissions from the use and operational phase accounting for 36% of all emissions[2] and a further 11% coming from the manufacturing, construction and demolition phase[3].

Decarbonising the built environment requires energy efficiency measures, switching to renewable heating and cooling systems, and improving resource efficiency and circularity in buildings throughout the entire supply chain. To achieve this, the European Commission[4] has set a structure around the EU's energy and climate goals called the Clean Energy Package for all Europeans. Key building-related policies of this package are as follows[5]:

1. The Energy Performance of Buildings Directive (EPBD) lays down a harmonised building performance calculation methodology, and minimum performance requirements for new buildings and renovations.
2. The Energy Efficiency Directive (EED) targets 32.5% energy efficiency improvements by 2030.
3. The Renewable Energy Directive (RED) targets having 32% renewable energy by 2030.
4. The Governance Regulation ensures implementation of these goals through national energy and climate plans and national long-term strategies[6].

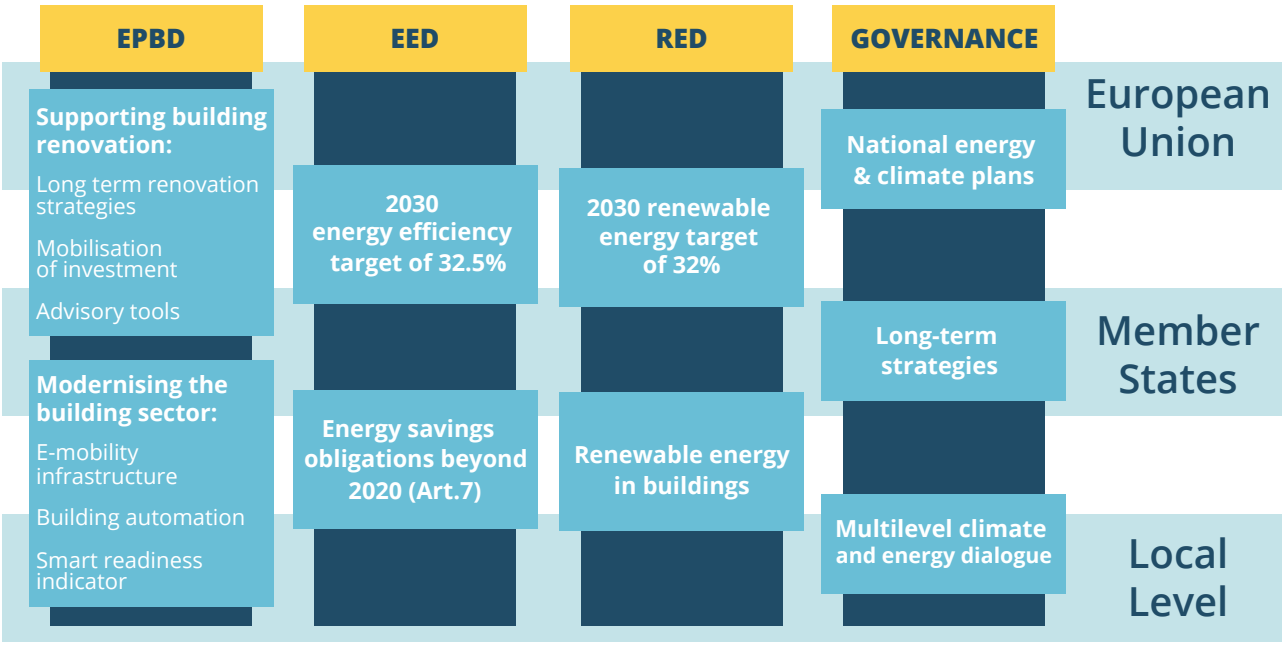


Figure 1 - Main buildings-related clean energy package elements. Source: BPIE.

[2] European Commission (2020). Renovation Wave Communication

[3] IEA (2020) Energy Technology Perspectives and IEA (2019) Material Efficiency in Clean Energy Transitions. International Energy Agency.

[4] The EU executive branch.

[5] European Directives are binding legislative acts setting out EU-wide goals. Member States (MS) are free to decide how to transpose directives into national laws.

[6] National energy and climate plans are national plans to reduce carbon emissions, and long-term renovation strategies specific strategies to decarbonise the building stock.

The European Green Deal (2019) set clear goals for the EU to become climate neutral by 2050, and makes clear that the built environment is a priority. The Green Deal puts forward a climate law to embed the legal commitment for achieving climate neutrality. As part of this effort, EU leaders agreed in December 2020 on reducing greenhouse gas emissions by 55% by 2030, compared to 1990 levels.

In 2020, the European Commission released the so-called Renovation Wave strategy as a concrete plan to decarbonise the building sector. The Renovation Wave strategy aims to double the built environment renovation rate by 2030 by enforcing existing measures – energy performance certificates, long-term renovation strategies, more financial and technical support – and by introducing some new instruments.

These new instruments include (i) mandatory minimum energy performance standards, and (ii) developing a 2050 roadmap for reducing whole life-cycle carbon emissions in buildings by 2023. Two other instruments likely to be implemented are (i) improvement of construction products' sustainability, likely by including sustainability criteria in the revision of the Construction Products Regulation, and (ii) review of targets for material recovery in the Waste Framework Directive.

Finally, in March 2020, the European Commission released an updated Circular Economy Action Plan which includes measures that will help stimulate Europe's transition towards a circular economy, and encompasses the entire life-cycle of products, including supply chains. To this end, related to buildings, the European Commission is currently developing the following:

1. Review of the Construction Products Regulation to improve the labelling of environmental footprint, and increase the sustainability performance of construction products;

2. Digital building logbooks and material passports to improve the traceability of construction products and enable recovery and reuse;

3. The Level(s) framework[7] usage for public procurement;

4. Guidelines to reduce construction and demolition waste[8].

[7] Level(s) is the common EU building sustainability assessment and reporting framework. For more details see section 4.1.

[8] Construction and demolition waste accounts for 60% of all waste generated in the EU. https://ec.europa.eu/growth/sectors/raw-materials/eip/commitments/recycling-secondary-raw-materials-sustainable-optimization-construction-processes-civil_en

2.

THE ROLE OF LIFE-CYCLE ASSESSMENT AND ENVIRONMENTAL PRODUCT DECLARATIONS IN REDUCING UPFRONT EMISSIONS FROM THE BUILDINGS AND CONSTRUCTION SECTORS

Construction of new buildings is expected to double across the world by 2060, which is why reducing upfront carbon emissions is becoming essential for the sector's climate goals. Minimising energy demand through improvements in energy efficiency remains a critical contribution to achieving climate neutrality and will play the largest role in curbing emissions in the period to 2030[9]. However, when the efficiency of the building stock increases, the relative share of embodied emissions also increases. This highlights the importance of WLC assessments and upfront emissions reduction.

2.1 LIFE-CYCLE APPROACHES IN BUILDINGS

Reducing upfront emissions and improving materials efficiency depend on an effective mixture of technical innovation in manufacturing, building design, construction, standards and regulations. Enforcing more ambitious building standards will also require assessment, tracking and reporting of embodied carbon, reduction targets from the industry and developing new circular business models.

This is why European policymakers have started introducing 'soft measures', i.e. policy incentives, labelling and certification schemes based on environmental impact measurement methodologies, before actually regulating WLC with 'hard measures', including mandatory caps and minimum thresholds[10].

LCA studies and WLC accounting assess the impact of a construction product or building over its complete life-cycle, beyond its operational 'use phase'. WLC focuses primarily on carbon emissions, while LCAs also evaluate other environmental impacts.

Transparent carbon accounting at each life-cycle stage can enable developers to compare new construction and renovation projects, as well as to prioritise and optimise the allocation of resources and account for associated emissions. LCAs can be (i) 'cradle to gate' – covering environmental impacts from the building phase up to the use phase – or (ii) 'cradle to grave' – impacts throughout all building stages, until the end of the useful lifetime.

This aligns with the environmental performance database under development in in Brazil (SIDAC), which will initially focus on upfront emissions (product stage - cradle to gate, presented in Figure 2), related to the selection of material in the design and construction stages. Focus on construction products and manufacturers' data is aligned with the database under development in Brazil (SIDAC), which will initially focus on cradle to gate and upfront emissions from the product stage (presented in Figure 2).

[9] International Energy Agency (IEA) (2021). Net Zero by 2050

[10] For example, the EU's Construction Products Regulation, Level(s) and all voluntary certification schemes use LCA methodology.

2.2 ENVIRONMENTAL PRODUCT DECLARATIONS

Environmental product declarations (EPDs) are descriptive summaries of construction products, which manufacturers publish to provide an overview of the environmental properties of their products. EPDs cover all parts of the life-cycle of a product[11]. EPDs are an important source of LCA data in the construction sector[12]. The EU has created standards to ensure that the environmental properties of construction products are reported in a transparent and uniform way in the EU and sets minimum requirements for the LCA methods applied. Two standards are important in the context of WLC and embodied carbon in the construction sector: EN 15804 and EN 15978.

