EUBIM TASKGROUP

BIM AND TWIN TRANSITION

CHALLENGES AND OPPORTUNITIES FOR EU PUBLIC CONSTRUCTION CLIENTS

HANDBOOK 2.1 for Implementing Building Information Modelling by the European Public Construction Sector

TECHNICAL INFORMATION

Title BIM and Twin Transition: Challenges and Opportunities for EU Public Construction Clients

Edition April 2026

ISBN 978-989-35262-1-7

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In Collaboration with: EU BIM Task Group

Publisher EU BIM Task Group, in collaboration with CERIS, Instituto Superior Técnico, Universidade de Lisboa (Twinlab Research - www.twinlab.pt)

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FOREWORD

This is the second handbook published by the EU BIM Task Group: a strong network of public bodies responsible for the built environment, harmonising the use of BIM across the EU, as a basis for a holistic digital and sustainable EU Construction sector, by enabling higher efficiency in public projects, use of open standards and knowledge transfer.

The handbook aims to support EU public clients and policy makers by the implementation of the EU "Twin Transition" and thus to ensure a more resilient, green and digital construction ecosystem. Private partners play an important role as well, so we welcome them as readers and users too.

The handbook provides both strategic guidance and action recommendations.

Starting with an analysis of the current complex policy framework, it elaborates on the opportunities and challenges of existing data methods, like LCA and BIM. Then it explores digital tools such as EPD, DPP and DBL and their joint role for a successful implementation of the Twin Transition. In conclusion, it offers implementation strategies and an outlook till 2030 for the EU Twin Transition.

It blends together experiences from academic research and practice, the status quo of a work in progress, as we expect to gain more valuable insights from further use cases in the future - the findings will be presented in the following version.

This handbook is an inspiring and, at the same time, a practical and helpful companion for smart decision-making and implementation by public bodies on their Twin Transition path, for more innovation and better use of metadata across the whole lifecycle of built assets.

Wishing you interesting insights and takeaways, and looking forward to getting feedback and proposals for the next steps on our common Transition Journey.

Milena Feustel
Chair of the EU BIM Task Group

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EXECUTIVE SUMMARY

Europe's built environment is at the intersection of two transformations that must advance together: the green transition, driven by the climate and circularity agenda, and the digital transition, driven by the rise of BIM, data-driven workflows and artificial intelligence. This handbook, prepared by the EU BIM Task Group, makes the case that these are not parallel tracks but a single Twin Transition, and that success in one increasingly depends on success in the other.

The policy landscape now reflects this logic. The European Green Deal, the Renovation Wave and the Fit for 55 package set the direction. The recast Energy Performance of Buildings Directive (Directive (EU) 2024/1275), the revised Construction Products Regulation (Regulation (EU) 2024/3110) and the Ecodesign for Sustainable Products Regulation (Regulation (EU) 2024/1781) translate that direction into obligations for the built environment: zero-emission new buildings by 2028/2030, mandatory disclosure of whole-life global warming potential, a construction Digital Product Passport framework, and progressive digitalisation of product and building data. The 2025 European Affordable Housing Plan and the European Strategy for Housing Construction reinforce this agenda with a productivity and affordability lens.

Delivering on these commitments requires aligned methods and digital instruments. Life Cycle Assessment (LCA), anchored in EN 15804+A2 and EN 15978, provides the common quantitative language. Environmental Product Declarations (EPDs) are the base layer. Digital Product Passports (DPPs) aggregate product information along the value chain. Digital Building Logbooks (DBLs) bring this information together at building level, across the full life cycle, and link it to renovation passports and digital building permits. BIM is the integrating environment through which these data flow: its information-management workflows are framed by the EN ISO 19650 series, while data exchange relies on the open IFC schema (ISO 16739, currently IFC 4.3).

This handbook is organised to follow this logic. It opens with the Twin Transition agenda and the EU policy frameworks that shape it (Chapters 1–2), then moves to methods and data foundations (Chapter 3, LCA and BIM), before addressing the three digital data instruments at product, product-life-cycle and building scale (Chapters 4–6: EPD, DPP, DBL). Chapter 7 discusses implementation, governance and the policy recommendations needed to make this work at scale. A closing chapter synthesises priorities and outlook to 2030.

PART I

FOUNDATIONS

Context and regulatory landscape

1 \ THE TWIN TRANSITION IN THE BUILT ENVIRONMENT

1.1 \ UNDERSTANDING THE CONTEXT

The building industry is currently undergoing a significant transformation, requiring a shift toward sustainability and digitalisation. We are changing the way we design, create, and maintain the built environment because of this double transformation. This is also a significant part of the European Union's vision for the future, supporting key initiatives such as the European Green Deal and the Digital Europe plan. The building sector must adapt to both of these changes to remain competitive, meet climate targets, and deliver long-term societal benefits.

ECONOMIC IMPACT AND PRODUCTIVITY CHALLENGE

Construction is a significant part of Europe's economy. It accounts for around 9% of EU GDP and employs close to 13 million workers in the construction sector itself, with the broader built-environment value chain reaching some 18 million jobs (FIEC, Construction Activity in Europe, 2023). This sector builds the homes, schools, workplaces, and infrastructure that support daily living and business. However, despite being a relevant sector, productivity has not changed much, and in many EU countries, it has even decreased over the past few decades. Many projects are finished late or over budget, and traditional building techniques remain scattered.

In short, the industry has not innovated as quickly as others, indicating it needs modernisation. The industry begins to believe that boosting production and reducing costs over time requires accelerating the adoption of technology, from digital tools to more contemporary techniques such as modular construction.

CLIMATE AND ENVIRONMENTAL NEEDS

The environmental impacts of construction are both significant and harmful. Buildings and construction use over 40% of Europe's energy (primarily operational, use-stage modules B1–B7) and produce about 36% of its energy-related greenhouse gas emissions. They also require substantial raw materials and generate significant waste. This sector is at the centre of climate and environmental initiatives because of its large footprint. The 36% figure combines both operational emissions and embodied carbon locked into materials, structures and finishes across the whole life cycle.

The European Green Deal aims to achieve climate neutrality in Europe by 2050. The Fit for 55 package is designed to reduce greenhouse gas emissions by 55% by 2030. To achieve these goals, it is essential that buildings significantly improve their performance. This involves improving energy efficiency and opting for cleaner materials and construction methods. The Circular Economy Action Plan emphasises minimising waste and encouraging the reuse and recycling of building materials. The industry should shift from the traditional "take-make-dispose" model to a more sustainable circular approach, focusing on designing products with their entire life cycles in mind. Making the green transition is an essential step towards minimising a building's environmental footprint over its whole life cycle.

1.2 \ THE DIGITAL TRANSITION IN THE BUILT ENVIRONMENT

Along with the push for sustainability, the construction industry is going through a digital transition. Digital technologies and methods are changing how projects are planned, designed, and executed. Building Information Modelling (BIM) is at the centre of this change. It is a way for people to work together to create and manage information throughout a project's life cycle. BIM allows architects, engineers, contractors, and owners to work collaboratively, supported by 3D models full of data. Using BIM, stakeholders can plan construction sequencing, identify problems or conflicts before they occur on site, and refine designs with accurate pricing and quantity information. This data-driven teamwork helps people make better choices, waste less, and get more done in both the design and construction stages.

A wave of digital tools is bringing a new level of modernity to the sector, complementing BIM:

- Digital twins, which serve as virtual replicas of physical objects, empower people to monitor and assess a building's performance after it has been built.
- Digital Building Logbooks (DBLs) are digital files that consolidate all the essential details about a building in one common location, including design specs, material lists, maintenance logs, and energy-efficiency data. DBL supports information retention and can be utilised to strategise enhancements or guarantee adherence.

Digital Product Passports (DPPs) are digital records for products (including construction products) that make key information accessible across the value chain, such as composition, origin, performance/compliance documentation, and sustainability data.

BIM, digital twins, DBLs, DPPs, and other digital tools are part of an ecosystem transforming construction into a high-tech, information-rich field. Through programmes like the Digital Europe Programme and the upgrading standards and procurement practices, the European Union is actively supporting this digital transition. The underlying premise is that a more digital construction sector is also more competitive and resilient.

1.3 \ THE GREEN TRANSITION IN THE BUILT ENVIRONMENT

The building industry is also going through a "green transition", a significant development that will reduce environmental damage and make the industry climate-neutral. This means using sustainable practices at every step of the building process, from choosing the right materials to running the building and reusing it when it is done.

Life cycle thinking is a key idea behind the green transition. Life cycle thinking considers a building's environmental impact from start to finish (from cradle to grave, and ideally from cradle to cradle). This is different from merely looking at the upfront costs or the energy used to run it. Life Cycle Assessment (LCA) is a method for measuring a building's environmental impact throughout its life, including carbon emissions, energy use, and water use. The ISO 14040 series and European standards (such as EN 15978 for building LCA and EN 15804 for product LCA) provide rules for conducting LCAs consistently. To do an LCA, you need accurate information about the materials and products utilised. Environmental Product Declarations (EPDs) are crucial for this. EPDs are standardised documents that show the environmental impact of construction materials. For example, they show how much CO_2 is released when 1 tonne of cement is produced. This allows assessing different options and choosing materials with a lower impact. Using LCA and EPD data when making design choices can significantly reduce a building's embodied carbon and resource use. On the other hand, circular economy measures, such as designing for disassembly, using recycled materials, or reusing parts from old buildings, also help products and components last longer and reduce waste.

Many EU countries are now encouraging, or even requiring, these practices. For example, some countries give projects that adopt life cycle and circular approaches an advantage when obtaining permits, and the recast Energy Performance of Buildings Directive (EPBD) (Directive (EU) 2024/1275) introduces mandatory calculation and disclosure of life cycle Global Warming Portential (GWP) for new buildings (from 1 January 2028 for new buildings >1,000 m² and from 1 January 2030 for all new buildings). These changes show a shift in thinking: the success of a building is no longer judged solely by how it looks and how much it costs, but also by how well it performs environmentally throughout its life cycle.

CALL TO REALITY

> The EU has created frameworks such as Level(s), a comprehensive European framework for sustainable buildings, to help standardise and improve efforts to become more environmentally friendly. Level(s) provides a set of standard rules and measures for assessing how well a building performs in categories such as greenhouse gas emissions, resource consumption, water use, health and comfort, and cost over its lifetime. It provides a common vocabulary and a set of standards that align with Europe's climate targets. Although different standards and certifications already exist, including BREEAM or LEED, Level(s) stands out as a voluntary EU-wide framework that helps align Member States around common objectives. By using these kinds of frameworks, the industry is moving away from ad-hoc green indicators and towards clear, measurable sustainability goals.

1.4 \ THE TWIN TRANSITION IN ACTION

The true strength of the Twin Transition lies in merging digital innovation with sustainability goals. Leading businesses and government agencies no longer see the digital and green transitions as separate but as complementary efforts that support one another. Digital technology helps keep the environment healthy by providing the tools we need to plan, implement, and track the necessary adjustments to achieve our green goals. On the other hand, the goal of sustainability gives digitalisation initiatives a purpose and direction.

In real life, the synergy is evident. BIM-based design tools can add LCA calculations directly to the model. This lets project teams know right away how much carbon or resources alternative design options will require. For instance, an architect can change the design of a structure or switch out a material and see right away how that changes the building's embodied carbon or expected energy use. Getting feedback like this in real time makes it far easier to create buildings that satisfy high environmental criteria from the start, rather than having to fix or make up for mistakes later.

Digital twins of finished buildings fill the gap between what the designer wanted and what the building actually does. By continuously monitoring how the building operates (energy use, indoor air quality, etc.), the digital twin helps identify problems or maintenance needs, ensuring the building operates as sustainably as planned. Digital tools also make things more open and accountable. For example, a public client may use a digital dashboard to track a project's progress toward waste-reduction goals, or a facilities manager may receive automatic notifications when the interior climate falls outside the ideal range. Data is the new motor of sustainability, replacing guesses with facts and one-time calculations with ongoing optimisation.

The Twin Transition also gets help from policies that connect digital and sustainability goals. For example, the European Commission's Transition Pathway for Construction clearly asks for a "greener, more digital construction environment" to make the industry more resilient and competitive. Public procurement standards are changing to include both digital management (such as BIM use) and sustainability indicators (such as carbon reporting). This is pushing the sector forward on both fronts simultaneously. It is evident that digital tools are not an end in themselves, they are a means to achieve better, more sustainable built results.

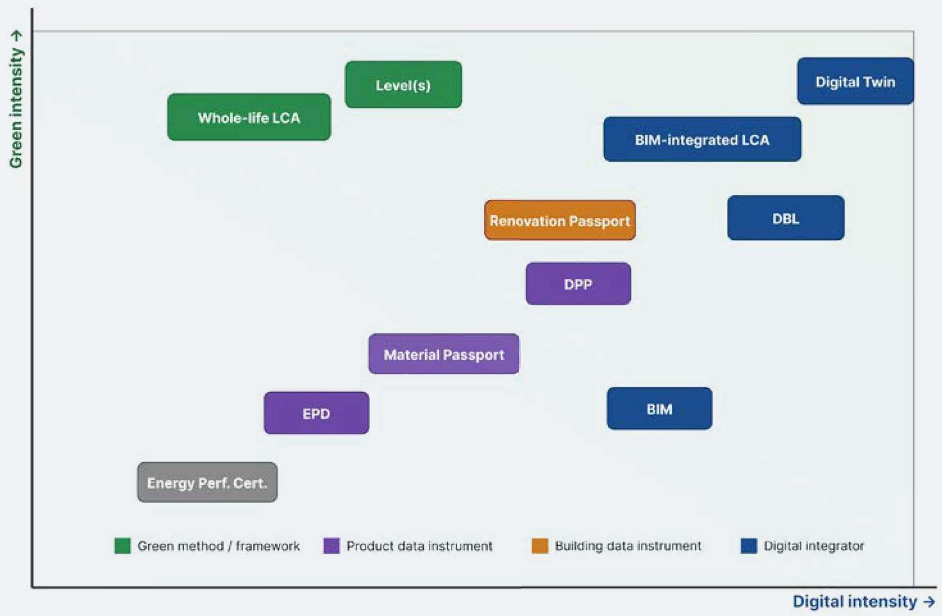


Figure 1 - Major digital instruments and green methods

CALL TO REALITY

Germany has set an example of how Twin Transition synergy can work in the real world by creating the BIM-based Building Circularity Passport. *Die Werkbank* IT, a tech company, and EPEA, an environmental institute, collaborated to develop this digital tool. It automatically creates a "material passport" for a building during the design phase. The system can then easily calculate a building's carbon footprint, material recyclability, and residual value by analysing the components listed in the model using BIM data and environmental algorithms. The Circularity Passport for new public buildings was first tested in municipal pilot projects in 2023. It allows planners to modify designs within seconds to enhance sustainability. This real-world pilot demonstrates that integrating life cycle data into BIM makes sustainability easier to understand and a valuable part of the design process. Planners said that what used to require days of LCA consulting can now be done with a single button press. This means better decisions and greener results from the outset of a project.