EN 15804 is the EPD standard for the sustainability of construction products and materials. This standard harmonises the structure for EPDs in the construction sector, making the information transparent and comparable. Reporting on the impacts of the material extraction and manufacturing phase (see product stage in Figure 2) is mandatory within EN 15804, because these processes are under the control of the manufacturers. Manufacturers can decide to voluntarily assess the other life-cycle phases based on modules provided. EPDs under EN 15804 must be third-party verified.

The EN 15978 standard assesses the environmental performance of a complete building. It specifies requirements for the LCAs methodology and other quantified environmental information that is used. The standard is applicable to new and existing buildings and renovated projects. The EN 15978 standard uses EPD data and covers all life-cycle phases.

Benefits of using EPDs

In 2019 an update of the EN 15804 standard was announced that will apply from July 2022. The inclusion of additional requirements (e.g. mandatory end-of-life scenario and formatting) shows that efforts are being made to improve the quality of EPDs and highlights their role as a source of environmental data in the construction sector. Beyond data provision, EPDs have benefits for:

- Product manufacturers: EPDs demonstrate manufacturers' commitment to product sustainability, help them benchmark products' environmental properties throughout the supply chain, and position their products in relation to the competition.

- Developers and designers: EPDs provide environmental information required to obtain a green building label, and help them choose products that reduce a building's emissions over its lifetime.

- Policymakers: EPDs are an important source of environmental data in the context of policy compliance (e.g. minimum performance standards) or procurement for public buildings. This information is also crucial for monitoring progress of building decarbonisation and compliance with climate goals.

[11] ISO (2006). www.iso.org/obp/ui/#iso:std:iso:14025:ed-1:v1:en

[12] European Commission Joint Research Centre (2010). International Reference Life Cycle Data System (ILCD) handbook

Ongoing challenges with EPDs

The European EN 15804 standard includes guidance on which impact categories should be reported in EPDs. The standard indicates format, certain mandatory life-cycle phases that must be covered, and high-level methodological requirements for LCAs. However, the organisations doing the LCA underlying EPDs can still choose between different datasets and between different acceptable methodological approaches included in the standard. As a consequence, EPDs for similar products are not always comparable.

To ensure that the LCAs in underlying EPDs are performed in a consistent way, guidelines with core methodological steps called 'product category rules' have been developed. Common product category rules give more clarity and consistency for EPDs of similar products in the assessment of their environmental and WLC impact. However, the major problem is disparities between product category rules of different products, especially if they compete in similar applications. This improves comparability and credibility, but some other improvements could be made:

- The increasing number of impact categories makes it more difficult to collect primary data, because it requires monitoring more pollutants (or using proxy data that reduce reliability).
- Uncertainties are usually not considered in EPDs, even though they are far from negligible.
- EN 15804 sets a common standard for creating EPDs, but multiple product category rules imply the lack of a harmonised guidance about how the standard should be applied. As it stands, each EPD scheme owner can adopt its own PCR.
- In many cases, there is no data available for a raw material and a proxy impact dataset is being used, which may, in fact, bear no resemblance to the actual raw material. A single EU impact database could improve the accuracy of EPDs.
- While product category rules enhance quality of EPDs, it can be still difficult to compare them because the underlying LCAs can be performed with different methodologies and system boundaries. This variety of possible approaches reduces confidence in the robustness and reliability of EPDs.
- Furthermore, different EPDs are also published in multiple EPD formats required by different operators. In addition, several of them are also not machine readable, being simple PDF files.

HIGHLIGHTS

- LCA allows measurement of the lifetime environmental footprint of a buildings and is the best approach to identify carbon mitigation potential and effectively manage carbon budgets.
- In Europe, life-cycle data used in the construction sector comes mostly from environmental product declarations. EPDs are LCA summary reports used by product manufacturers to demonstrate commitment to sustainability objectives. They provide quantitative data to enable carbon reductions in the supply chain of buildings.
- Normally, the only primary data in most EPDs are the direct emissions of CO2, energy and water use. All other tend to be secondary.
- Harmonisation of LCA methodologies underlying EPDs remains a challenge, which makes comparison of EPDs difficult.
- All EPDs in Europe complying with EN 15804 have a mandatory third-party certification to ensure consistency.
- EPDs should avoid, whenever possible, the use of generic or "proxy" impact data.
- EPDs and single common product category rules should be mandatory tools as they make the environmental impact attributes of different products more easily comparable.

3.

EUROPEAN EXAMPLES OF POLICIES TARGETING UPFRONT EMISSIONS IN BUILDINGS

Some countries in Europe have started mandating disclosure of WLC emissions. These tend to be countries with the strictest energy efficiency regulations[13].

The map below (Figure 2) displays the leading WLC regulations in European countries[14]. The Netherlands, Denmark and France have introduced CO_2 limits for a large share of new buildings, while Finland and Sweden have plans to do so. Switzerland, Germany and the UK have LCA requirements for public buildings. Below we give details on most of these national regulations.

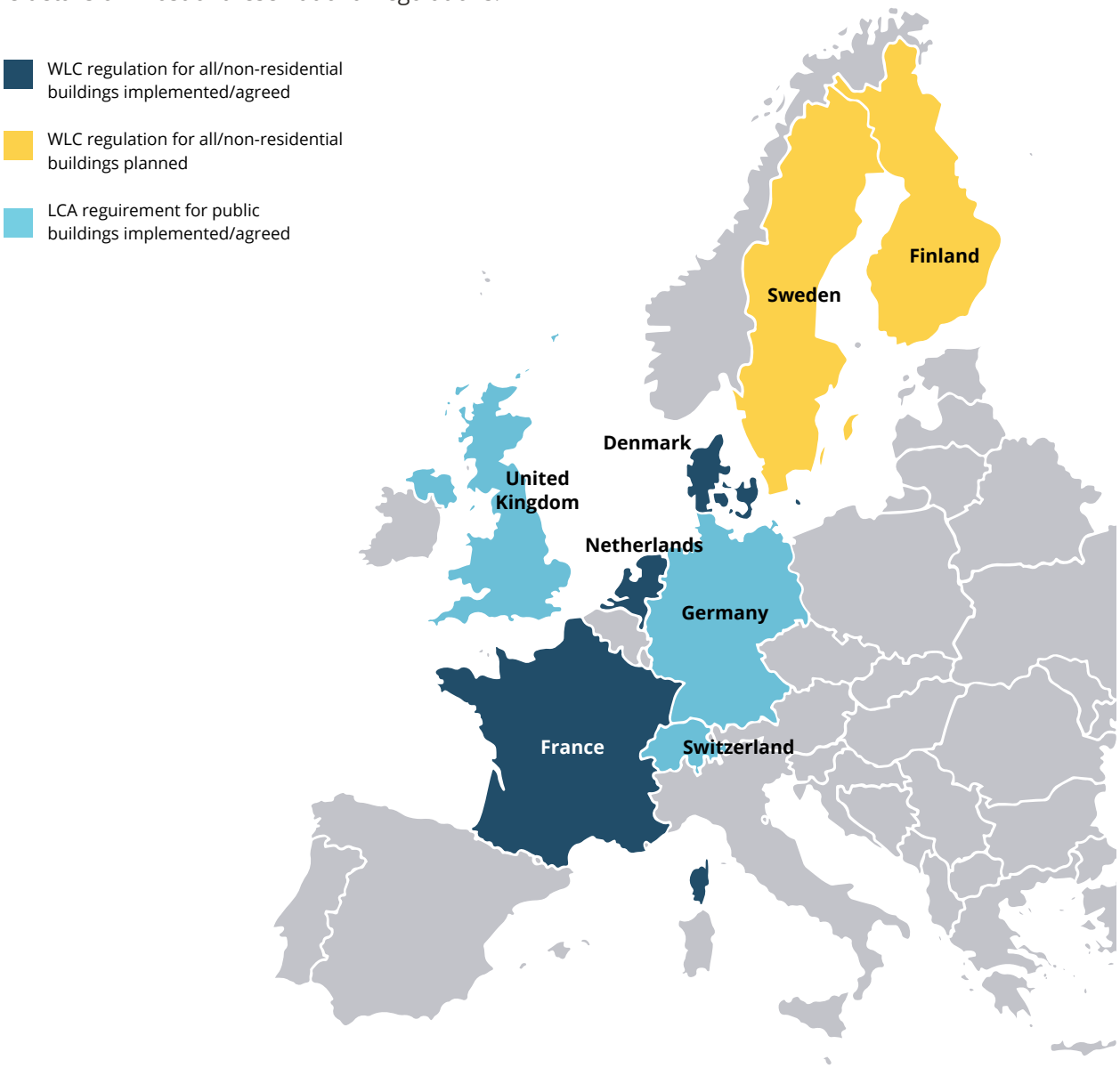


Figure 2 - Map of the leading whole-life carbon regulations in Europe. Map design: Showeet. Source: BPIE, 2021.

[13] BPIE (2021). Whole-life carbon: Challenges and solutions for highly efficient and climate-neutral buildings

[14] This includes EU Member States and non-Member States in Europe, such as the UK and Switzerland.

The Netherlands: Environmental Performance of Buildings Regulation

The Netherlands has integrated WLC in its building code in the form of an obligatory environmental performance of buildings score. Since 2018, new office buildings larger than 100m^2 and new residential buildings are obligated to calculate 11 environmental impact categories, including embodied carbon of materials, according to a national calculation methodology. This calculation is based on an LCA methodology and translated into environmental 'shadow costs' for the project[15]. The government has set an environmental impact ceiling – a maximum impact a project can have. This ceiling will be gradually lowered to reach the 2030 goal of reducing the environmental impact of building construction by half compared to its implementation in 2018. The requirements for new residential buildings have already been made stricter in 2021, with a maximum shadow cost reduced from €1.00 per m^2 to €0.80 per m^2.

France: Environmental regulation for new buildings

The RE2020 regulation for new construction in France applies from 2021 to new residential and non-residential construction projects requiring a building permit[16]. The aim of the regulation is to reduce the environmental impact of new buildings based on their life-cycle emissions, and improve energy efficiency and adaptability to future climate conditions. Maximum reference values for embodied carbon of 640 kgCO_2eq/m^2 for single family buildings and 740 kg CO_2eq/m^2 for multi-family buildings apply[17]. The environmental data necessary for the building LCA is in the INIES database, which is freely accessible[18].

This regulation is supported by the E+C- label, which is a voluntary label that aims to stimulate the development of energy-positive buildings and buildings with low embodied and operational carbon. The E+C- label tests which ambition levels are realistic and can be included during future updates of threshold values in building regulations.

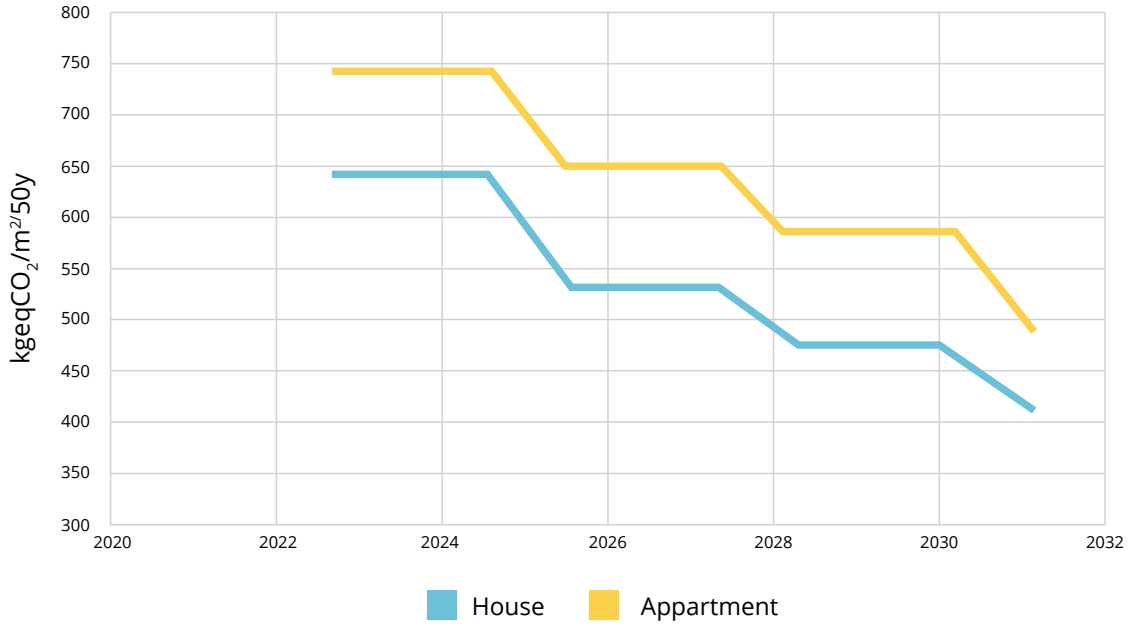


Figure 3 - Average embodied carbon limits in France. Source: Ministère de la Transition écologique 2021.

[15] The environmental impact of CO_2 emissions and other impact categories like material depletion or acidification are translated into 'shadow costs' in euros for each category to make the rather abstract impact of kg CO_2 tangible. These costs are subsequently aggregated into a single score.

[16-17] https://www.legifrance.gouv.fr/jorf/id/JORFARTI000043877205

[18] http://www.rt-batiment.fr/IMG/pdf/guide_re2020_dhup-cerema.pdf

Denmark: Sustainable Construction Regulation

The sustainable construction regulation in Denmark set WLC limits for all new residential and non-residential buildings with a floor area over 1,000m^2, starting in 2023. Structures smaller than 1,000m^2 must perform an LCA study. Maximum threshold values have been set in kg CO_2eq per square metre, and range between 5 and 12 kgCO_2eq/m^2/year. From 2023, every two years the maximum threshold will be progressively reduced, and voluntary performance targets will be added, as the construction sector gains experience with sustainable construction methods. Tools used to calculate the LCA are LCABYG and LCCBYG. The goal is to integrate these tools into building information modelling (BIM, see section 5), in order to improve the user interface, and allow for evaluating carbon impacts starting at the early design phase[19].

Sweden: Regulation on Climate Declarations for Buildings

Starting in 2022, the Swedish government intends to introduce requirements for developers to prepare and submit climate declarations for all new residential and non-residential construction projects requiring a building permit as a part of the Regulation on Climate Declarations for Buildings.

In the initial phase, there will be no impact ceiling for embodied carbon or environmental impact of construction projects. The Swedish National Board of Housing, Building and Planning proposes to implement maximum values for environmental impact for new construction projects starting from 2027. These values are expected to be lowered over time, by 40% in 2035, and 80% by 2043. Environmental data to be used in the evaluation is saved in the Swedish National Board of Housing, Building and Planning's database.

Finland: Low carbon assessment method for buildings

The Finnish government is developing a carbon assessment method and benchmarks for different building types (such as residential and commercial) with a decision for single-family buildings still to be taken. The Finnish government intends to implement maximum threshold values starting in 2025. The assessment method evaluates the WLC impact of buildings. It is based on the European EN 15978 standard and is compatible with the Level(s) Framework. A public consultation on the assessment method in the context of the Land Use and Building Act in 2020 indicated that the method is considered clear and comprehensive enough.

HIGHLIGHTS

- The Netherlands, Denmark, France, Sweden and Finland have established some WLC accounting regulations or initiatives.
- Most WLC accounting regulations are being introduced in countries where new buildings are already very efficient and the electricity grid uses a relatively high percent of renewable energy.
- Most countries are rolling out the regulation incrementally. The initial stages are focused on reporting and data collection, and the embodied carbon limits are added at a later stage.
- Assessment methods are defined on a national level and sometimes linked to the European industry standards.

[19] https://im.dk/Media/C/4/Endelig%20aftaletekst%20-%20B%c3%a6redygtigt%20byggeri%20-%205.%20marts%202021.pdf

4.

VOLUNTARY SUSTAINABILITY CERTIFICATION SCHEMES AND RATING TOOLS FOR BUILDINGS

Voluntary green building rating tools provide information that a building is meeting a certain environmental performance standard. In practice, green building tools tend to drive the market towards more sustainable practices. They raise public awareness about the building's environmental performance, as well as they drive workforce training to build such buildings. Green building tools also influence change in corporate strategies and investment models by providing a transparent and reliable documentation of a building's green credentials.

4.1 EXAMPLE OF A PUBLIC GREEN BUILDING TOOL - LEVEL(S)

The European Commission has developed a tool – Level(s) – to assess and report on sustainability aspects throughout the lifetime of buildings. The goal is to provide a common language on sustainability and circularity of buildings targeting the mainstream market. Level(s) is an easy entry point to sustainability assessment, especially for new building and refurbishment projects which currently consider such an assessment as being too complex and costly. It is essentially a tiered approach to LCA in buildings with a focus on enabling comparability, data availability and benchmarking.

The Level(s) framework can assess buildings from the earliest stages of their conceptual design, all the way through to their projected end-of-life. It is not a new standalone building certification scheme, nor does it establish performance benchmarks, but rather links the individual building's environmental impact with other priorities such as healthy and comfortable spaces, adaptation and resilience to climate change, and whole building life-cycle cost and value. Given the importance and the long-term horizon of the EU's climate goals, the European Commission has established a policy roadmap to gradually mandate the use of Level(s) from a voluntary framework to, eventually, a standard requirement in buildings.