Note: www.epea.com/en/services/buildings/resource-passes

2 \ EU SUSTAINABILITY FRAMEWORKS FOR THE BUILT ENVIRONMENT

2.1 \ THE EUROPEAN GREEN DEAL

The European Green Deal was launched in 2019 to serve as the EU's primary strategy to achieve climate neutrality across Europe by 2050. It raises the EU's 2030 target for reducing greenhouse gas emissions to at least 55% and encompasses a variety of policy adjustments in sectors such as energy, industry, transportation, agriculture, and buildings to fulfil these commitments.

The "Fit for 55" legislative package is a key part of implementing the Green Deal. Presented by the European Commission in 2021 as a set of interlinked proposals, it has since been progressively adopted through revisions of core EU climate and energy laws, including updates to energy efficiency and renewable energy rules and reforms of the EU Emissions Trading System.

2.2 \ CIRCULAR ECONOMY ACTION PLAN

The EU is also promoting a Circular Economy agenda to ensure that resources are used in an environmentally sustainable way. The Circular Economy Action Plan (CEAP) was adopted in March 2020 and targets greater circularity in the construction and building sector by encouraging the use of recycled materials, improving disclosure of environmental impacts, and imposing more demanding sustainability requirements, including climate and environmental criteria, that extend beyond traditional safety concerns. The plan also extends Ecodesign principles, setting more stringent rules for materials such as steel, cement, and chemicals, and promotes the use of DBLs to track key building information throughout a building's life.

An important part of the CEAP is the endorsement of the Level(s) framework, designed to assess and integrate life cycle sustainability metrics into public procurement and EU sustainable finance decisions. By considering an entire building's life cycle, the plan seeks to reduce carbon emissions, promote the use of bio-based materials for carbon storage, and ensure that new public projects meet high sustainability standards. The strategy also includes reviewing recovery and recycling targets for construction and demolition waste, placing greater emphasis on recycling quality and increasing the reuse of excavated materials.

The action plan makes it clear that while more transparent data is helpful, achieving true circularity in construction requires innovation not just in design but also in demolition, sorting, and materials recycling techniques.

2.3 \ HOW EU CLIMATE POLICY AFFECTS THE SECTOR

The Green Deal and all other EU policies will only work if the built environment changes. Buildings in the EU account for over 40% of total energy use (mostly operational, during the building's use stage) and about 36% of total CO_2 emissions (combining operational and embodied carbon). This makes this industry crucial in the fight against climate change. The EU cannot meet its climate targets unless we make fundamental changes to how we build, redesign, and run buildings. As a result, European climate policy has a direct impact on buildings, both through tiny regulatory adjustments and large-scale programmes that urge individuals to act.

The EU Renovation Wave strategy is a significant aspect of the Green Deal. It aims to address the problem of most of Europe's old buildings being energy inefficient. The goal of the Renovation Wave is to at least double the annual renovation rate by 2030 and to encourage "deep" renovations that significantly reduce energy use.

The EPBD recast (Directive (EU) 2024/1275) reinforces this renovation push, introducing minimum energy performance standards to encourage the worst-performing buildings to improve and a cumulative goal of renovating around 35 million building units by 2030, which would create approximately 160,000 new green construction jobs. The Renovation Wave not only benefits the environment but also aims to reduce energy poverty by making homes more energy-efficient and by creating local construction jobs and skilled trades to support the economic recovery from COVID-19.

In December 2025 the European Commission launched the first European Affordable Housing Plan, complemented by the European Strategy for Housing Construction. Together, these initiatives position digitalisation, industrialised and modular construction, and advanced sustainable materials as the key levers to scale up housing supply while meeting climate and circularity goals - reinforcing the relevance of the Twin Transition agenda for the built environment. Follow-up instruments are scheduled, including the Affordable Housing Act (2026) and a Housing Simplification Package (2027), alongside a new Pan-European Investment Platform and revised State aid rules for social and affordable housing.

Another pillar of Fit for 55 targets the building stock. The recast EPBD (Directive (EU) 2024/1275) requires new public-sector buildings to be zero-emission from 1 January 2028 and all new buildings from 1 January 2030, mandates the calculation and disclosure of whole-life GWP (life cycle GWP) for new buildings above 1,000 m^2 from 2028 and for all new buildings from 2030, and sets a renovation trajectory for the worst-performing existing stock, with class E thresholds for non-residential buildings by 2030 and class D by 2033. Taken together, these measures raise operational performance while, for the first time, making embodied carbon a regulated metric in European construction.

CALL TO REALITY

> Originating in the Netherlands, the *Energiesprong* programme uses prefabricated facades and roofs, equipped with insulation and solar panels, to upgrade homes to net-zero energy within days and with minimal disruption. Early pilots took place in Dutch social housing, where entire rows of townhouses received new exterior shells and plug-and-play energy systems, eliminating residents' heating bills. Financing is structured so that the expected energy and maintenance savings help pay for the retrofit over time, an innovative performance contracting model.

THE EU TAXONOMY FOR SUSTAINABLE ACTIVITIES

The EU Taxonomy is a framework to guide sustainable investments in sectors such as construction and real estate by establishing technical criteria and explicit sustainability goals for green buildings. It defines more demanding requirements for energy performance, carbon footprint, and circularity (for example, for large new non-residential buildings, primary energy demand must be at least 10% below the national Nearly Zero-Energy Building (NZEB) requirement and undergo whole-life carbon assessments in accordance with EN 15978 and the Level(s) framework). The Taxonomy also encourages the reuse and recycling of construction materials, setting minimum thresholds for recycled content and requiring that major renovations achieve significant energy savings, all under the principle of "Do No Significant Harm" to other environmental objectives.

Driven by these requirements, financial institutions are requiring sustainability data from developers and project sponsors, driving the market toward greater transparency and performance. As a result, major real estate players are increasingly disclosing the carbon impacts of new construction, and green building certification schemes are adapting to Taxonomy benchmarks. The EU Taxonomy is thus playing a transformative role by driving measurable improvements in sustainability and accelerating the transition to environmentally responsible building across Europe.

CALL TO REALITY

> Some EU Member States have already put strict building rules in place, even as EU-level frameworks such as the EU Taxonomy and the recast EPBD are being implemented and phased in through national transposition (with the transposition deadline for the recast EPBD set for 29 May 2026), standards, and market practice. France's RE2020 thermal and environmental regulation not only makes it harder for new buildings to meet energy-efficiency standards, but also sets limits on carbon footprints and climate resilience. It states that new construction projects must conduct an LCA and meet minimum embodied carbon levels. Builders must obtain a "Carbon" permit in addition to a conventional energy permit and demonstrate that the materials used in the design adhere to the carbon ceilings. This French example demonstrates how policies can translate sustainability ideals into practical action at the national level.

2.4 \ STANDARDS AND TOOLS FOR SUSTAINABLE PRACTICE

The EU and industry stakeholders have developed a range of tools, standards, and methods to support the use of these high-level frameworks. These help professionals consistently measure and improve the sustainability of buildings. The Level(s) framework, LCA standards, EPDs, and digital tools such as BIM that integrate sustainability data are among the most important. These tools provide technical support that links policy goals to the work that needs to be done every day.

LEVEL(S): A COMMON EU FRAMEWORK FOR BUILDING SUSTAINABILITY

Level(s) is the European Commission's main voluntary framework for judging and reporting on how sustainable buildings are. After years of development and experimental testing, Level(s) was officially released in 2020. It provides a consistent language and set of indicators for building sustainability performance across six macro-objectives. These macro-objectives include: (1) greenhouse gas and air pollutant emissions over the life cycle; (2) resource-efficient and circular material flows; (3) efficient use of water resources; (4) healthy and comfortable spaces; (5) adaptation and resilience to climate change; and (6) cost, value, and risk (life cycle cost and value assessment). There are 16 core indicators that measure each macro-objective. These include life cycle GWP (indicator 1.2), total water consumption, indoor air quality, and the ability to adapt and break down in different situations.

Level(s) aims to incorporate life cycle thinking and circular principles into construction projects and push project teams to consider the building's complete life cycle, encouraging designers to balance operational energy efficiency with embodied carbon in materials. It also considers how easily a building's components can be disassembled or recycled when it is no longer needed, aligning with the principles of the circular economy.

Level(s) is designed to be adaptable by having three levels of participation that work for varied project sizes and skill levels:

- Level 1 (Concept design) - using simple, primarily qualitative indicators to identify broad sustainability aims and examine choices throughout early design. (For instance, at Level 1, one might subjectively analyse site selection, fundamental form factor for energy, or design techniques for adaptability.)
- Level 2 (Detailed design and construction) - using quantitative indicators with established measurements (sometimes needing calculations or modelling matched with EU standards). A thorough building LCA could be done at this level, energy and water use could be evaluated more accurately, and precise goals for waste, recycled content, and other things could be set. Most Level(s) users hoping for robust outcomes work at Level 2.
- Level 3 (As-built and in-use) - measuring actual performance after the facility is operating. This means monitoring whether the building meets its design goals (e.g., energy use, indoor air quality) and conducting reviews when people move in. Level 3 is about closing the loop and using real results to improve future practice.

One of the best things about Level(s) is that it follows European standards, such as EN 15978 for whole-building LCA and EN 15804 for product EPD data. This ensures that the calculations, reports under Level(s) are robust and comparable. Level(s) is increasingly referenced as a common framework for assessing and communicating the sustainability performance of buildings. In the sustainable finance context, EU-level criteria for building-related activities have cited Level(s) as a tool that can support the tracking of whole-life carbon performance, alongside the wider EU Taxonomy framework. The 2020 Circular Economy Action Plan explicitly points to using the Level(s) approach to LCA into public procurement and the EU sustainable finance framework. In parallel, the EPBD recast strengthens policy instruments for renovation (including renovation passports), and the Commission has highlighted how Level(s) can be applied to renovations, creating favourable conditions for wider, more consistent sustainability reporting across building projects.

Level(s) offers practical tools (such as checklists, calculation guidance, Excel templates), an open-source approach that certification schemes and national standards can use to improve. Level(s) is now part of the rating systems or training programmes of many Green Building Councils in Europe. Level(s) is appealing to public-sector construction clients and politicians because it takes a broad yet consistent approach. It lets them include sustainability conditions in bids and collect data in a way that makes it easy to report on climate and environmental goals. Level(s) provides designers and developers with a means to organise their sustainability plans and demonstrate to investors or authorities how well they are performing. Importantly, Level(s) is BIM-compatible, as its indicators can be integrated into digital building models to automate data collection and analysis.

CALL TO REALITY

> Level(s) Pilot in Slovenia – The Level(s) framework pilot project in Slovenia is an example of how Europe is turning its green goals into action. During its design and construction, the Knauf Insulation Experience Centre (a 640 m² office building) was one of the first structures to use Level(s), the EU's framework for sustainable buildings. This two-storey project became a model for sustainability, and people from the European Commission, industry, and the Slovenian government kept a close eye on its progress. Slovenia is currently exploring how to revise its building codes to make them more sustainable throughout the life cycle of buildings. The study shows how one green building pilot can get more people into the construction industry (ec.europa.eu/newsroom/env/items/672166).

LIFE CYCLE ASSESSMENT IN CONSTRUCTION

LCA looks at a building's environmental impact across every stage of its life: from the manufacturing and transport of materials, through construction, the many years the building is in use (including energy and maintenance), and finally end-of-life - whether demolition, disposal or recycling. Rather than focusing on a single moment, such as construction costs or annual energy bills, LCA provides a complete picture of where impacts arise and how design choices shift them between stages. To make assessments comparable across projects and countries, Europe has built a coordinated set of standards that organise the calculation into clearly defined life cycle modules.

LCA for buildings is organised by life cycle modules set out in EN 15804+A2 and EN 15978: A1–A5 cover the product and construction stages, B1–B7 the use stage, C1–C4 end-of-life, and module D the benefits and loads beyond the system boundary. Structuring assessments around these modules allows environmental impacts to be calculated, compared and aggregated consistently from product level up to whole-building performance.

LCA was considered difficult, time-consuming, and often not required. Now it is becoming mainstream due to new regulations (such as France's RE2020, the EPBD recast, which require the calculation and disclosure of life cycle GWP for new buildings) and rising client expectations. Numerous LCA tools are now available for building design, often as cloud platforms or BIM plugins. Tools such as One Click LCA, eTool, and Tally (among others) include integrated EPD databases and enable fast calculation of a building's environmental profile, even in early design stages. As these tools become more user-friendly, LCA is shifting from a specialist exercise to a routine part of sustainable design.

LCA is crucial because it reveals impacts that operational energy models miss. A highly insulated building, for example, may have low heating demand but rely on insulation with high manufacturing emissions. Only a life cycle perspective exposes this trade-off and supports better design choices. LCA also identifies "hotspots", such as a particularly carbon-intensive component (e.g. a façade cladding type), encouraging a switch to lower-impact alternatives. In renovation projects, LCA can help decide whether to retrofit an existing structure or construct a new one by quantifying the embodied carbon savings from reuse.

CALL TO REALITY

> The Circular Retrofit Lab in Brussels is a strong example of how life cycle and circular thinking can work in practice. This project was one of six EU Horizon 2020 "Buildings As Material Banks (BAMB)" pilot projects. It took a group of outdated student housing modules at the *Vrije Universiteit* Brussel and made them more circular. The design used Level(s) ideas of adaptability and deconstruction. New partitions, facades, and building systems were installed using demountable, modular components (such as click-in connections and reversible adhesives) to enable easy disassembly, modification, or future reuse. More than eight student units were converted into a live demonstration of how an existing building can be given new life and flexibility for diverse uses (such as co-working space, exhibition space, eco-guesthouse, etc) without generating demolition waste. The Circular Retrofit Lab shows how real-world projects can meet EU framework goals. It used digital planning, new materials, and stakeholder partnerships to reduce waste and establish a "building materials bank" on campus. These examples show that the abstract concepts of LCA and circularity can be translated into real-world outcomes with imagination and the right tools.
>
> www.bamb2020.eu/pilots/circular-retrofit-lab

BIM AND DIGITAL INTEGRATION FOR SUSTAINABILITY

It would be very hard to meet the EU's sustainability and reporting targets in construction without digital tools. BIM is one of the most important. It has already changed the way design and construction work by improving collaboration, visualisation, and data management. It is now also a key factor in making sustainability work.

When project teams use BIM alongside LCA and other analyses, they can achieve significant results. For example, BIM-LCA integration may provide real-time feedback on how design choices affect the environment directly within the 3D model. Designers can utilise BIM plugins to automatically calculate the carbon footprint, rather than manually extracting quantities and entering them into separate LCA tools, which is time-consuming and error-prone. This makes it easy to make changes quickly. For example, if the BIM model changes from a concrete slab to a wood slab, the total embodied carbon can be calculated virtually immediately.

Some of the advantages of using BIM for sustainability analysis are:

> **Early design optimisation:** BIM allows teams to assess energy, daylight, and materials from the earliest design stages. By modelling options (e.g. different massing and materials) and linking them to performance calculations, teams can select solutions that balance aesthetics and sustainability and identify lowcarbon strategies before key decisions are made.

> **Improved compliance and reporting**: BIM can be set up to check the model against specific criteria, identifying materials without EPD or designs that miss targets. It can automatically compile data for compliance reports using Level(s) indicators or EU Taxonomy criteria.

> **Open collaboration**: A shared BIM model provides a single source of truth. All stakeholders can access sustainability data, such as carbon values or elements designed for disassembly, making tradeoffs transparent and improving collaboration. This information can be carried into the operational phase after handover, allowing the model to evolve into a digital twin.

CALL TO REALITY

A high-rise project in Morocco demonstrated how digital and life cycle methods can be integrated in practice. Researchers from VUB and *Instituto Superior Técnico* developed an automatic BIM-based LCA/LCC tool (BIMEELCA) which they validated using the 250-metre Mohammed VI Tower in Salé (Rabat-Salé), one of the tallest buildings in Africa. Using a Revit model at the early design phase, the tool automatically generated quantity take-offs, assigned environmental and economic data to materials and elements, and performed both streamlined (A1–A3) and complete LCAs (Santos *et al.*, 2020).

The case study shows that even for a complex high-rise structure, BIM can be used to automate life cycle calculations, identify high-impact components and support early-stage design decisions. Although this is not an EU initiative, it demonstrates the kind of integrated digital-and-sustainable workflow that the Twin Transition promotes: using BIM not only for geometry but also as a data environment that enables rapid, consistent, whole-life analysis of buildings.

PART II

TOOLS AND METHODS

From LCA to Digital Product Passports

3 \ LIFE CYCLE ASSESSMENT AND BIM

3.1 \ ISO 14040 SERIES AND EN 15804

LCA follows internationally recognised standards to ensure consistency and alignment. The ISO 14040 series and EN 15804 are two of the most important standards. They provide the concepts, framework, and specific advice needed for credible, functional analyses. These standards are now essential for professionals because they help ensure consistency across businesses and countries.

THE ISO 14040 SERIES: PRINCIPLES AND METHODOLOGY

LCA is based on two paired standards (ISO 14040:2006, principles and framework; and ISO 14044:2006, requirements and guidelines), which explain its rules and principles. Together, they form a complete system for conducting systematic, repeatable evaluations. The ISO 14040 series stresses a four-step approach to make sure that assessments are complete and follow best practices:

- **Defining the goal and scope:** The initial step in LCA is to determine the study's objectives and establish its scope. This step creates the foundation for the analysis and identifies the intended audience.
- **Life Cycle Inventory (LCI) Analysis:** The second step is to collect data on the product's life cycle, including inputs (such as raw materials and energy) and outputs (such as emissions and waste). For a building, this could include information on how materials are extracted, moved, used to build, and used for energy. The inventory is often the stage that consumes the most resources, as it requires extensive data and careful record-keeping. ISO 14044 emphasises the importance of using current and representative data to improve the reliability of results.
- **Life Cycle Impact Assessment (LCIA):** At this point, professionals review the inventory data to assess potential environmental impacts. To learn more about the environmental impact of a product or process, researchers examine factors such as its potential to contribute to global warming, its resource use, and its water use. For instance, the amount of carbon dioxide released into the atmosphere is measured to assess its impact on climate change, and the amount of resources extracted from the ground is calculated to determine their impact on material scarcity.
- **Interpretation:** The last step is to examine the data and make sense of it so you can draw valuable conclusions and find ways to improve.

EN 15804: GUIDANCE FOR THE CONSTRUCTION SECTOR

While the ISO 14040 series provide a general framework, EN 15804 offers guidance for conducting LCAs of construction products. This European standard addresses the complexities of the construction sector, where buildings and infrastructure involve a wide range of materials, processes, and life cycle stages.

One of EN 15804's key contributions is its introduction of Product Category Rules (PCRs). PCRs establish consistent methodologies for assessing similar products, ensuring comparability across different manufacturers and regions. For instance, PCRs for cement or steel define the functional units, system boundaries, and data requirements specific to those materials. This standardisation is critical in construction, where methodological variations can lead to inconsistent results.

EN 15804 divides LCA into distinct **modules**, each corresponding to a specific phase of a products or buildings existence. These modules include:

- **A1–A3: Product Stage –** covering raw material supply, transportation, and manufacturing processes (for example, emissions associated with cement production or steel fabrication).
- **B1–B7: Use Stage –** addressing impacts during the operational phase of the building, such as energy consumption for heating and cooling, maintenance activities, and the replacement of materials.
- **C1–C4: End-of-Life Stage –** focusing on deconstruction, waste processing, and the disposal or recycling of materials. This includes evaluating the environmental implications of demolition practices and material recovery.

EN 15804 also defines specific environmental impact categories, enabling comprehensive assessments of construction products. The core indicators include:

- **Global Warming Potential (GWP):** Measured in CO_2 equivalents, it quantifies the contribution to climate change from greenhouse gas emissions.
- **GWP Fossil (GWPf):** Measured in CO_2equivalents, it quantifies the contribution to climate change from greenhouse gas emissions of fossil fuels or other fossil carbon sources.
- **GWP Biogenic (GWPb):** Measured in CO_2 equivalents, it accounts for greenhouse gas emissions and removals associated with biogenic carbon (e.g., CO_2 uptake and release from biomass).
- **GWP land use and land use change (GWPl):** Measured in CO_2 equivalents, it reflects emissions and removals (including CO_2, CO, and CH_4) arising from changes in carbon stocks due to land use and land-use change (LULUC).
- **Ozone Depletion Potential (ODP):** Measured in kg CFC-11 equivalents, this evaluates the impact of emissions on depletion of the stratospheric ozone layer.
- **Acidification Potential (AP):** Measured in mol H^+ eq. (per EN 15804+A2), it reflects the potential of emissions to cause acid rain and affect soil and water systems.
- **Eutrophication Potential (EP):** Under EN 15804+A2, eutrophication is no longer reported as a single indicator; it is split into three categories (freshwater, marine and terrestrial) covering nutrient enrichment of aquatic and terrestrial environments.
  - *EP-freshwater (EPf):* measured in kg PO_4 equivalents – the fraction of nutrients reaching freshwater ecosystems.
  - *EP-marine (EPm):* measured in kg N equivalents – the fraction of nutrients reaching marine ecosystems.
  - *EP-terrestrial (EPt):* measured in mol N equivalents – the accumulation of nutrient-related acidification in terrestrial ecosystems.
- **Photochemical Ozone Creation Potential (POCP):** Measured in kg NMVOC eq. (per EN 15804+A2; the earlier A1 reporting in kg C_2H_4 eq. is no longer used), it evaluates the contribution to ground-level ozone (smog) formation.
- **Abiotic Depletion Potential – Fossil Fuels (ADPf):** Measured in MJ, it accounts for the depletion of non-renewable energy resources such as oil, coal, and natural gas.
- **Abiotic Depletion Potential – Minerals & Metals (ADPm):** Measured in kg Sb (antimony) equivalents, it focuses on the depletion of non-renewable material resources (minerals and metals).
- **Water Depletion Potential (WDP):** Measured in cubic metres of water (world equivalent, deprived), it quantifies water consumption weighted by regional water scarcity (user deprivation potential).

Climate change is only part of the story. The revised standard reflects a broader understanding that buildings also affect air quality, water, soils and human health. Accordingly, EN 15804+A2 introduced further core indicators that should also be reported: Particulate Matter emissions (PM, disease incidence), Ionising Radiation Potential (IRP, kBq U-235 eq.), Ecotoxicity – freshwater (ETP-fw, CTUe), Human Toxicity – cancer and non-cancer effects (HTP-c and HTP-nc, CTUh), and Soil Quality / Land Use (SQP, dimensionless Pt). In parallel, EN 15978 (revised) introduces module A0 (land and related services prior to construction) to complement modules A1–A5, B1–B7, C1–C4 and D.

HARMONISING ISO AND EN STANDARDS

The ISO 14040 series and EN 15804 work well together to establish a strong framework for LCA in the building industry. ISO 14040 sets out broad rules, while EN 15804 provides sector-specific guidance to address the issues that arise when evaluating building materials and products. These standards work together to ensure that practitioners can conduct thorough, consistent analyses, thereby making LCA results helpful and trustworthy.

ISO 14040 gives general guidelines for the life cycle of a building material (it tells you how to set up and do the LCA). In contrast, EN 15804 specifies the specific impact categories, data needs, and system boundaries that apply to that material. This synergy makes LCA results more credible and helps industry professionals make better decisions. The standard EN 15978, which provides a framework for measuring the overall environmental performance of buildings, supports building-level LCA in practice. EN 15978 aligns with the modular methodology of EN 15804, meaning that product-level data (such as EPDs prepared in accordance with EN 15804) can be used consistently and aggregated in whole-building evaluations.

3.2 \ ACCELERATING LCA IMPLEMENTATION USING DIGITAL TOOLS

The following sections present an example of a BIM-based LCA tool and demonstrate its application in a real case study. SmartLCA is a tool developed by the Civil Engineering Research and Innovation for Sustainability (CERIS) at the University of Lisbon, made available for industry use. The tool operates within BIM authoring software, using the building's information model for LCA calculations. To begin an analysis, the user must specify the project stage (Figure 2), with two options available:

- **Level 1:** For conceptual design and initial project stages.
- **Level 2:** For detailed design and construction phases.

When Level 1 is selected, the tool generates a list of questions on life cycle design concepts (Figure 3). These questions are presented in a binary yes/no format and include prompts for a brief description of how each idea has been integrated into the building's design. Upon completing the questionnaire, the results can be exported into an Excel table for further analysis and documentation.

Figure 2 - Levels of analysis depending on the project stage.

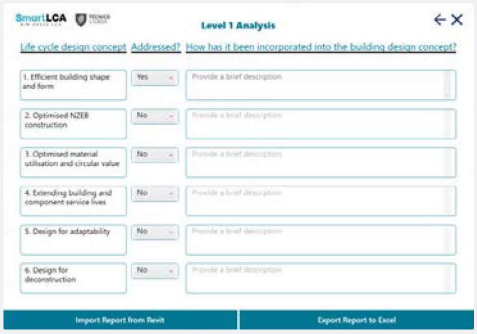


Figure 3 - Level 1 analysis questionnaire (conceptual design phase).

For a more comprehensive assessment during later project phases (detailed design, construction, or even tendering), Level 2 is used. Upon selecting Level 2, the tool prompts the user to specify the type of analysis to conduct (Figure 4). Three options are available:

- **Level(s) LCA:** a full LCA of the building model.
- **Level(s) GWP:** a focused analysis of the GWP indicator.
- **Level(s) Cost:** a Life Cycle Cost analysis.

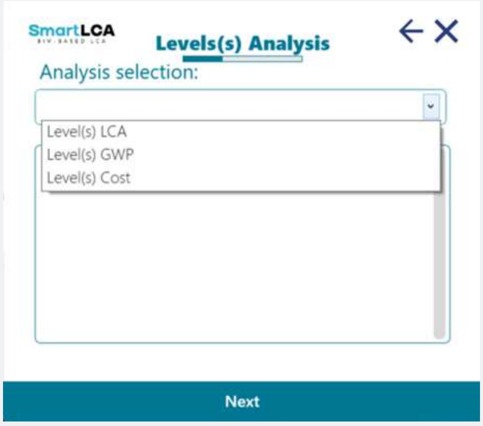


Figure 4 - Analysis selection

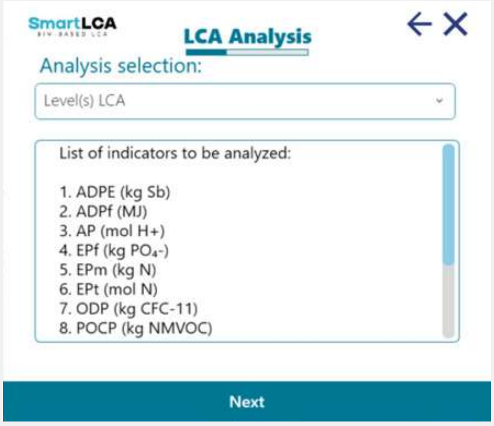


Figure 5 - Selection of LCA environmental indicators (Level(s) LCA).

When Level(s) LCA is chosen, the tool initiates an Environmental Indicator Analysis. A window displays all the considered environmental indicators for this analysis (Figure 5). After this selection, the tool automatically creates corresponding parameters within the BIM model, based on a predefined LCA data template (see Table 1). These parameters will hold the values of each environmental indicator for every building element in the model.

Table 1 – Product data template section for the BIM-LCA plugin.