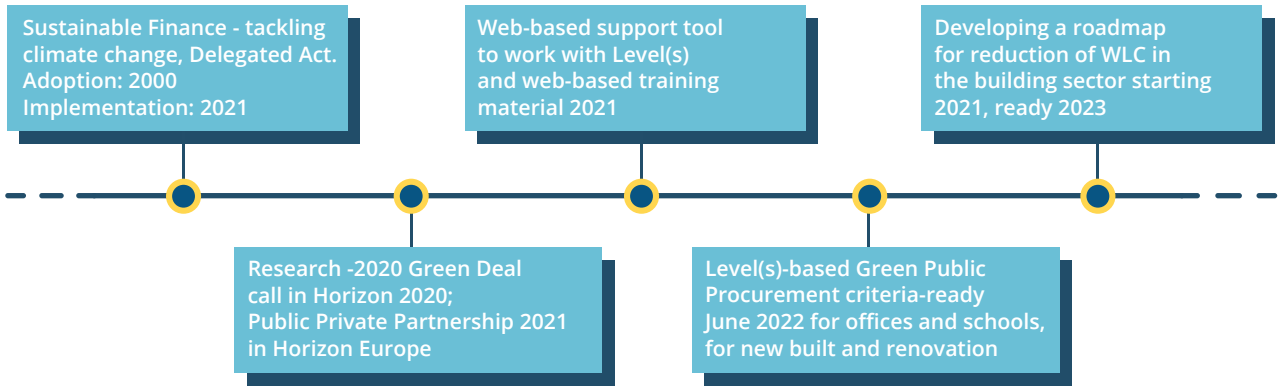


Figure 4 - Timeline of policy initiatives referencing Level(s). Source: BPIE, based on different sources of information.

4.2 COMMERCIAL SUSTAINABILITY CERTIFICATION SCHEMES AND RATING TOOLS

Commercial sustainability certification systems are voluntary tools mostly used to help asset owners distinguish the sustainability performance of their buildings from others in the market. So far, developers and owners have used them to create their brands and to increase the real estate value. Initially, certification schemes were focused mostly on energy performance, and have lately started including broader sustainability objectives, such as health and well-being, and responsible consumption and production.

Although green building certification is not yet a standard practice across the sector, some commercial rating tools are gaining market prominence. These include the Haute Qualité Environnementale (HQE) from France, the UK Building Research Establishment Environmental Assessment Method (BREEAM), the German Sustainable Building Council (DGNB) and the Leadership in Energy and Environmental Design (LEED) from the United States.

Given the vast number of building certifications in use globally, it can be challenging to compare them and understand their similarities and differences. The various systems have not been developed with a uniform focus and weighting of attributes in mind: some focus on a single criterion such as health and well-being, others on environmental factors, and others again on sustainability from a broader perspective. However, all these schemes include carbon measurement. Some include WLC measurements, by giving credits (or points) for projects that specify materials, use EPDs or perform whole building LCAs (e.g. LEED, HQE and DGNB).

HIGHLIGHTS

- Voluntary and commercial sustainability certification schemes and rating tools broaden the focus beyond the product level to consider the building as a whole. They drive the uptake of EPDs in the construction sector.
- The EU's public tool, Level(s), has been designed as a common environmental and whole-life assessment and reporting framework. It is expected that this framework will be gradually required in public procurement, sustainable finance and building regulations.
- Many commercial building certifications are in use globally, and have different methodologies and sustainability criteria. In recent years they have incorporated criteria related to the use of LCA for the specification of construction materials in their evaluation methodology.

5.
DATA TOOLS

Easily accessible and reliable data of the building stock is essential for developing effective strategies to decarbonise the sector. LCA, benchmarking, performance improvement and effective building management all depend on the availability of granular data about the building and materials. Tools such as digital building logbooks, material passports and building information modelling, together with environmental databases, foster the digitalisation of the building sector and facilitate building LCAs and EPD creation.

Compared to other industries, the construction sector is underdeveloped in terms of overall digitalisation and data applications[20]. Building-related data in the EU, particularly on the environmental performance of buildings, continues to be relatively scarce and of inconsistent quality and limited accessibility. Data quality and availability are often quoted as the main barriers to the rollout of WLC regulation in the built environment.

Building sector players and public authorities in the EU have started developing tools such as building logbooks, material passports and building information modelling (BIM) that could help accelerate digitalisation and improve systematic data collection, management and application. Applying these tools can save additional costs and overcome inefficiencies, promote innovation and reduce investment risk and project costs, stimulating investor confidence.

5.1 BUILDING LOGBOOKS AND MATERIAL PASSPORTS

A **digital building logbook** is a repository of building information. It acts as a single point of input, access and visualisation of all the information associated with a building unit throughout its life cycle.

The building logbook represents a record of major events and changes over a building's life cycle, such as change of ownership, tenure or use, maintenance, refurbishment and other interventions (see Figure 5).

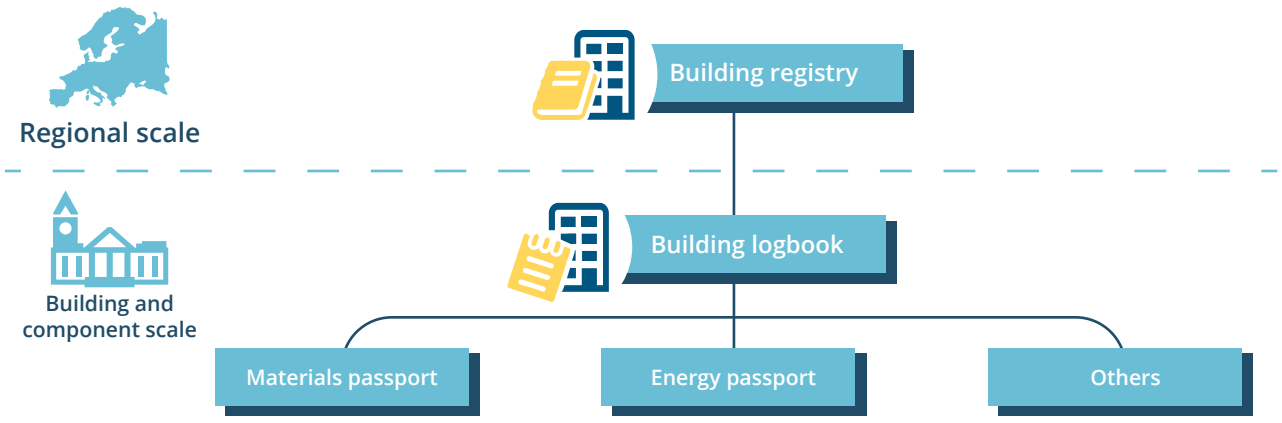


Figure 5 - An example of a building logbook integrating various building data sources. Source: BAMB, 2020.

The building logbook connects to multiple databases and a variety of stakeholders over the building's lifespan. It can include LCA data, administrative documents, plans, description of the land, the building and its surrounding, technical systems, traceability and characteristics of construction materials, performance data such as operational energy use, indoor environmental quality, smart building potential and life-cycle emissions.

[20]McKinsey Global Institute (2016). Digital Europe: Pushing the frontier, capturing the benefits

A limitation of existing building logbooks is a lack of a common logging and data structuring approach, which frequently results in some useful data being discarded or not logged, or that existing data being incompatible with other building stakeholders' systems.

Digital building logbooks could be improved by creating a common data template, where data could be easily and efficiently inserted and accessed by all parties. Having common data standards, such as the data formatting that the non-profit InData is working on, would also improve interoperability of various databases and building information management systems. This would contribute to a more systematic capture and management of building data. An example of the types of data found in existing digital building logbooks is shown in Figure 6.

Figure 6 - Data fields in existing logbooks. Dark Blue squares represent partial inclusion of the types of data. Source: BPIE.

Material passports provide information about the quality, origin and location of materials and products and provide insights into which materials can be used once the building is renovated or reaches the end of life. One of the benefits of material passports is that they encourage smart design and eliminate waste by making available information about materials that can be used for circular construction projects. Material passports are either standalone registers similar to logbooks, or simply modules integrated in existing logbooks.

5.2 BUILDING INFORMATION MODELLING

Building information modelling (BIM) creates a digital model (digital twin, see Figure 7) of the physical building based on construction product characteristics (e.g. wood, concrete, steel), water and electricity systems, and HVAC installations. This allows designers and other construction stakeholders to compare and evaluate construction design choices. Building-specific data could also be connected to different platforms, such as a digital building logbook or material passport [21,22].

BIM has been unlocking more efficient working practices, stakeholder collaboration and visualisation for design, construction and maintenance of built assets[23]. It can efficiently drive down project waste and cost.