Indicator / Parameter	I – Level(s) LCA	II – Level(s) GWP	III – Level(s) LCC	Units
ADPf (abiotic depletion, fossil fuels)	x	–	–	MJ
ADPm (abiotic depletion, minerals & metals)	x	–	–	kg Sb eq.
AP (acidification potential)	x	–	–	mol H^+ eq.
EPf (eutrophication, freshwater)	x	–	–	kg PO_4 eq.
EPm (eutrophication, marine)	x	–	–	kg N eq.
EPt (eutrophication, terrestrial)	x	–	–	mol N eq.
ODP (ozone depletion potential)	x	–	–	kg CFC-11 eq.
POCP (photochemical ozone creation)	x	–	–	kg NMVOC eq.
WDP (water depletion potential)	x	–	–	m^3 world eq. deprived
GWPt (global warming potential, total)	x	x	–	kg CO_2 eq.
GWPf (global warming potential, fossil)	x	x	–	kg CO_2 eq.
GWPb (global warming potential, biogenic)	x	x	–	kg CO_2 eq.
GWPl (global warming potential, land use and land use change)	x	x	–	kg CO_2 eq.
Initial Costs	–	–	x	€/$m^2 \cdot$ yr

These environmental indicators enable the tool to automatically compute the relationship between each element's quantity (from the BIM model) and its associated environmental impacts, as described by Ferreira *et al.* (2022a; 2025). The specific parameters addressed by the tool's LCA functionality include ADPf, ADPm, AP, EPf, EPm, EPt, ODP, POCP, WDP, GWPt, GWPf, GWPb, and GWPl.

Each indicator is defined per functional or declared unit and is automatically multiplied by the quantity of the corresponding construction element (measured directly from the BIM model). The indicator parameters are embedded within each BIM object (e.g., wall, floor, roof) and their material components, ensuring precise integration of LCA data into the model for analysis.

When Level(s) GWP is selected, the plugin performs a targeted analysis of ***Global Warming Potential***. This assessment evaluates four primary GWP indicators: GWPt, GWPf, GWPb, and GWPl. The tool automates the calculations as defined in Ferreira ***et al.*** (2022b; 2025), where the impact per functional unit (per material quantity) is multiplied by the area or volume of that material in the model. Figure 6 shows a screenshot of the tool interface, listing the required GWP indicators for this analysis.

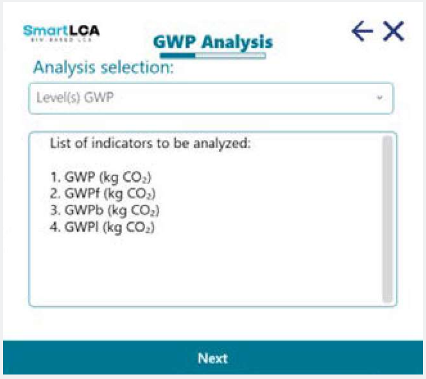


Figure 6 - Selection of GWP indicators (Level(s) GWP).

CONNECTION WITH THE DATABASE

For the tool to automatically calculate the overall impacts of the BIM model, it is essential to obtain environmental impact data for each component and populate the model's elements with the corresponding values. There are two methods for providing data for each component of the BIM model:

> **Online Integration:** Connect directly to an online database (the "ecoPortal", Figure 7) and search for an appropriate EPD for each component in the model.

> **Manual Entry:** Input the EPD data manually by specifying the impact values for each environmental parameter. The tool will then calculate total impacts based on the model quantities and the entered per-unit impact data.

Figure 7 illustrates the tool's connection to the ecoPortal (IBUdata) online database, which is one of Europe's largest repositories of EPDs. This integration allows semi-automatic retrieval of up-to-date materials data from EPDs and other IBU datasets, ensuring that the LCA uses the most current and specific information available.

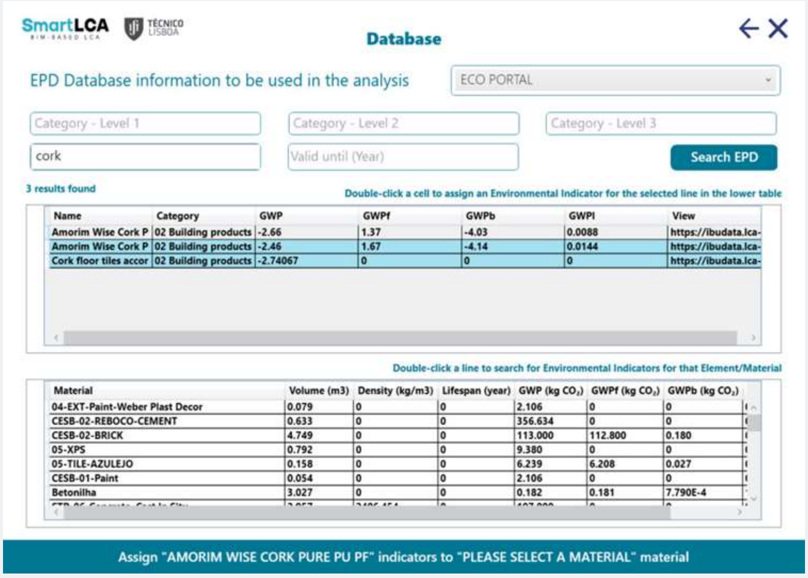


Figure 7 - Connection to the ecoPortal database for automated EPD data retrieval.

3.3 \ ATREM HOUSE CASE STUDY

The Atelier dos Remédios (ATREM) House in Montemor-o-Novo, Portugal, is a single-family residence of 163 m², with an additional 58 m² agricultural outbuilding on a 5,900 m² rural plot (Figure 8). The project combines contemporary construction techniques with sustainability principles, repurposing demolition materials such as earth, stone, and brick for the foundations and employing prefabricated systems to minimise on-site labour and waste.

The house is a single-storey U-shaped volume set at the highest point of the plot, opened southwards around a central courtyard that links its three wings - living and dining (east), services (north) and bedrooms (west). A raised-ring wall around the courtyard protects the roof garden from winter winds, and the reinforced-concrete structure on a continuous foundation slab responds to the rocky subsoil. The compact layout, passive solar orientation and well-insulated envelope give the building a strong baseline performance that the LCA then quantifies in detail.

Figure 8 - 3D model view of the ATREM House case study.

BIM MODEL ANALYSIS AND RESULT VISUALISATION

The application of the SmartLCA tool to the ATREM House BIM model provides a comprehensive set of LCA results. For example, the GWP assessment results are automatically generated and can be reviewed in list form as shown in Figure 9. Results from the tool can be exported in various formats, including Excel spreadsheets (see Figure 9 for a tabulated view within the BIM software). In addition, the plugin produces pie charts that display the total results for each impact indicator, including ADPm, AP, EP, ODP, POCP, and GWP, with each construction component's contribution differentiated by colour (Figure 10). A 3D visualisation is also available, using a colour-coded scheme to illustrate the relative impacts of BIM model elements (Figure 11). In this scheme, green highlights elements with the lowest environmental impact, while red highlights those with the highest impact, providing an intuitive visual overview of the building's impact "hot spots".

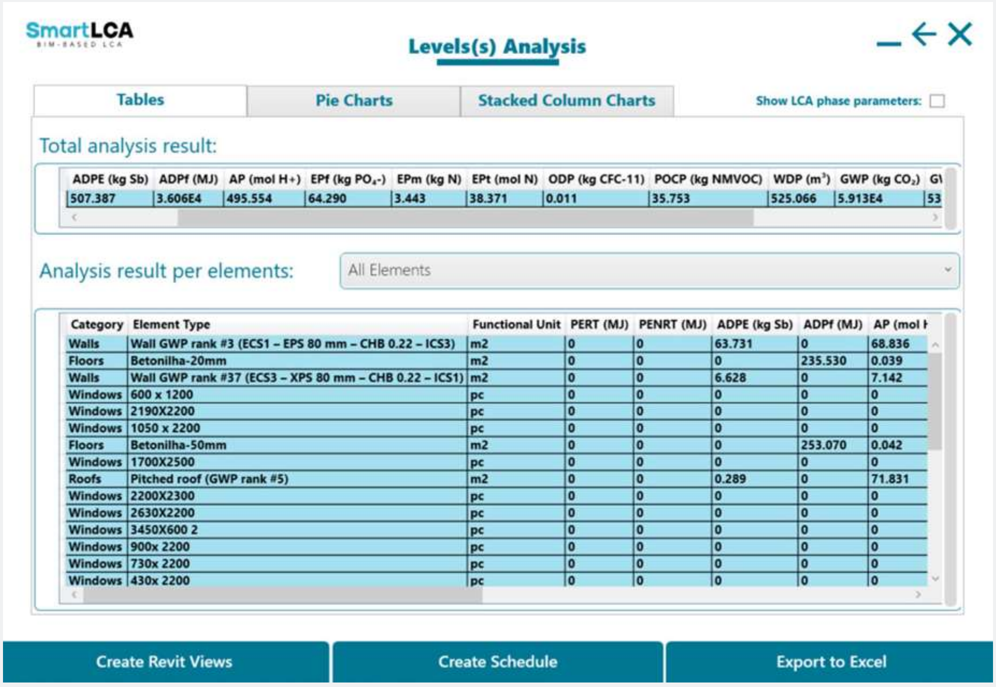
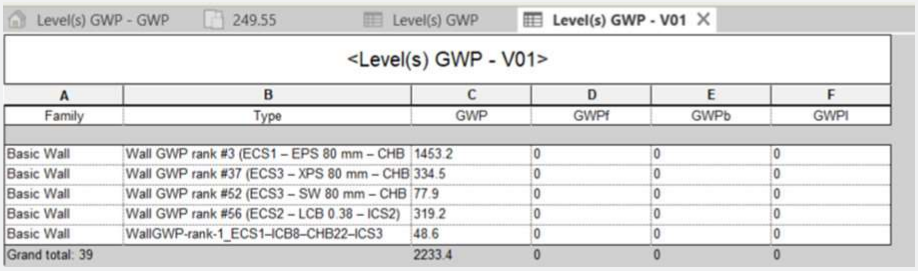


Figure 9 - List of total GWP analysis results (SmartLCA output).



<Level(s) GWP - V01>

A	B	C	D	E	F
Family	Type	GWP	GWPf	GWPb	GWPl
Basic Wall	Wall GWP rank #3 (ECS1 – EPS 80 mm – CHB	1453.2	0	0	0
Basic Wall	Wall GWP rank #37 (ECS3 – XPS 80 mm – CHB	334.5	0	0	0
Basic Wall	Wall GWP rank #52 (ECS3 – SW 80 mm – CHB	77.9	0	0	0
Basic Wall	Wall GWP rank #56 (ECS2 – LCB 0.38 – ICS2)	319.2	0	0	0
Basic Wall	WallGWP-rank-1_ECS1–ICB8–CHB22–ICS3	48.6	0	0	0
Grand total: 39		2233.4	0	0	0

Figure 10 - Tabulated GWP results as displayed in the BIM (Revit) environment.

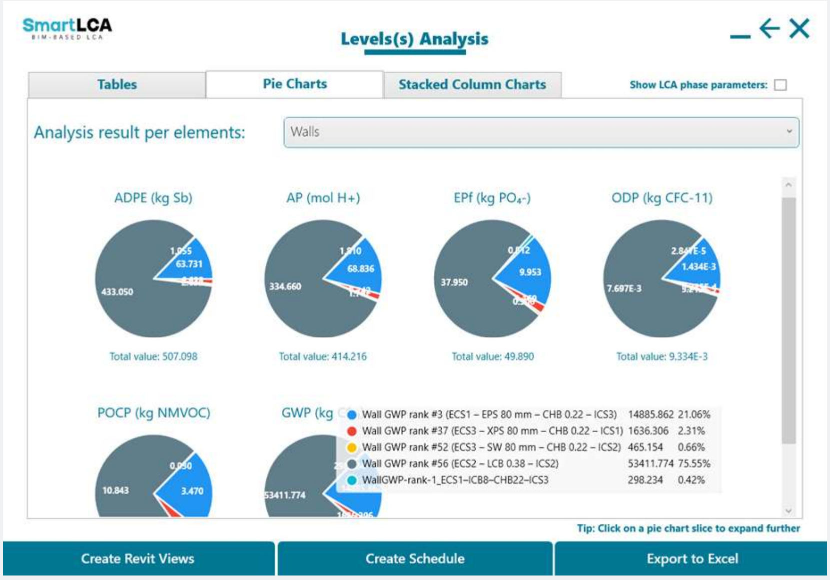


Figure 11 - Pie chart showing the distribution of total results per indicator (ADPm, AP, EP, ODP, POCP, GWP), with different colours representing each component's contribution.

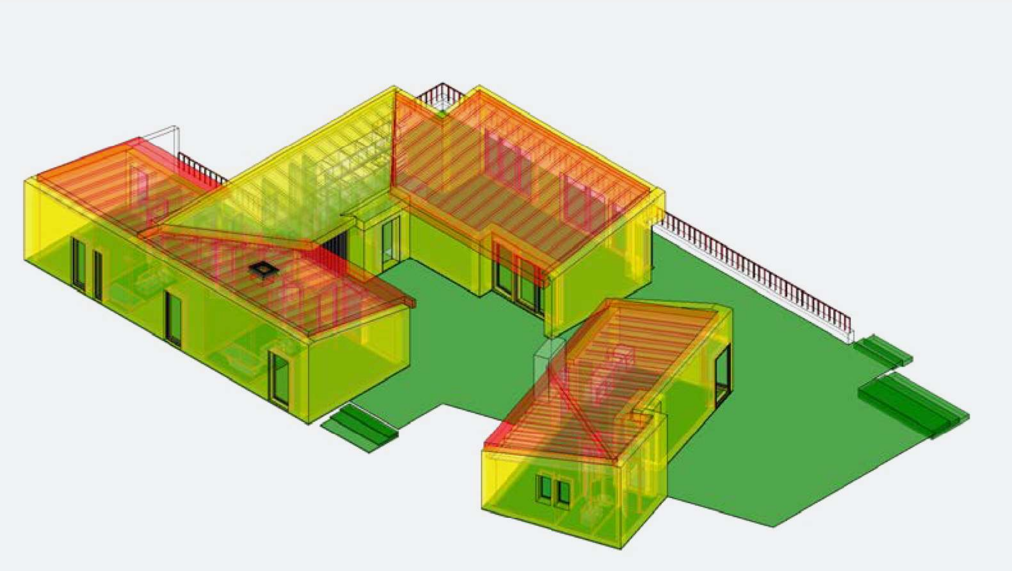


Figure 12 - 3D visualisation of the building's results for an impact category (e.g., EPf), using colour-coding to indicate low (green) vs. high (red) impact elements.

PURPOSE-DRIVEN APPROACH FOR BIM-BASED LCA

Considering LCA solely at the end of the design process, such as during the technical design phase, drastically limits the opportunity to improve building design. At this point, most key decisions about materials, systems, and building principles have already been made, limiting LCA to minor material substitutions rather than allowing for real design optimisation.

As a result, a more consistent and structured strategy is required, one that incorporates LCA across multiple design phases and is adaptable to various evaluation objectives. Early-stage LCA can help with exploratory and comparative evaluations, driving strategic design decisions, whereas later-stage assessments can refine and validate final solutions. This staged method allows environmental performance to actively inform the design process rather than just verifying it at the end.

Figure 13 depicts the Level(s) framework, and highlights the need to align design phases, BIM, and European sustainability guidelines in the construction sector. The framework proposes aligning LCA with design development, with a preliminary LCA stage at Level 2A and Level 2B reserved for the detailed design phase.

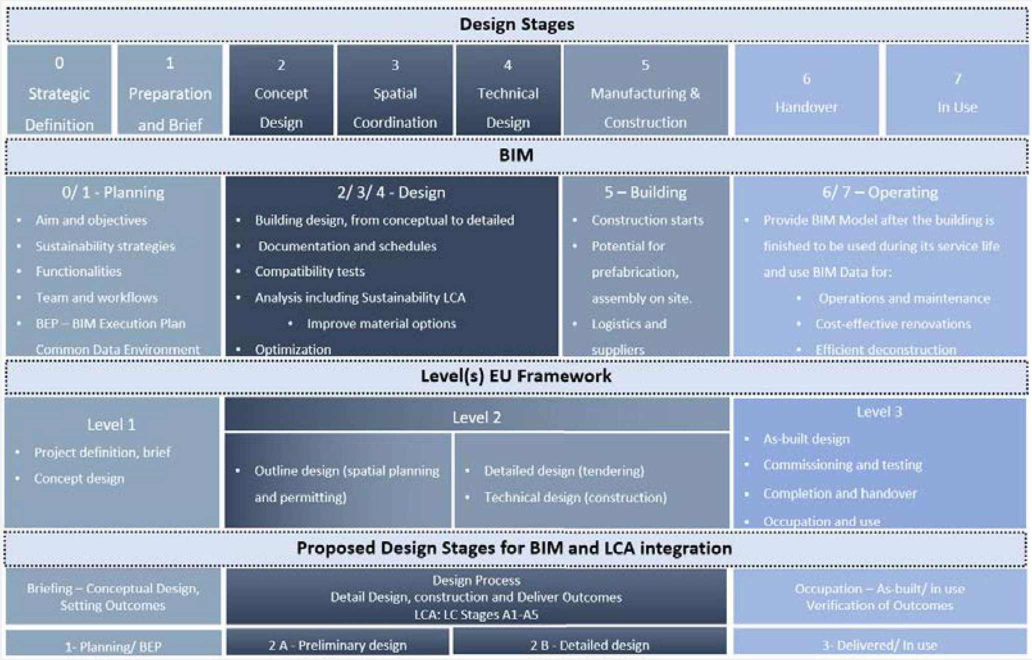


Figure 13 - Design phase versus BIM and the Level(s) EU framework, highlighting the main objectives of each phase. Addressing the issue of LCA, BIM, EU directives and the proposal of its integration along the design phases. Including the suggested naming and conventions.

The purpose-driven approach to BIM-based LCA specifies different data requirements based on the level of design progress. Figure 14 illustrates this phased, purpose-driven approach, which was implemented in the plugin and then applied to the case study.

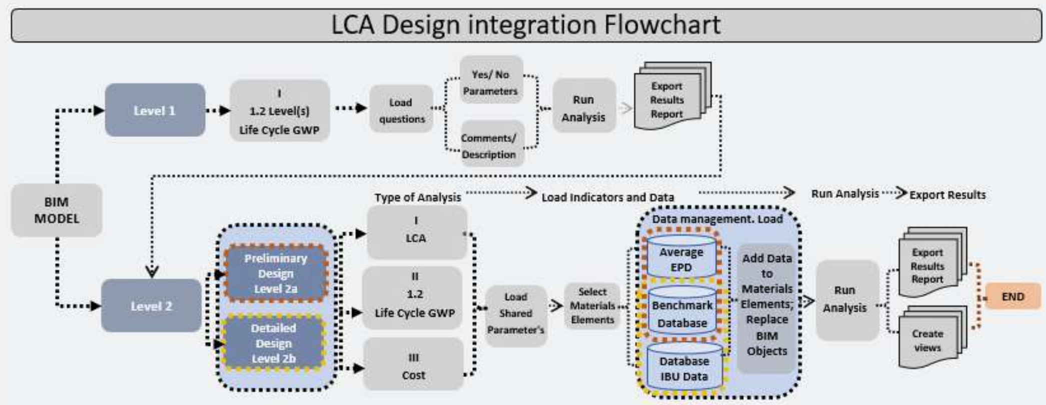


Figure 14 - LCA plugin workflow diagram: identify the intermediate levels of assessment depending on the project's design phase and the data required as inputs and outputs.

LEVEL 1 - STRATEGIC DEFINITION

In Level 1, the strategic definition of the preliminary design phase, a questionnaire based on the Level(s) framework is provided to the design team (Table 2) to address the environmental objectives of the specific project; the results are then incorporated into the BIM Execution Plan (BEP).

Table 2 - Level(s) framework (Level 1)

Life cycle design concept	Addressed?	How has it been incorporated into the building design concept?
1. Efficient building shape and form	No	
2. Optimised nearly zero energy building (NZEB) construction	No	
3. Optimised material utilisation and circular value	No	
4. Extending building and component service lives	No	
5. Design for adaptability	No	
6. Design for deconstruction	No	

LEVEL 2A - PRELIMINARY DESIGN

The importance of introducing an intermediate LCA level, Level 2A, aligned with the concept design phase, is to support designers in material decision-making. By using a simplified assessment, designers can quickly analyse average data for a material without the need to attach to a specific EPD. The Level 2A aims to drive a path towards decarbonisation by integrating the LCA into design development, enabling disruptive changes to material options. This preliminary level of assessment could also be used in public competitions/procurement proposals where no specific material can be addressed. Still, environmental concerns should be considered by policymakers when deciding whether to include environmental criteria.

Given that no specific EPDs are available at this stage, it is necessary to generate average EPDs to ensure LCA calculations are valid and consistent. To accomplish this objective, particular criteria for selecting the EPDs to be utilised for average calculations are required. These criteria include the provisions given below:

> **a) Material and Use Consistency**: All selected EPDs pertain to the same material.
> **b) Standards Compliance**: The EPDs comply with ISO 14025:2006 (ISO, 2006) and EN 15804:2012+A2:2019/AC:2021 (EN 2019/2021), ensuring adherence to internationally recognised LCA standards;
> **c) Functional Unit Alignment**: EPDs use the same functional unit (e.g., 1 cubic metre).

- **d) Programme and Validity**: EPDs are issued by credible organisations, such as the International EPD® System or the *Institut Bauen und Umwelt e.V. (IBU),* and are valid for the duration of the study.
- **e) Number of EPDs**: The number of EPDs selected should be the same for all building materials within the same project. Typically, 3, 5 or 10 EPDs are used to calculate the average values.

LEVEL 2B - DETAILED DESIGN

At this point, the final LCA for the technical design should be performed. When carrying out the final evaluation, it is essential to use specific EPDs rather than the average EPDs used in the previous stage.

CALL TO REALITY

> A survey published by the German Construction Industry Federation showed that SMEs support sustainability objectives but face difficulties using LCA software and dispersed digital platforms. Initiatives offering simplified digital tools, templates and shared databases significantly improve participation and inclusion. The findings underline that adoption depends less on ambition and more on the usability and proportionality of tools (www.bauindustrie.de/themen/digitalisierung).

4 \ ENVIRONMENTAL PRODUCT DECLARATIONS

4.1 \ EPDS IN CONSTRUCTION

EPDs are standardised documents that provide verified information on how construction products impact the environment throughout their life cycle. They cover the impacts of raw material extraction, manufacturing, use, and end-of-life treatment, and follow international standards such as ISO 14025 and EN 15804. By offering product-specific information, EPDs support more accurate LCAs and, consequently, better decisions.

The European Commission's Level(s) framework strongly promotes the use of EPDs to improve the quality of LCA data in construction projects. This evidences the importance of having accurate and structured data when calculating environmental impacts, allowing product comparison within the same category based on environmental performance and fostering compliance verification with environmental criteria.

EPDs can only achieve their full potential if they are widely trusted and used across the industry. This requires clear standards and consistent methods so that an EPD from one Member State is comparable with an EPD from another. In essence, EPDs provide a common language for describing the environmental performance of construction products and buildings, but that language must be standardised to be effective. Standards such as EN 15804 (for construction products) and EN 15978 (for building-level assessment) define this common language by specifying what an EPD should include and how to assess its impacts. Along with ISO 14040/14044 (LCA methodology) and ISO 14025 (Type III environmental declarations), they enable robust environmental assessments.

BARRIERS TO THE DIGITAL IMPLEMENTATION OF EPDS

Despite being grounded in common European and international standards, EPDs have evolved in a fragmented and uneven manner across countries, programme operators and product categories. This fragmentation represents one of the main obstacles to their effective use as reliable building blocks for LCA, digital workflows and circular economy strategies in the construction sector.

A first source of fragmentation lies in the interpretation and application of PCRs. Although these rules are intended to ensure comparability between similar products, in practice they are sometimes defined too broadly or applied inconsistently. As a result, EPDs may rely on different assumptions, system boundaries, background datasets or electricity mixes. These methodological variations can lead to significant discrepancies in reported environmental impacts that do not reflect real differences in product performance, but rather differences in calculation choices.

In addition to methodological inconsistencies, the completeness and quality of EPD data vary considerably. Some EPDs do not cover all life cycle stages or omit relevant impact categories, particularly in older declarations prepared before the EN 15804+A2 revision. Also, manufacturers often face difficulties in producing comprehensive EPDs due to cost, data availability and technical complexity, which can result in uneven market coverage and bias.

There are also relevant technological barriers to be considered. Traditionally, EPDs have been published as PDF documents (sometimes digitised from paper), which are readable by humans but poorly suited for automated processing. Although machine-readable formats such as ILCD+EPD are emerging, their adoption remains uneven, and data structures are not always fully aligned across databases and software platforms.

Together, these factors mean that EPDs have not yet fully realised their potential as a foundation for data-driven sustainability in construction. Fragmentation at the methodological, organisational and digital levels weakens comparability, limits automation and increases transaction costs for designers, contractors, clients and regulators.

EFFORTS TOWARD EPD HARMONISATION

Aware of these problems, industry and government officials have begun working to make EPD processes more consistent. The revision of EN 15804 (Amendment A2) was a step forward in this sense, expanding EPD reporting to include more life cycle stages beyond the production phase. This means they must cover impacts from cradle to grave, with an extra focus on circularity.

This modification raised some issues that had to be addressed: EPD programme operators had to update their databases, and existing EPDs had to be updated to accommodate the new phases. Some early EPDs only covered A1–A3, therefore, comparing them with subsequent EPDs that cover A–D can be confusing. Harmonisation has thus been a moving aim, enhancing completeness while necessitating adaptability.

The European Commission and other industry groups have been working on harmonised guidance and mutual recognition of EPD schemes to maintain consistency. The ECO Platform is a European umbrella group of EPD programme operators that works to standardise the fundamental format and verification of EPD data across the EU. The ECO Platform helps ensure that an EPD from one country can be understood and recognised in another by bringing together accurate statistics and encouraging interoperability between national programmes. Some programme operators have begun using an ECO Platform "Quality Mark" to demonstrate compliance with EN 15804 and to gain recognition from their peers.

Legislation is another way policymakers aim to achieve harmonisation. The revised Construction Products Regulation (Regulation (EU) 2024/3110) strengthens harmonised rules for construction products and introduces a construction digital product passport framework to make key product information accessible electronically. This increases the need for consistent, comparable environmental data (often provided through instruments such as EPDs) and interoperable reporting formats across the EU. Member States are also increasingly requiring environmental product information for some materials through public procurement rules and construction codes.

CALL TO REALITY

> The ECO Platform's work to harmonise EPD data across Europe is a leading example of cross-border cooperation. Digital tools that connect directly to shared EPD databases are already available. For instance, several BIM-based LCA platforms can link to the IBU EPD Database and to the ECO Platform's ECO Portal, two of Europe's largest and most harmonised repositories of EN 15804-compliant EPDs.
>
> These integrations demonstrate the potential of consistent EPD data, enabling semi-automatic LCA calculations directly within digital design models, using up-to-date environmental information for building components.

4.2 \ THE DIGITAL TRANSFORMATION OF EPDS

As more people start using EPDs, there is a push to make EPD data digital so that it is easier to find and use. The digital transformation of EPDs involves converting their content into formats that machines can read, enabling data exchange and automated processes without issues.

The ILCD+EPD is one of the key emerging digital EPD formats in Europe and can contribute to this progressive digitalisation. It is an XML-based schema that extends the European Commission's ILCD (International Life Cycle Data System) to include the whole data structure needed for EPDs and allows different software applications, such as LCA tools, BIM platforms, and procurement systems, to automatically read, interpret, and process EPD information in an interoperable way.

Achieving this vision requires more than shared data schemas. It depends on adopting open standards and platforms such as ISO 21930 (international EPD requirements), ISO 22057 (data templates for using EPD information in BIM), and ISO 23386 (methodology for describing and managing properties in interconnected data dictionaries) and ISO 23387 (data templates for construction objects) provide the foundation.

As interoperability grows, linking digital EPD information to BIM models enables automatic updates to life cycle impact calculations, ensuring that LCAs performed during design phases always use verified, up-to-date environmental data. However, integrating these systems smoothly remains challenging.

INTEGRATION WITH LCA TOOLS AND BIM WORKFLOWS

Combining EPD data with BIM and other design tools is among the most promising outcomes of the convergence of digitalisation and sustainability. Project teams can assess the environmental impacts of a design while it is still being developed by attaching EPD information to BIM objects. With this real-time LCA feature, architects and engineers can evaluate design options based on cost, structural performance, embodied carbon, and acidification potential, among other factors. If a designer changes one product for another in the BIM model, for instance, the change in carbon footprint can be determined immediately if both products have digital EPDs. This promotes a more iterative, sustainable design process that integrates sustainability at every stage.

New standards and technologies are being developed to make this kind of integration easier. ISO 22057:2022 is a necessary standard that defines how EPD information should be structured for use in BIM, enabling indicators such as GWP or water use to be accurately linked to BIM elements.