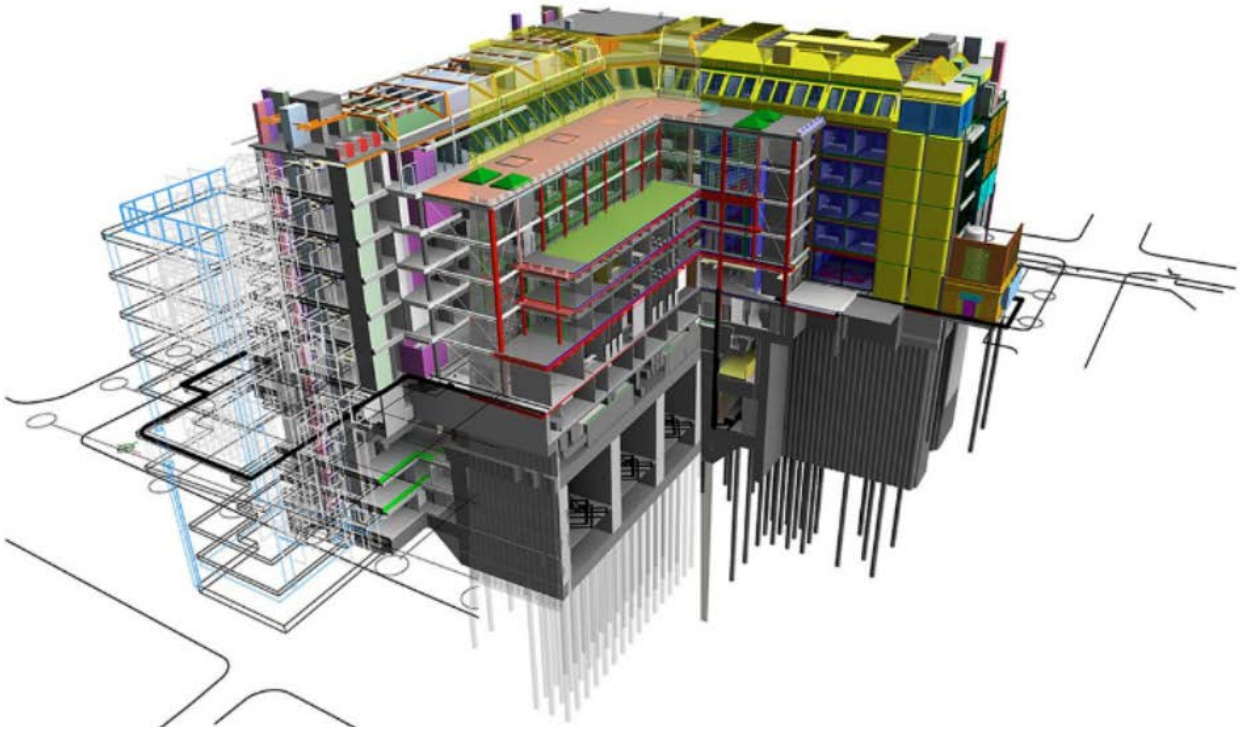


Figure 7 - Copyrights: STW Architects /Bouygues UK.

How does BIM work as an environmental assessment tool?

BIM uses plug-in software, which sustainable design experts can use to undertake virtual building performance analysis and, within the 3D model, simulate environmental scenarios, as the design advances. Examples of BIM plug-in software are Revit, ArchiCAD, Blender, Sketch UP, Dprofiler and Rhinoceros. Additional independently operated (energy) calculation tools are used, and plugged or integrated into BIM software. These include Green Building Studio, One click LCA and Tally, which are plug-ins integrated with Revit, or specific software such as DesignBuilder.

In many cases, separate and specific LCA tools that are not integrated directly in the BIM process are still used to calculate environmental impacts, such as SimaPro, Athena, GaBi and eLCA. Rather, these tools take data about material quantities and products from the model and insert this in separate LCA software. The level of environmental analysis is dependent on the sustainability requirements of the project, and can include LCA of energy, water and lighting scenarios.

[21] https://www.researchgate.net/publication/331313865_Concept_for_a_BIM-based_Material_Passport_for_buildings

[22] https://www.bamb2020.eu/wp-content/uploads/2019/02/BAMB_MaterialsPassports_BestPractice.pdf

[23] https://ascelibrary.org/doi/pdf/10.1061/%28ASCE%29LM.1943-5630.0000127

Combining BIM and LCA occurs regularly, but still faces informational, technical, functional and organisational challenges. Facilitating the interoperability between BIM and LCA[24] software will make it easier for architects and building designers to assess the environmental impact of building design choices. PREN ISO 22057 is a draft standard that contains principles and requirements to facilitate the use of EPD environmental information in digital construction tools like BIM and the assessment of complete buildings by making the data machine interpretable. It is expected to facilitate further digitalisation of the construction sector and lower the threshold for companies to integrate LCA and BIM methodologies.

HIGHLIGHTS

- Building logbooks are a single point of input, access and visualisation of all the information associated with a building unit throughout its life-cycle.
- Material passports provide all relevant information about materials used in buildings.
- Building information modelling facilitates centralised data management for building projects. It can provide access to all relevant information and optimise resource allocation, and has potential to improve overall environmental impact.
- Integration and interoperability of LCA and BIM data is still at its nascence, but efforts are being made to standardise this, as illustrated by the draft ISO 22057.

[24] https://climatechange.ucdavis.edu/climate-change-definitions/biogenic-carbon/#:~:text=Biogenic%20carbon%20is%20the%20emissions,processing%20of%20biologically%20based%20materials.

6.

ENVIRONMENTAL DATABASES FOR THE BUILDING SECTOR

Several European countries have created environmental databases for the building sector. These databases all store construction EPDs, sometimes combining them with other types of environmental data. National EPD programme operators are charged with verifying EPDs, appointing third-party EPD producers, determining product category rules and sharing EPD data with stakeholders. Most of these databases are online.

Databases go beyond EPDs by linking to primary and secondary environmental data, and sometimes providing services to database users in the form of methodological guidelines for LCA/EPD calculations and digital LCA software or tools. This information can support users to carry out complete building LCAs or assessments under voluntary building certification schemes (see Figure 8).

It was noticed that many databases, especially EPDs, are converging for the use of the ILCD+EPD data format. This format is a technical means for transporting information associated with an EPD in a structured way. It is based on the established ILCD data format created by the European Commission.

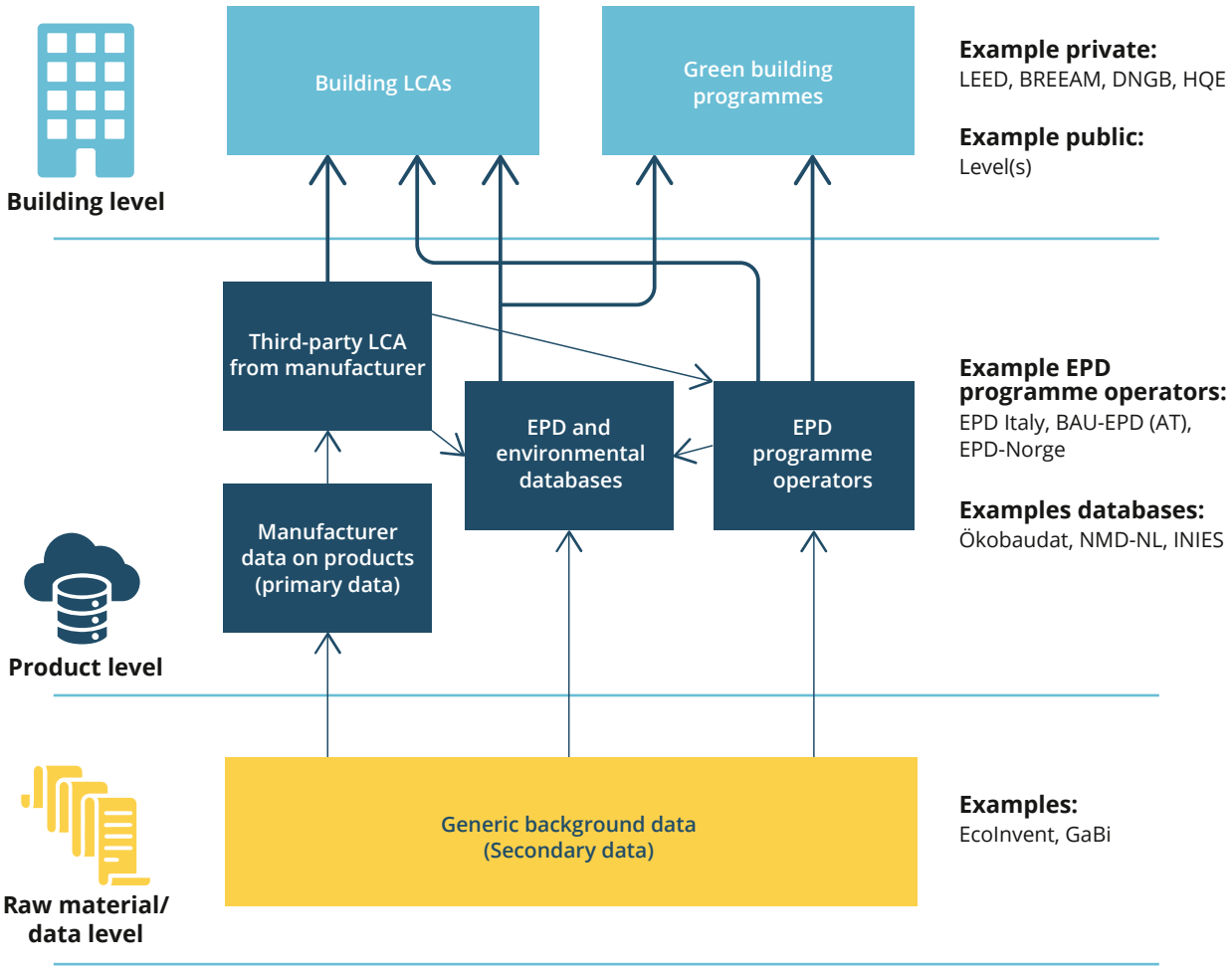


Figure 8 - Interlinkages between EPD programme operators and environmental databases. Source: Rockwool.

Austria – BAU-EPD

Bau-EPD runs the Austrian EPD programme aimed at German-speaking countries and has an online database with Austrian EPDs that is freely available to the public[25]. Bau-EPD develops documents for EPD creation in accordance with the international EN 15804 and ISO 14025 standards.

The database on the website contains EPDs for various construction products, which can be downloaded free of charge. The database consults secondary data providers, Ecoinvent and Gabi, to generate documents.

Bau-EPD has a direct partnership with the Italian EPD programme, and is also linked to the German Ökobaudat and the Austrian Baubook database including the eco2soft live-LCA calculation tool. It also collaborates with the Austrian and German authorities and various research institutes.

Bau-EPD is a subsidiary of the two major building certification organisations in Austria: the Austrian Association for Sustainable Buildings (ÖGNI) and the Austrian Association for Sustainable Construction (ÖGNB), both of which have members active in the building and construction industry. An overview of the organisational structure is presented in Figure 9.

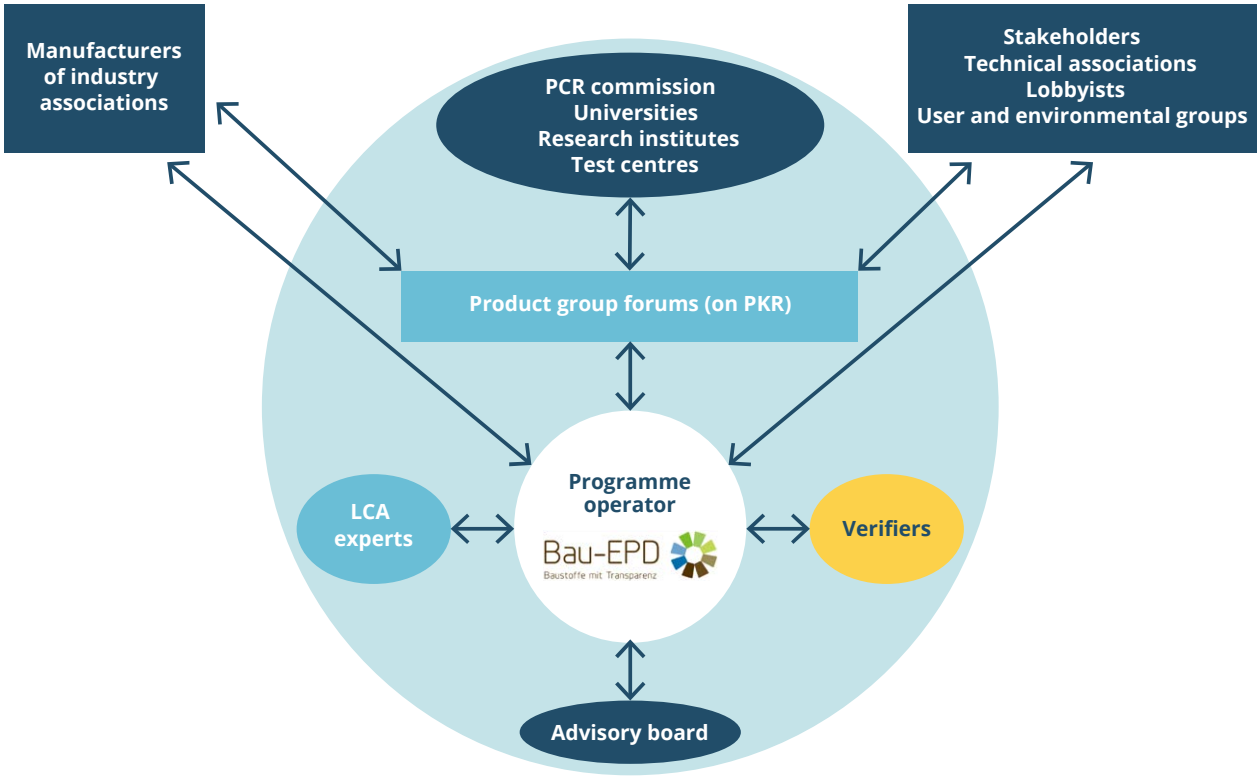


Figure 9 - Structure Bau-EPD operator (Source: Bau-EPD).

France – INIES

INIES is an EPD database overseen by a consortium of construction sector representatives and public authorities, and managed by the Alliance HQE-GBC[26]. Manufacturers and trade associations provide information voluntarily, and the data is freely available to the public. A technical committee supervised by

[25] In close collaboration with institutions from these countries

[26] Fiches de Déclaration Environnementale et Sanitaire - FDES

the French Association for Construction Products (AIMCC) assures data quality and checks compliance of new EPDs with the EU standards. A significant portion of this data is audited by an independent third party.

The online platform (see Figure 10) allows searching and accessing EPDs, including information about the type of EPD (e.g. individual product or industry average), the LCA database consulted for preparing it, and the type of the EPD third-party verification certification. The data can be accessed through various search criteria, such as product type, name, description, manufacturer, environmental impact specified per life-cycle phase, the reference lifetime (years) and estimations of transport distances[27].

INIES business model

The INIES database sells the licence to web services, which then allow academic and commercial customers to access and download the data in predefined formats. Data is verified through two programmes, the INIES programme and the PEP Ecopassport programme, which provide fixed-price third-party verification, required to upload EPDs into the database. To become an accredited verifier of EPDs, a fee must be paid to the programme operators. The recently launched voluntary label "Energy positive and carbon negative" (E+C-) uses the LCA datasets provided by INIES. Lessons learned from the E+C- scheme will provide information for future buildings regulation and standards.

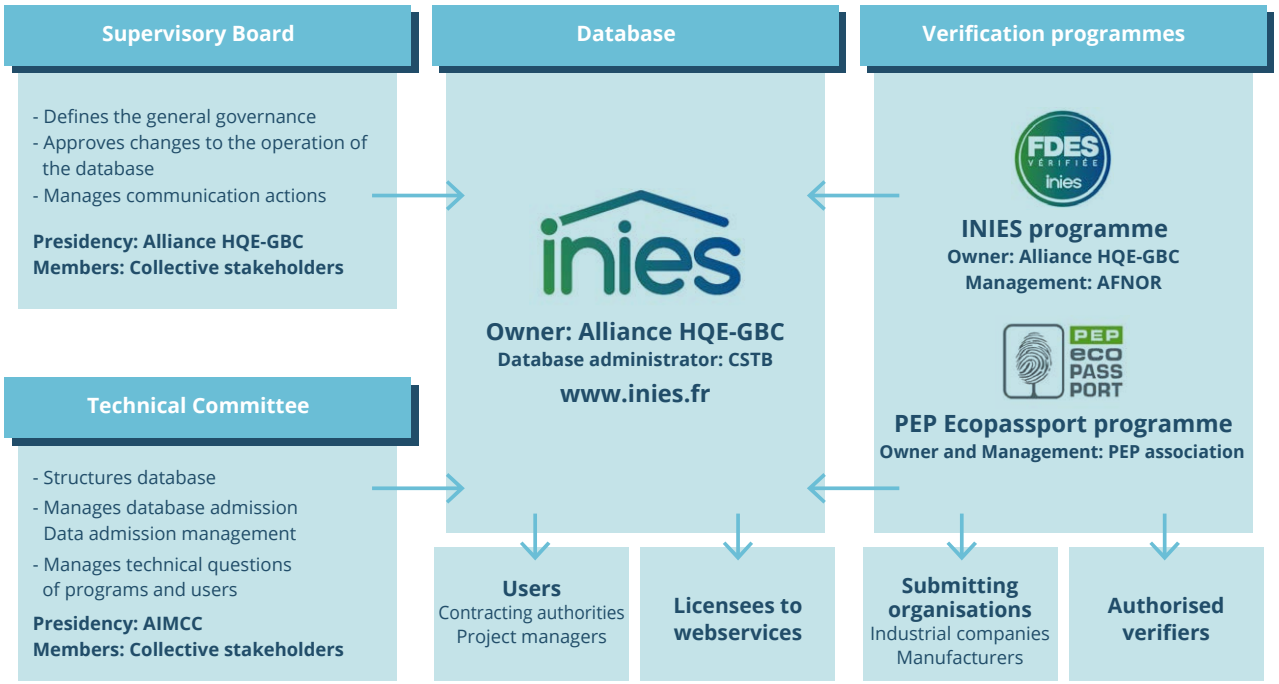


Figure 10 - INIES organisational structure. (Source: INIES).