CALL TO REALITY

> A real-world example of this technological direction is the SmartLCA plugin developed in academic research and presented in chapter 3, which integrates BIM with LCA. The plugin allows a direct connection between BIM and the online ecoPortal/IBU EPD database, enabling automatic filling in of material environmental indicators and real-time computation of life cycle impacts. The case shows that this type of integration can transform sustainability assessment from a slow, manual reporting effort into an automated, continuous design feedback mechanism.

5 \ DIGITAL PRODUCT PASSPORTS

5.1 \ DEFINITION AND POLICY BASIS

A DPP is a digital record of a product that provides crucial information on its components, materials, and life cycle. It serves as an electronic "identity card" for a product, recording data such as material composition, technical characteristics, supply chain history (uses, modifications, etc.), environmental implications, and end-of-life alternatives, including recyclability and reusability. A more precise definition of the DPP, grounded in the academic literature, describes it as *"a digital interface composing a certified identity of a single identifiable product by accessing the set of life cycle registrations linked to this object in order to yield insight into the sustainability and circularity characteristics, the circular value estimation, and the circular opportunities for both that product and its underlying components and materials"* (van Capelleveen ***et al.***, 2023). This definition captures what makes the DPP structurally different from a conventional product datasheet or an EPD: it is not a static document but a dynamic, lifecycle-spanning record, capable of being updated as the product moves through manufacturing, use, and end-of-life.

The concept of DPPs is anchored in EU law through the Ecodesign for Sustainable Products Regulation (ESPR) (Regulation (EU) 2024/1781) and, specifically for construction products, through the revised Construction Products Regulation (Regulation (EU) 2024/3110). Together, they establish the legal framework for digital product passports, while detailed product scopes, data requirements and timelines are to be rolled out progressively through delegated and implementing acts.

The ESPR extends the earlier Ecodesign framework beyond energy-related products to a wider range of products with significant environmental impacts. It establishes a digital product passport system and provides the legal basis for introducing product-specific requirements progressively through delegated acts and Commission work plans, rather than through a single "one-size-fits-all" deadline. The first ESPR Working Plan (2025–2030), adopted in April 2025, sets the initial priority product groups and horizontal measures (including requirements on reparability and recycled content) that will structure the next waves of delegated acts.

So, in the construction sector, the CPR and ESPR together create a policy mandate and framework for DPPs. This twin policy effort is intended to make digital passports increasingly standard for construction products as delegated and implementing requirements are introduced over the coming years. These policy drivers emphasise a strategic vision: by institutionalising DPPs, the EU seeks to develop a shared digital infrastructure for product data. The expectation is that this will break down information silos in the construction value chain, much as EPD harmonisation strives to standardise environmental data. It's also worth noting that the EU's Circular Economy Action Plan clearly identifies digital product information as a significant enabler of circularity.

DPP DATA REQUIREMENTS

The ESPR outlines core information that every DPP should include, setting a baseline for the DPP. According to the ESPR, a DPP shall or may consist of, at a minimum, the following categories of information:

> **Product identification:** A unique product identifier (e.g., a serial number or code) and classification codes like the EU's tariff code (TARIC).

> **Regulatory compliance and standards:** Declarations of Performance (DoP under CPR) and other compliance documents, any relevant EU *Ecolabels* or certifications. It also covers safety information on restricted or hazardous substances that the products may contain, in line with chemical safety and REACH requirements.

> **Life cycle instructions:** Guidelines for installation, use, maintenance, and repair of the product, as well as instructions for disassembly, recycling, or safe disposal at end-of-life. This ensures that anyone handling the product at any stage can easily find out how to use it optimally and, eventually, dispose of or reclaim it.

- **Environmental performance:** Key metrics on the product's environmental impact, such as embodied carbon (often drawn from an EPD), recycled content, recyclability rate, and durability/lifespan data.
- **Producer and supply chain information:** Details on the manufacturer, any importers, and relevant supply chain actors, often including unique facility and operator identifiers to trace the product's origin.

Collectively, these data pieces transform the DPP into a critical instrument for bridging the information gaps in today's construction supply chain. By gathering and sharing standardised data about each product, DPPs provide all stakeholders with trustworthy information accessible from a single source of truth throughout a building's life cycle.

IMPLEMENTATION TIMELINE

DPP requirements will not arrive on a single universal date for all products. Under the ESPR framework, digital product passport obligations will be introduced product-by-product through delegated acts. In parallel, the revised CPR establishes a construction digital product passport system for construction products, which entered into force on 7 January 2025 and, for most provisions, applies from 8 January 2026. However, many obligations (including the construction DPP framework, harmonised technical specifications and digital DoPs) are being phased in progressively through delegated and implementing acts, with transitional periods that may extend well beyond 2026. This underlines the need for the building industry to prepare early through pilots, data governance and tooling, so that compliance can scale as EU product-specific requirements are rolled out.

To structure the transition under the revised CPR, in December 2025 the European Commission published the first CPR Working Plan for 2026–2029. The Working Plan sets out a product-family-specific roadmap for standardisation requests and for the revision of harmonised technical specifications (harmonised European standards and European Assessment Documents), together with an indicative timeline for their mandatory application. Manufacturers and standardisers should therefore track the Working Plan closely to anticipate when each product family will transition to the new harmonised specifications and to the sustainability sections of the Declaration of Performance and Conformity (DoPC).

To support this transition, the ESPR framework is designed to enable scalable implementation (including the use of digital product passport service providers) and to avoid disproportionate burdens as requirements are rolled out. Recognising that generating and maintaining DPPs might entail significant expense and technical complexity, the ESPR is expected to support SMEs in this transition, including providing technical advice, financial support, and standard tools to lessen the burden. An analogy can be drawn to the early days of barcoding: initially, small suppliers found it hard to adopt, as a result, third-party solutions emerged to help them generate and manage barcodes. Similarly, we can expect a new ecosystem of DPP service providers that will offer user-friendly platforms where a manufacturer can input their product data (material content, etc.).

The service generates a compliant DPP (with a QR code data carrier, for example) without the company needing to build its own IT system from scratch. Importantly, the CPR does not prescribe a single technical architecture: depending on the product family, data carriers may include QR codes, RFID tags, registry links or distributed-ledger records, provided that the information is accessible, interoperable and persistent. One projected trend is the introduction of "DPP-as-a-Service" providers, third-party platforms that can host and manage digital passports for smaller enterprises, so they do not need to establish in-house IT systems.

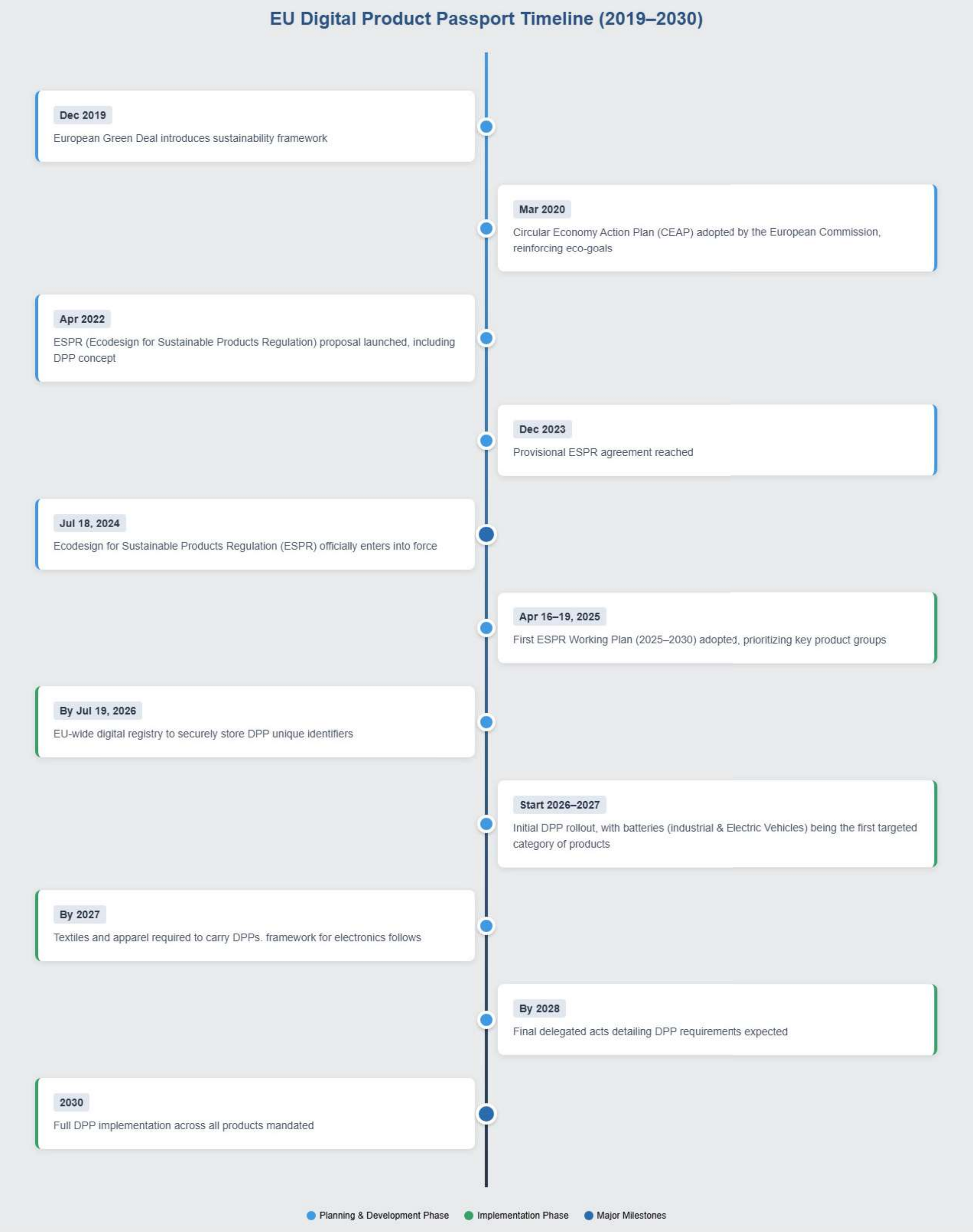


Figure 15 - DPP implementation timeline

Articles 9 to 14 of the ESPR set out the technical architecture underpinning DPP systems. Several provisions deserve attention for construction practitioners. Article 11 requires that DPPs remain accessible even after the economic operator that created them ceases activity in the EU - an obligation that cannot be met through simple in-house data management and that implies the necessary involvement of specialised Digital Product Passport Service Providers (DPPSPs). These third-party providers may perform different roles: creating Unique Product Identifiers, registering DPPs to the EU registry, hosting data with appropriate access controls, and maintaining mandatory long-term backup copies. Because these roles carry different levels of risk and public interest, they should ultimately be subject to differentiated regulatory requirements.

Backup operators - whose function is critical to the long-term availability of data underpinning circular economy strategies - warrant stricter standards, including alignment with ISO/IEC 27001:2022 and potentially ex-ante certification under the European Data Governance Act. Article 13 requires the European Commission to establish a secure EU DPP Registry by 19 July 2026, storing at minimum the unique identifiers of all products placed on the market.

This infrastructure milestone precedes the bulk of construction product delegated acts - giving industry a concrete target for piloting integration workflows before mandatory compliance arrives for their specific product categories.

Regarding long-term financing of DPP data access, several models are under discussion: FRAND licensing arrangements (already used in analogous EU vehicle data regulations), anonymised market data commercialisation by service providers, and Public-Private Partnerships to share the cost of mandatory backup infrastructure. Defining viable financing mechanisms is among the most critical unresolved questions, and future amendments or delegated acts should address it explicitly.

CALL TO REALITY

> One of the pioneering examples demonstrating the importance of passports in construction was the EU-funded BAMB (Buildings As Material Banks) project (2015–2019), which brought together 15 partners from 7 European countries to implement circular economy principles in the AEC sector through the use of material passports. The project launched the Material Passports (MPs) as digital data structures defining the characteristics of building materials and components to promote their recovery and reuse. In essence, these represented early concepts that preceded the DPP, developed to preserve long-term material value, facilitate the reverse supply chain, and assist in selecting sustainable and circular materials. The BAMB project generated a library of over 400 material passports and a software platform to host them. These passports featured information to help identify valuable materials in existing structures (treated as repositories of resources) and to enable reversible building design – constructing buildings so they can be easily disassembled and their components reused. The success of BAMB shows that standardised, digital information on items can genuinely increase the value of materials over time and support new circular business models in construction. It also identified obstacles, notably the need for shared data standards and integration with design processes, which directly influenced the EU's current approach to DPPs. BAMB's legacy is evident in today's policy: the transition from the phrase "material passport" to "Digital Product Passport" reflects the understanding that it's not only raw materials but the complete product life cycle data that must be gathered for true circularity.

5.2 \ DPPS DEVELOPMENTS

Looking at early projects, it is essential to study the antecedents to DPPs. Over the past decade, numerous types of digital passports have been conceptualised. In the building sector, the notion of Material Passports (MPs) gained traction through research and pilot projects. Within the DPP context, CIRPASS was a key EU-funded project: a consortium of thirty-one entities set out to define the main requirements for a DPP system and to explore DPP-enabled business models, with prototypes for three product categories - batteries, textiles and electronics. CIRPASS produced over fourteen deliverables covering DPP system architecture, standardisation gaps, costs and benefits for SMEs, use cases, and benchmarking of existing DPP-oriented reference architectures against the goals set out in the ESPR. A second phase, CIRPASS-2, is now under way. It aims to deploy and validate live DPPs in 13 lighthouse pilots across four value chains (textiles, electronics, tyres and construction), with a focus on cross-pilot interoperability, SME adoption and standards-based implementation. Published results include DPP reference architecture proposals, ontology and semantic interoperability tools, user-story frameworks and risk mitigation strategies.

There is a persistent terminological uncertainty in this sector surrounding passports. Terms like recycling passports, C2C passports, and product passports have all been used with overlapping meanings. Ultimately, as the EU geared itself for widespread deployment, the term "Digital Product Passport" became the favoured nomenclature, subsuming many of these earlier conceptions into a more consistent concept (The EU is also pushing the idea of a DBL for full buildings, which complements product-level passports by monitoring data at the building level, from design through operation).