Germany – Ökobaudat

The Ökobaudat is a freely accessible, online LCA database for buildings, operated by the German Federal Ministry of the Interior. With the help of the eLCA software tool made available by the Federal Institute for Building, Urban and Spatial Development Research (BBSR), the data can be used to calculate environmental impacts of a building over its complete life cycle. The Ökobaudat is used as the central database for the Bewertungsystem Nachhaltiges Bauen (BNB) sustainable building rating system used for life-cycle assessments in public buildings.

[27] https://www.base-inies.fr/iniesV4/dist/consultation.html

The data in the Ökobaudat is also used by the DNGB building rating and certification tool and the Danish Green Building Council[28]. The Ökobaudat plug-ins allow its data to be used within BIM programmes like Revit and ALLPLAN. Similarly, the Ökobaudat information can be used in other LCA software tools such as CAALA and LEGEP.

There are three types of data in the database:

1. Category A data consists of verified EPDs in compliance with the EN 15804 and ISO 14025 standards, with publicly available product category rules.

2. Category B data has not been produced in accordance with ISO 14025 and is externally verified before being accepted.

3. Category C data consists of generic data for which no specific product information is available, based on the GaBi database[29].

Ökobaudat business model
Access to the Ökobaudat is free. Data can only be provided by an EPD programme operator that is recognised by the Ökobaudat administration. If EPD operators are not officially recognised by Ökobaudat, the EPD information undergoes additional verification by a technical committee before it can be uploaded to the database to assure data quality.

Manufacturers pay fees to the EPD programme operators to create, update and upload their EPDs to the Ökobaudat. Project developers of public construction projects are more likely to use products whose EPDs are uploaded to Ökobaudat, in particular if they aim to build sustainably certified projects (e.g. BNB). This serves as an incentive for manufacturers to upload their product EPDs.

Uploading EPDs to the database also shows a commitment to transparent environmental data sharing and sustainable construction practices. This increases the chance of these construction products being used in private sector projects that aim to be, for example, certified by the DNGB scheme.

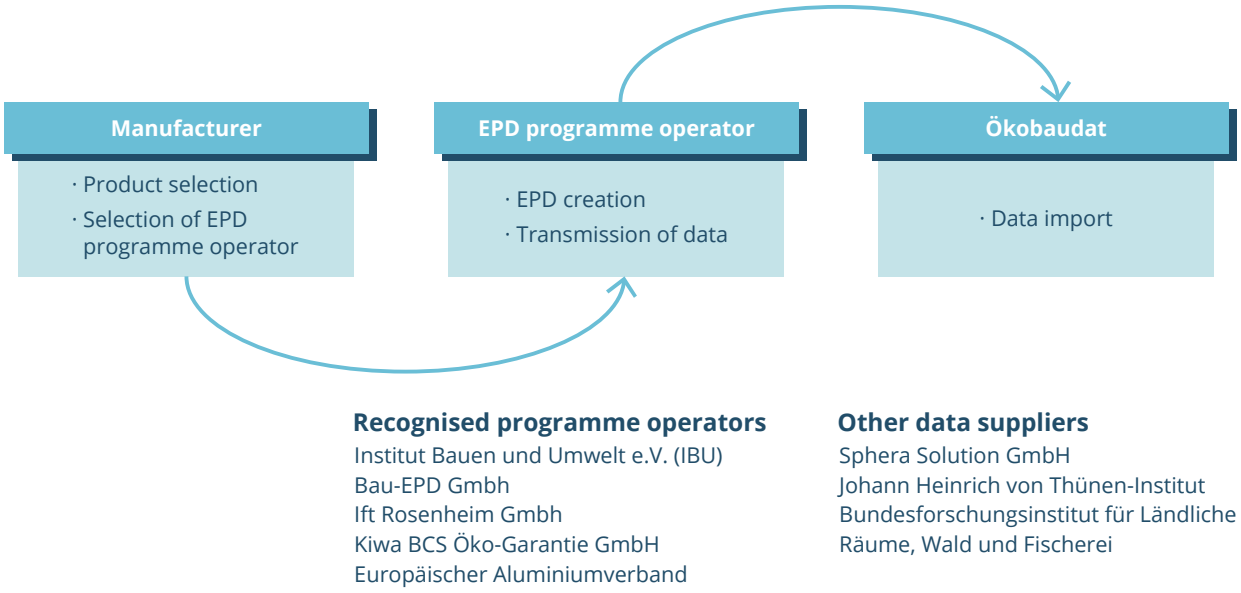


Figure 11 - Overview of the Ökobaudat EPD verification process.

[28] https://www.oekobaudat.de/fileadmin/downloads/0068G_BF_200106ms.pdf

[29] https://www. oekobaudat.de/anleitungen/datennutzer.html

Italy – EPD Italy

EPD Italy is the national EPD programme operator and the sole national accreditation body in Italy with the capacity to validate EPDs and adopt uniform EPD methodologies. Product category rules and requirements for LCA and EPD tools are accessible in a PDF format on the website. The EPD procedures are developed in accordance with ISO 14025 and EN 15804 standards.

EPD Italy is a member of the ECO platform and works on mutual recognition with the national EPD programme operators in Spain, Norway, Germany and Austria, among others.

EPD Italy contains a digital EPD database available free of charge on its website. It also includes a list of LCA tools for specific product categories (e.g. concrete, ceramic tiles, plastics) complying with the Italian Decree on Minimum Environmental Criteria.

The Netherlands – National Environmental Database

The National Environmental Database (Nationale Milieudatabase) was established in parallel with a national calculation methodology for the environmental performance of buildings (Bepalingsmethode Milieuprestatie). This non-profit association manages two types of data:

1. Environmental impact of basic construction materials and generic profiles of manufacturing processes, based on expert-inserted industry averages and LCA databases like Ecoinvent.
2. Product cards – data based on EPDs provided by product manufacturers.

The Dutch national calculation methodology is based on EN 15804 and includes product category rules for specific products and guidelines for LCA studies.

The methodology also includes a verification protocol, which must be completed before data can be included in the national environmental database (see Figure 12). Once the product cards are included in the database, the national calculation methodology prescribes how this data can be used for online calculation tools to determine environmental performance of building projects (see Figure 9). Currently seven such tools are available. In 2020, the national calculation methodology was amended to include a methodology to calculate and establish the environmental impact of renovation measures on the overall environmental performance of a building.

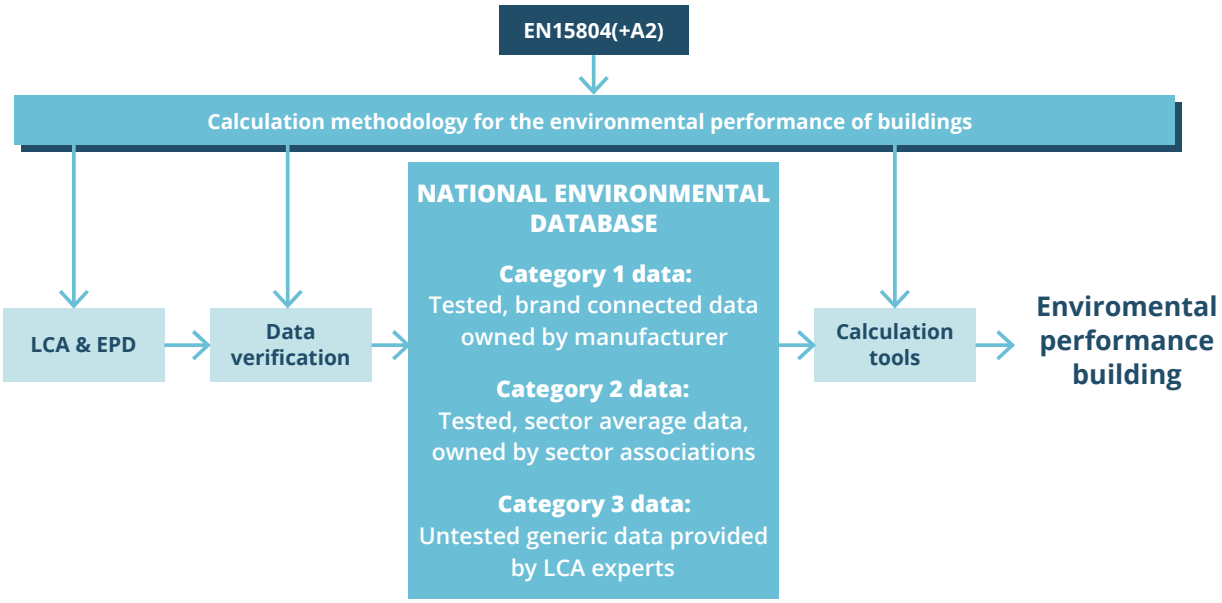


Figure 12 - Dutch environmental performance calculation methodology overview.

The Dutch building code (Bouwbesluit) requires each new building project of more than 100m² to calculate the environmental performance and sets a threshold value. Product manufacturers are encouraged to perform LCA analyses and upload outcomes to the national environmental database.