The concepts of Material Passport and DPP overlap in many areas, as both are built on the same goals of enabling and promoting circular economy principles. However, they have nuanced distinctions in some areas, such as:

> **Primary Focus**: Material passports focus mainly on the material composition of buildings, offering the potential to build digital material cadastres and, therefore, placing greater emphasis on the concept of urban mining. On the other hand, DPPs focus on products individually and on how their sustainability can be enhanced, containing datasets that summarise the components, materials, and chemical substances within a product, as well as information on repairability, spare parts, and proper disposal. DPPs also emphasise the use phase more than the material passport. Overall, MPs focus on material circularity and recovery, DPPs focus on product compliance and traceability of life cycle data along the supply chain, and building passports focus on building performance improvement and building renovation.

> **Industry context**: Material passports are specific to the built environment, while DPPs are cross-sectoral.

> **Repair and maintenance**: DPPs emphasise product repairability and spare parts, while MPs are mainly focused on recovery and recycling.

> **Key stakeholders**: DPPs are more oriented towards supply chain actors, authorities and consumers, while the MP is mainly oriented towards professionals in the construction sector.

In terms of content, the scope of data in DPPs is extensive. The ESPR defines a non-exhaustive set of data that a product passport may contain, ranging from unique identifiers (such as a Global Trade Item Number, GTIN) to information on compounds of concern and repair instructions. For construction products, a DPP might consolidate data that is currently distributed across safety datasheets, manuals, EPDs, and certificates. For example, a DPP for an electrical wire might include its CPR fire rating, RoHS compliance for hazardous substances, an EPD for its environmental impacts, directions for safe removal, and a unique ID code linking it to a batch and manufacturer. Currently, most of this information is either not gathered or not shared along the supply chain. The introduction of DPPs is designed to overcome that information gap, ensuring that meaningful data accompanies products beyond manufacture. This will need digitising older information (such as old product certificates) and capturing new data (for instance, recording each time a product is maintained or refurbished during usage). DPPs have different granularity levels that structure data in a hierarchical manner, from generalised to instance-specific product data. This granularity level is to be specified in future delegated acts and can be broken down into these three levels:

> **Model level**: Data that is shared across all items of a model.

> **Batch level**: Subset of data specific to a group of items produced in a similar way (e.g., a set of products made in a particular factory within a specific timeframe).

> **Item level**: Data specific to a single item of a model (i.e., an individual instance of a product).

Interoperability considerations for DPPs are comparable to those for EPDs. Standardisation bodies (such as CEN and ISO) are developing data templates and dictionaries for product characteristics (as reflected in standards such as EN ISO 23386/23387 for construction product data templates) that serve as structured formats for product information, ensuring machine-readability and consistent labelling of data. The idea is that if a product's attributes (such as dimensions or thermal performance) are entered according to a standard PDT, generating a DPP is essentially a matter of exporting that data along with any additional lifespan information. PDTs consequently create a basis for DPP data, helping to link the DPP with digital construction BIM workflows. The CPR and ESPR clearly underline the necessity for DPP systems to be interoperable with such data template techniques, so that the rich data in passports can be directly imported into BIM models or asset management systems.

CALL TO REALITY

Around the same time as the BAMB project, commercial passport platforms began transforming research initiatives into real-world applications. In 2017, the Dutch organisation Madaster Foundation launched the first commercial Material Passport (MP) platform for the building industry. The Madaster platform serves as an online database for storing building materials data, using BIM and 3D scans to register and mark building components digitally. This organisation also developed the Circularity Indicator (CI) to assess the circularity of buildings using information uploaded by users to the platform. Beyond BAMB and Madaster, platforms like EPEA, Upcyclea in France, Concular in Germany, and Cirdax in the Netherlands have contributed to the commercialisation and refinement of MPs and DPPs.

5.3 \ EPDS AND DPPS: BUILDING BLOCKS OF THE CIRCULAR ECONOMY

A useful way to frame circular decisions is through the well-known "R-strategies" (or R-hierarchy) for a Circular Economy. These strategies range from R0 (Refuse) and R1 (Rethink) – which aim to design out the need for new products – to R8 (Recycle) and R9 (Recover) – which deal with material processing at end-of-life. Figure 16 illustrates this hierarchy, categorising the R-strategies into short, medium, and long loops (derived from Circularise). Short loops (R0–R2) focus on smarter product use and manufacturing, ensuring we refuse unnecessary consumption, rethink product design and use, and reduce resource use from the outset. Medium loops (R3–R5) focus on extending product lifespans through reuse, repair, and refurbishment. Long loops (R6–R9) involve giving materials new life through remanufacturing, repurposing, recycling, or energy recovery.

The general principle is that the earlier (shorter) loops preserve more of a product's value and embodied energy, yielding greater sustainability benefits than the later loops. DPPs and EPDs together are key enablers for these strategies. For the short and medium-term loops, DPPs provide transparency into a product's condition and maintenance needs (facilitating R3–R5 actions) and even support new service-based business models (for example, a company could use DPP data to offer maintenance-as-a-service, knowing exactly which parts might need replacement when). For the longer loops, DPPs list the material composition and any hazardous substances, which is crucial information for R6–R9 actions such as remanufacturing or recycling. EPDs, on the other hand, quantify the environmental significance of choosing one loop over another. If a DPP indicates a component can be reused (R3) or repurposed (R7), the EPD can quantify the impact avoided by doing so compared to making a new product. This makes the ***trade-offs transparent***: stakeholders can see, in environmental terms, the payoff of opting for a circular route.

The combination of EPDs and DPPs has a crucial role in transforming the building sector into a more circular economy. As we can see, both tools address the core challenge of information transparency in different but complementary ways. With harmonised EPDs in place, stakeholders can trust the environmental data when purchasing materials, designing buildings, or formulating policies. At the same time, DPPs add a dynamic dimension by enabling data-driven asset management and material recovery processes. A building can be viewed not merely as a static structure, but as a repository of valuable materials with known quantities and properties ("material banks"). DPPs make it possible to inventory these material stocks digitally: one can imagine a future database of all building components in use, searchable by material type or by location, which would revolutionise how we plan deconstruction and recycling. This, in turn, could empower new circular marketplaces where reclaimed components are traded easily, since their provenance and characteristics are digitally documented.

Realising the vision of EPDs and DPPs as the building blocks of a circular digital economy will require ongoing effort and collaboration. It is not just about developing the technical standards, but also about ensuring industry uptake and continuous improvement of these tools. Trust in the data is a critical aspect that must be maintained: this implies that the rigorous third-party verification process for EPDs must continue (so that stakeholders know the environmental data is credible), and that DPP systems must be secure and tamper-proof (so the product information cannot be falsified or lost). We also need clear, user-friendly tools and interfaces that can handle large amounts of complex information without overwhelming people. If we address these challenges, the potential benefits for policy design and implementation could be significant.

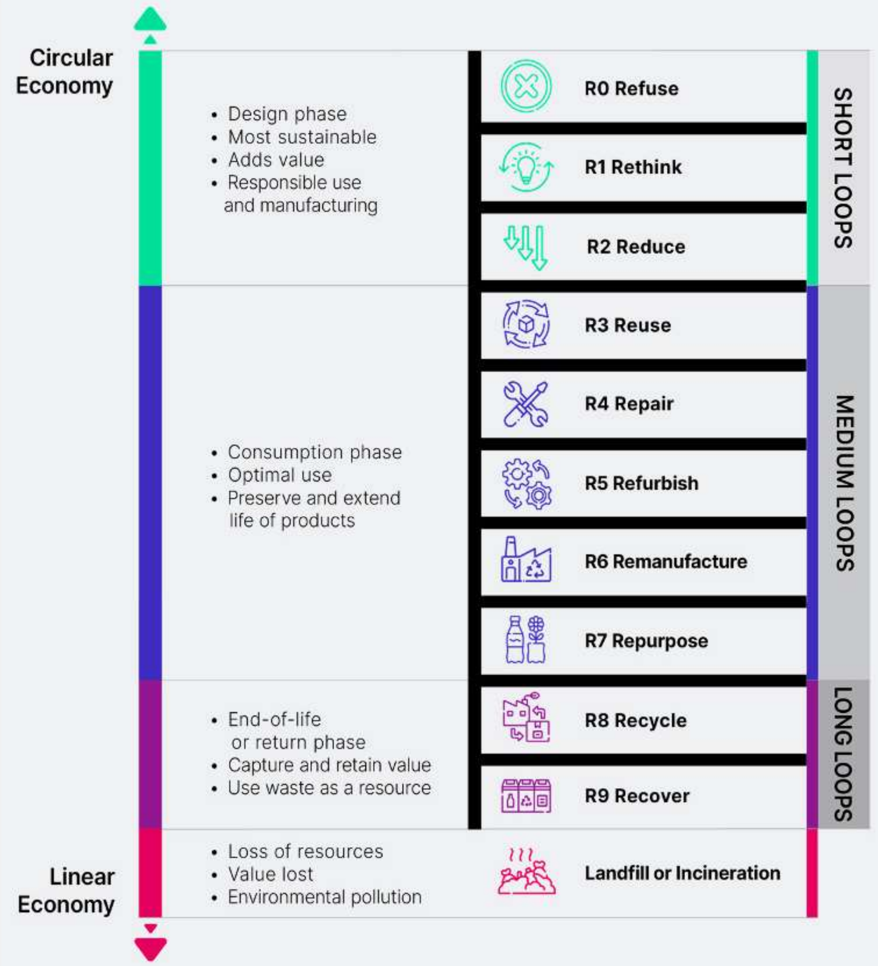


Figure 16 - The "R-Strategies" for a Circular Economy, categorised by short, medium, and long loops (derived from Circularise).

5.4 \ FROM EPD TO DPP: THE INTEGRATING ROLE OF BIM

As discussed above, EPDs and DPPs are complementary tools, and their integration holds an ambitious promise for the building industry's Twin Transition goals. When combined, an EPD and a DPP provide a complementary view of a product: the DPP describes what the product is, how it should be installed, maintained, disassembled and recovered at end-of-life, while the EPD quantifies the environmental cost of those choices across the life cycle. Together, they allow designers, clients and regulators to move from qualitative narratives about sustainability to structured, comparable and machine-readable data that can flow through BIM models, procurement systems and building logbooks.

In practice, we can expect DPPs to increasingly incorporate or reference EPD data as part of their environmental information. Rather than duplicating data, a DPP might link to an EPD document or include a subset of key LCA indicators for the product. Indeed, the revised CPR envisions DPPs as the vehicle through which mandatory environmental data (such as a product's carbon footprint) is transmitted to end users. This means, for example, that a manufacturer creating a DPP for a steel beam will also need to either attach an official EPD for that steel beam or ensure the DPP's built-in data fields correspond precisely to the EPD results. Ongoing standardisation efforts are likely to formalise these relationships so that a "carbon footprint" entry in a DPP is calculated in accordance with EN 15804 (the European standard for EPDs), thereby remaining entirely credible and comparable across products.

The incorporation of EPD content into DPPs also streamlines data management. Today, a construction product might be accompanied by a stack of documents, a technical datasheet, an EPD, a safety datasheet, perhaps user manuals - each often in PDF or paper form. Soon, a unified DPP could serve as a ***single source of truth*** that either contains all such information or provides live links to it, accessible with one scan or click. This unified approach is particularly advantageous for BIM. One can imagine a BIM model of a building in which every component (every beam, window, and brick) is assigned a unique digital passport. Clicking on an element in the model could automatically fetch its complete profile: not just mechanical properties and manufacturer details, but also environmental indicators from the EPD section of the passport, and even real-time information such as the availability of spare parts or the nearest recycling facilities when that component reaches end-of-life.

From a policy and standards viewpoint, effectively linking DPPs with EPDs (applying that link within BIM) will require careful alignment and interoperability. The data models and classifications used for EPDs and for DPPs should be made compatible so that information can flow between them without friction. Work is already underway on this front. For example, the Product Data Template standards (EN ISO 23386 and EN ISO 23387) are developing a common language and structure for product information, which can help ensure that digital product data (like that in a DPP) maps correctly to the data in an EPD. In practical terms, we might see standardised schemas in which an "Environmental Impact" section of a DPP adheres exactly to EN 15804 reporting formats, making the DPP's sustainability data essentially an extract of a compliant EPD. The European Commission's broader DPP initiatives across various sectors (electronics, batteries, textiles, etc.) are also addressing how to include or reference LCA data in digital passports.

The construction sector can draw lessons from these efforts to avoid reinventing the wheel. Another area of synergy is ensuring that DPP information is BIM-compatible. Since BIM is the environment where product data (from passports) and building data converge, it is crucial that DPP data can be imported or linked into BIM software without loss of meaning. The vision put forth by policymakers, as seen in the CPR's emphasis on integrating DPP data with building models, suggests that future BIM tools will natively support connections to product passports. This could take the form of BIM platforms automatically retrieving up-to-date product information (including EPD metrics) from an online DPP database as designers select products for their building model. Ensuring common standards and APIs for such interoperability will be a technical priority in the coming years.

Within the broader landscape of digital passports, the DPP sits within a three-level hierarchy. At the material level, Material Passports focus on composition and recoverability, emphasising urban mining potential. At the product level, DPPs address individual products, their compliance, supply chain traceability, repairability, and disposal. At the building level, Building Passports or Digital Building Logbooks aggregate product, and material-level data into a whole-building record supporting renovation planning and performance monitoring. These three levels are complementary: a well-functioning DPP ecosystem at product level is precisely what enables the building-level logbook to carry reliable, structured data about every installed component.

6 \ DIGITAL BUILDING LOGBOOKS

6.1 \ DEFINITION, SCOPE AND DATA STRUCTURE

A Digital Building Logbook (DBL) brings together key information about a building in one place, enhancing transparency and supporting informed decision-making by all parties: owners, occupants, public authorities, investors, and others. The information it contains is deliberately wide-ranging, capturing the different stages of a buildings life, how it is used, and how it performs over time.

The digital logbook consists of the following key categories of data:

- **General information**: Basic identifying information of the building (location, age, kind, size, ownership).
- **Administrative information:** Regulatory and legal data, including permits, certifications, inspection reports, fire safety records, and compliance paperwork.
- **Technical characteristics:** Structural and design information, architectural plans, materials used (a material inventory of the building's components), and construction processes.
- **Operational data:** Information on building use and occupancy, maintenance and renovation history, and equipment (HVAC systems, elevators, etc.), including their service records.
- **Performance metrics:** Energy performance (e.g. Energy Performance Certificate data), water usage, indoor environmental quality parameters, and other sustainability indicators over time.
- **Financial and legal information:** Costs of construction and renovations, running costs, and legal statuses (such as heritage protections, warranties, insurance).