If manufacturer data is not uploaded, LCA tools will use conservative generic values rather than the actual, measured data. In practice this means that products that have individual EPDs achieve a better environmental score in the methodology, which makes them more attractive to designers and architects. Recently a validated calculation tool called 'MGP-toetshulp' has been made available that allows real-time environmental performance calculations in building information models.

Nationale Milieudatabase business model

The business model of the National Environmental Database is based on a licensing system. Data suppliers – companies and trade associations – pay a yearly contribution, in addition to a sum per product card they upload. Operators of validated calculation instruments and LCA companies that want to use the generic background-process data also pay an annual licence fee. LCA experts that want to be accredited pay an accreditation fee, and an annual licence fee to keep their accreditation.

Norway – EPD-Norge

EPD-Norge is the Norwegian Business Foundation for Environmental Declarations and functions as the national EPD programme operator. The EPD-Norge board and secretariat are responsible for administering the programme, in which they are supported by a technical committee and an EPD forum. The EPD forum[30] consists of professionals from the construction sector with EPC/LCA expertise, representing organisations from business, industry, manufacturers, authorities or LCA professionals. The technical committee verifies product category rule proposals, approves external verifiers and checks whether they are aligned with the programme guidelines and the ISO 14025 and EN 15804 standards (see Figure 13)[31].

EPD-Norge has its own digital database, EPD-Norge Digi, which contains environmental LCA-based data from EPDs provided by manufacturers. EPD-Norge is connected to the ECO platform, established by the European EPD programme operators. The data is freely available in an XML format to the public. In 2021 there was no specific software tool developed to facilitate access to the database with LCA software, but specific measures can be taken upon request.

Mutual recognition programmes exist with the German Institut Bauen und Umwelt (IBU) and the International EPD System (Sweden).

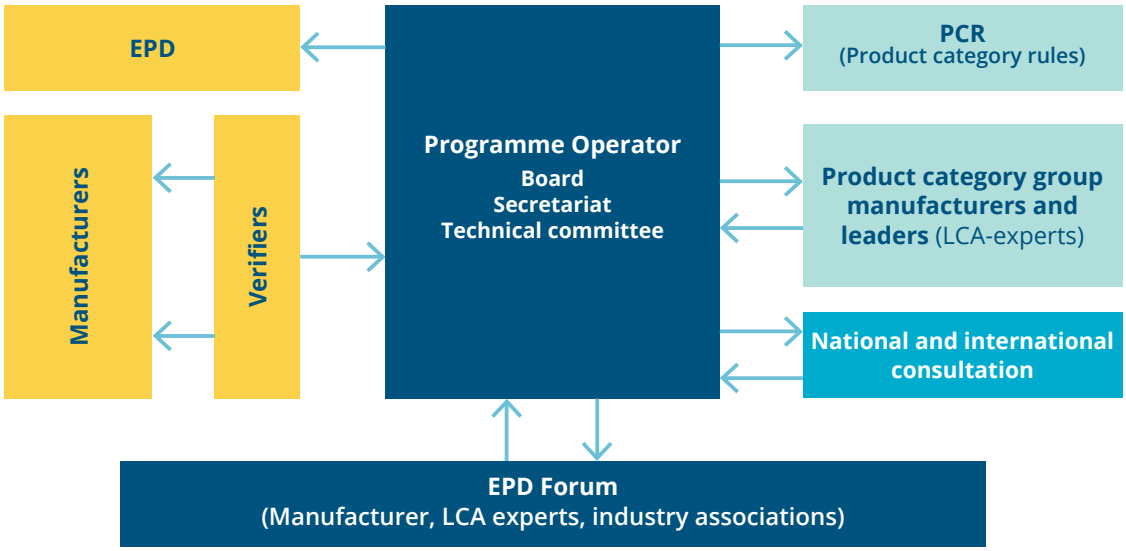


Figure 13 - EPD-Norge organisational structure.

[30] https://www.epd-norge.no/organisering/category399.html

[31] https://www.epd-norge.no/teknisk-komite-tc/category401.html

HIGHLIGHTS

- EPD databases have various business models. They can be run privately, with a subscription to be sold to data users and/or data providers. They can also be run publicly, where government entities take care of financing and operating, and database use is free.
- Many databases have initially been set up as voluntary, market-led initiatives, but are expected to be gradually integrated in national regulations, as has already been the case in the Netherlands.
- Some of these databases not only store EPDs, but also link them to secondary data sources and provide services, methodological guidelines and digital calculation tools. This integrated model reduces administrative burdens for market players and streamlines the uptake of WLC assessments of buildings.
- There is an effort to digitise the EPDs in order to facilitate the communication with other tools (e.g. BIM) and follow a single standardisation at EU level.

7.

LESSONS LEARNED ABOUT SETTING UP MECHANISMS FOR ASSESSING WLC IMPACTS IN BUILDINGS AND RECOMMENDATIONS FOR OTHER JURISDICTIONS

To understand the entire climate impact of the buildings sector and implement mechanisms to reduce these impacts, emissions embodied in the building's construction phase need to be measured. So far, most policy and market initiatives assessing embodied carbon have been voluntary. The voluntary nature of these initiatives has resulted in a slow and patchy uptake of low carbon construction practices.

Several European Member States have announced or started implementing reporting and disclosure legislation in order to reduce WLC in the construction sector. At the European level, standardisation of EPDs and whole building LCAs, as well as collaboration between national EPD operators, aims to improve comparability of WLC data of construction products and projects. Voluntary commercial building sustainability schemes are an important driver to meaningfully reduce the overall carbon footprint of buildings. Initiatives such as digital building logbooks, material passports and BIM improve WLC data availability and foster digitalisation of the buildings sector. Harmonisation of calculation methodologies for EPDs, whole-building LCAs and interoperability between BIM and LCA tools though still remain a challenge and need to be improved.

The European experiences can provide a set of useful learning points and recommendations for how WLC can be mitigated across the built environment.

LESSONS LEARNED:

- Setting the built environment on a climate neutrality pathway requires improving resource efficiency and sustainability throughout the entire supply chain, not only energy efficiency measures. This effort calls for clear baselines, granular data and suitable methodologies for estimating embodied carbon in the construction sector.
- The collection and management of LCA data needs to be organised in a uniform and systematic way, within agreed system boundaries and according to international standards. Data consistency enables comparison of products and services, and informed decision-making on what products, processes and suppliers to use when constructing a new building or renovating.
- Systematic industry- and product-specific data collection is possible if there is a mandatory, standardised reporting system with the same categories, requirements and formats applicable across all industry players. Some countries are starting to implement legislation to achieve this.
- Without clearly defined requirements, data collection methodologies and robust reporting systems, it is not possible to have comparable, accurate and measurable results. This can prevent actual emissions reductions.
- Many countries implement legislation in stages. They start with voluntary WLC disclosure measures. Once market actors are used to this, WLC legislation is implemented without necessarily requiring minimum performance standards at the beginning. The minimum standards are included and subsequently strengthened at later stages.
- In the evaluated countries, carbon targets were initially voluntary, and applied to public and commercial buildings. They were made mandatory later, with residential buildings also included in the scope.
- Digital tools for information management have potential to enable better decision-making throughout the building's lifespan, improve sustainability practices, drive down costs and incentivise innovation and new business models.

RECOMMENDATIONS:

- In the initial stages of policy design and implementation, there needs to be a trade-off between simplicity and accuracy, between data quality and granularity. A step-by-step approach will allow time for stakeholders to go through a learning process of collecting, reporting and utilising data.
- The policy should initially focus on carbon hotspots – parts of the supply chain with the highest emissions. Once this is regulated, the scope of policy could incrementally be extended to other parts of the supply chain. For example, a database could start off being voluntary with reporting energy and CO_2 emission hotspots in the supply chain.
- The data tracking and storing system could be made in modules. This would allow it to start with only carbon emissions and energy, and later include other environmental indicators and impact categories, such as material and water depletion, toxicity, pollution and biodiversity. This modular approach allows multiple layers of data granularity in later stages, as well as helping with the transition from voluntary to mandatory reporting.
- Centralised data repositories should be established to provide easy access to all buildings sector stakeholders.
- The trustworthiness of the data source is as important as the data itself. Data source validation and third-party verification need to be embedded in product labelling and certification schemes, LCA databases, benchmarking and reporting processes.
- Assessment methodologies and evaluation criteria should be aligned with international standards, and accompanied by detailed practical guidance for the consistent implementation by industry and construction professionals.
- Clarity and consistency around the implementation of WLC assessment needs to be appropriately communicated to all stakeholders to ensure the understanding of its benefits and to ensure its successful implementation.
- Environmental/LCA databases should be aligned with the country's existing regulatory or certification schemes that normally focus on buildings' overall performance and/or energy efficiency, like, for example, in Austria, France or Germany.

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BUILDINGS
PERFORMANCE
INSTITUTE EUROPE

Rue de la Science 23
1040 Brussels Belgium

Sebastianstra§e 21
D-10179 Berlin Germany

www.bpie.eu