Crucially, the DBL contains not just foundational data but also a continuous history of modifications to the building during its life cycle. For instance, if a building is refurbished, the logbook would record what was altered when it happened (materials replaced, new systems installed), and who performed those tasks. This produces a traceable record that can improve confidence and accuracy in procedures like property sales, insurance evaluations, and remodelling plans. A fundamental design principle of the DBL is the distinction between static information - construction drawings, original material inventories, permits, and structural records, which change little or not at all - and dynamic information, which must be automatically and regularly updated throughout the building's life: energy consumption, maintenance history, equipment performance, and indoor environment quality parameters. Enabling continuous dynamic updates requires the DBL to be designed as a live digital system connected to building management platforms, energy meters, and IoT sensors - not merely a digital archive. For public clients specifying DBL requirements in procurement, this distinction is consequential: it is not sufficient to define what data will be captured at handover. The specification must also address how dynamic data will be generated, validated, and maintained across multiple decades and potential changes of ownership.

DBLs and DPPs are complementary tools, one at the building level, the other at the product level, and their combination exposes great potential for the circular economy and compliance. For example, if each fixture and material in a building has a corresponding DPP, the building logbook can draw on that to automatically complete the building's material inventory and attributes. Building owners and facilities managers then receive access to granular information, including the actual composition of installed items, their estimated lifespans, and their recyclability. By integrating DPP data, a DBL facilitates regulatory compliance at the building level: it can be verified that all installed items fulfil the required criteria and that, for instance, no forbidden compounds are present, since the DPPs store this information. This streamlines documentation for building-wide compliance checks, such as verifying that a major renovation used only certified products or demonstrating the building's adherence to circular economy criteria (a concept increasingly present in green building certifications and possibly future building regulations).

6.2 \ DEVELOPING A COMMON EUROPEAN FRAMEWORK FOR DBLS

The deployment of DBLs across the EU is currently in an early stage, but efforts are underway to build a uniform framework that Member States can accept. A significant challenge is defining the scope and structure of a DBL in a standardised way. To ensure that logbooks are compatible across different countries and software systems, a common data taxonomy is needed, essentially, an established list of data fields and definitions that any digital logbook should cover. Work by standardisation bodies such as CEN/TC 442 (BIM) provides a basis, since BIM standards already address the organisation of building data.

For DBLs to become pervasive, legislative requirements and incentives are necessary. The EU's Renovation Wave and the recast EPBD recognise the role of renovation passports and introduce the concept of a digital building logbook as a common repository for relevant building data, facilitating informed decision-making and information sharing. A possible next step is that Member States further operationalise DBLs through national rules (e.g., linking them to permitting, renovation incentives, or building databases). Beyond mandates, incentives can accelerate adoption, such as grants or tax rebates for building owners who implement a compliant DBL, or administrative advantages such as faster permit approval where digital documentation is provided.

A specialised variant worth highlighting is the Building Renovation Passport (BRP), applicable to existing buildings. Linked to a DBL, a BRP provides a structured renovation roadmap, typically spanning up to 20 years, that guides owner through a sequenced set of improvement steps capable of bringing the building to zero-emission standard by 2050. Rather than requiring immediate deep renovation, the BRP recognises that most journeys are incremental. A DBL that integrates BRP functionality becomes an active planning and compliance tool, tracking the building's current energy class, modelling the improvements needed to meet approaching regulatory thresholds, and documenting each completed measure. For public authorities managing large building portfolios, this combination offers a systematic basis for capital expenditure planning and for demonstrating compliance with the renovation trajectories introduced by the recast EPBD.

CALL TO REALITY

In Belgium's Flanders region, authorities launched the Woningpas (housing passport) in 2018, an online digital file for every residential building that consolidates all available information about the property. It automatically pulls data from government databases, covering energy performance certificates, renovation permits, soil and flood risk data, etc. As of 2024, the Woningpas platform holds information on more than 2.5 million homes in Flanders. A challenge they encountered is ensuring data quality and keeping information up to date, which requires ongoing effort and has led to engaging owners in verifying and adding details. For Europe, Woningpas is a proof-of-concept that DBLs can drive renovation decisions (by making recommended measures transparent) and reduce administrative burden. Scaling such passports EU-wide will require interoperability (so that a "logbook" in one country covers the same data as another's) and attention to data privacy and security.

6.3 \ INTEROPERABILITY AND DIGITAL INFRASTRUCTURE

Implementing DBLs across the EU construction sector poses both considerable obstacles and potential. One overriding problem is harmonising data and processes in a traditionally fragmented business. To make DBLs effective, stakeholders must converge on common data and assessment methodologies. A real step in this approach is improved alignment of EPD requirements and PCRs at the European level. Initiatives like the ECO Platform's digital EPD system and the establishment of horizontal standards under the CPR are paving the road for this harmonisation.

Another problem is the digital infrastructure needed to track items and structures throughout their life cycles. Because a building can contain thousands of components, each with its own passport, managing this volume of data can be challenging, addressing this will require robust digital platforms and advanced technologies like blockchain and distributed ledgers. The integration of DPPs, BIM and DBLs is also a strategic goal to streamline data transmission.

Achieving so implies that software manufacturers need to adopt open APIs and common standards so that, for instance, a BIM model can access a DPP repository or a national DBL without proprietary adapters. The view is that the EU and industry will coalesce around a set of open standards (like IFC for BIM, ILCD for environmental data, etc.), which will be enforced or supported through regulation. This will facilitate the informed decision-making that the Twin Transition promises: it enables better design choices, better renovation strategies and sounder policy decisions.

CALL TO REALITY

> Companies like Circularise and Eviden have established blockchain-based digital passport platforms where each product's data is maintained in a distributed ledger, offering traceability and security. In a demonstration project, Circularise developed a DPP prototype for plastic building components, showing how a QR code linked to a blockchain can reveal a product's recycled content and carbon footprint to any stakeholder with a smartphone. Such examples point to viable paths forward, but they also highlight how essential interoperability will be.

PART III

IMPLEMENTATION AND OUTLOOK

Governance, capacity and forward view

7 \ TWIN TRANSITION IMPLEMENTATION AND GOVERNANCE

Turning the Twin Transition from a policy agenda into routine practice requires more than regulation, it depends on clear principles, capable people, well-designed governance structures and effective policy instruments. This chapter sets out, in turn, the guiding principles that should orient decisions in the built environment, the enablers (skills, processes and culture) that determine how fast the sector can absorb change, the governance and implementation arrangements that sustain momentum, the regulatory and policy frameworks that provide direction, and a set of targeted recommendations for European, national and local actors.

7.1 \ GUIDING PRINCIPLES FOR A CHANGE

DIGITAL AND GREEN INTEGRATION

At the heart of the Twin Transition is the integration of digital and green objectives. Rather than treating digital transformation and sustainability as separate pursuits, they must advance together. Digital technologies such as BIM, digital twins, and smart sensors are powerful enablers of sustainability, helping optimise energy use, materials, and emissions. For example, BIM tools can embed LCA data to instantly evaluate a design's environmental impacts, informing more sustainable material choices. Similarly, digital twins can continuously monitor buildings to ensure they operate at peak energy efficiency. Embracing this principle means every sustainability initiative should use digital tools, and every digitalisation effort should advance environmental goals. As the European Commission has highlighted, *"tackling the twin challenges of the green and digital transitions together"* is crucial.

LIFE-CYCLE THINKING AND CIRCULARITY

A second guiding principle is adopting life cycle thinking as the norm for decision making. This means looking beyond upfront costs or operational energy use but also to the impacts from *cradle to cradle*. This is the vision supporting the Level(s) framework and a wider use of LCA at each project stage, allowing stakeholders to identify "hot spots" of high impact and intervene early to mitigate them. Circular economy concepts are also integral to this principle: designs should enable the reuse and recycling of components, minimising waste and treating building materials as resources for future projects. For instance, designing for disassembly and using recycled or bio-based materials makes it easier to recover components and reduce construction waste. Prioritising circularity implies favouring renovation over demolition, incorporating recycled content, and planning from the outset how materials and components can be repurposed.

DATA STANDARDISATION, INTEROPERABILITY AND TRANSPARENCY

Open data standards, interoperability, and transparency form a third key principle underpinning the Twin Transition. The sectors digital and green transformation is only possible if data about products, processes, and performance can be easily shared and understood by all stakeholders. This requires standardising digital data formats for construction and sustainability. Progress is being made, but unequivocal gaps remain: the principle of interoperability calls for intensifying these efforts. Adopting common European standards (such as those developed by CEN/TC 442 for BIM data) is one example of a good standardisation practice with real positive impacts on interoperability, but these harmonisation efforts should be reinforced. Besides this, this principle also calls for supporting open-source tools and open common data environments so that even SMEs can participate in this transition.

COLLABORATIVE GOVERNANCE AND SKILLS DEVELOPMENT

Technology and policy alone are not enough, the Twin Transition demands collaborative governance and investment in peoples skills. A multitude of actors (EU institutions, national governments, regional and local authorities, industry, academia, and civil society) must work in a coordinated way to be successful. Collaborative governance means establishing forums and coalitions where stakeholders co-create solutions and align initiatives. For example, the EU BIM Task Group brings together public organisations to shape the BIM transition pathway for construction, and several positive outcomes can result: common strategies lead to common targets, national governments devise implementation plans, and public bodies share similar experiences.

Alongside governance, skills development is a cornerstone of this principle. Europe's construction workforce needs new competencies in digital tools and in sustainable practices. This means a massive upskilling in construction, from on-site workers trained in digital equipment to designers fluent in energy modelling and LCA software. Public authorities also need capacity-building to handle innovative procurement, digital permitting or sustainability requirements.

A culture of continuous learning and innovation should also be fostered within organizations and companies, supported by knowledge-sharing networks and professional communities. Finally, understand that a strong leadership from the public sector can effectively drive industry-wide change.

CALL TO REALITY

> The City of Vienna has implemented digital twins for selected municipal buildings to support facility management. By connecting BIM models with sensor data, facility managers monitor energy consumption and indoor conditions and adjust system operation accordingly. The primary value has emerged during operation, not design, with measurable energy savings and fewer reactive maintenance interventions. This confirms that digital twins deliver their greatest benefits when linked to day-to-day management tasks (see more at smartcity.wien.gv.at).

7.2 \ ENABLERS OF CHANGE: PEOPLE, PROCESSES AND CULTURE

While technology and legislation set the stage, the success of the Twin Transition ultimately relies on individuals and organisations embracing new ways of working. The construction sector has long-standing cultural and organisational habits that can either enable or hinder innovation. In fact, the industry's conservative reputation and a persistent skills gap are recognised as major challenges to the Twin Transition. Many firms, especially small and mid-sized ones, lack staff with the necessary digital expertise or environmental training, and an ageing workforce makes it difficult to attract fresh talent. Traditional silos in the value chain (owners, designers, contractors, suppliers working in isolation) further impede coordination on digital and green initiatives. These human and organisational factors mean that even when new tools are available, they may be resisted or used inconsistently. Therefore, addressing the people side of change is just as important as any policy or technical fix. This section examines four key enablers (training, change management, incentives, and culture) that determine the extent to which digital and sustainable practices take root in the construction sector. It focuses on building the skills, mindsets, and organisational conditions to support a digital-green transformation, as well as the incentives needed to overcome initial hesitation. By strengthening these enablers, policymakers and industry leaders can turn the Twin Transition from a top-down mandate into a bottom-up movement embraced by the workforce.

REALITIES OF THE TRANSITION

Alongside the enabling factors described above, an honest reading of the sector must also acknowledge its constraints. Today, robust EPDs cover only a limited share of construction products on the European market (estimates suggest around 30%), and developing a single EPD typically costs between €3,000 and €15,000, a significant cost for the many SMEs that make up most of the supply chain. BIM adoption itself is shaped by a handful of proprietary authoring tools, which raises questions of vendor lock-in and interoperability that open standards such as IFC only partly resolve.

The market remains fragmented across Member States, with heterogeneous national mandates, classification systems and procurement cultures. Contractual, liability and insurance frameworks have not yet fully adapted to federated digital models and shared data environments, creating real uncertainty about who owns, maintains and is accountable for information over a building's life. Finally, the bulk of Europe's built stock is existing buildings (often poorly documented), for which retrofitting BIM, LCA and DPP workflows is considerably harder than applying them to new construction. Recognising these realities is not a counsel of despair but a precondition for designing policies, pilots and training that meet the industry where it is.

TRAINING AND SKILLS DEVELOPMENT

A skilled workforce is the keystone of any industry transformation. Education and training ensure that professionals have the capabilities to use BIM tools, interpret sustainability data, and implement new processes. The EU identified the ICT skills gap in construction as a barrier as early as 2012, and it remains pressing today. To address this, multiple efforts are underway to upskill both new entrants and the existing workforce:

> **Integrating digital and sustainable topics in curricula:** Universities and vocational institutes across Europe are updating their courses to include BIM modelling, data management, and green building design. EU-funded education projects like BIMzeED and Net-UBIEP have developed shared modules for teaching BIM for zero-energy buildings, showing how international collaboration can create reusable educational resources.

> **Continuing professional development (CPD):** For the current workforce, short courses and certifications are crucial for rapidly disseminating new skills. Professional bodies (engineering institutes, architectural associations, etc.) increasingly offer CPD modules on topics such as implementing EN ISO 19650 standards, BIM coordination, LCA and circular construction methods.

> **Digital training platforms and hubs:** E-learning and collaboration platforms have expanded access to training, which is essential for SMEs and remote regions. Based on existing online tools, the construction sector has upskilled thousands of workers in digital and green competencies. Additionally, "train-the-trainer" programmes build local capacity: a central competence centre might train a cohort of BIM/Twin Transition coaches, who in turn support projects across regions or public agencies.

CHANGE MANAGEMENT AND ORGANISATIONAL CULTURE

Implementing BIM and sustainability frameworks often requires significant organisational change. Public agencies and private companies alike may need to rethink traditional workflows, break down silos between departments, and cultivate a culture that embraces innovation and collaboration. Effective change management strategies are therefore critical to complement the technical measures:

> **Leadership and vision:** Strong leadership is needed to articulate why the Twin Transition matters and to champion its adoption from the top. When senior management visibly supports digital and green objectives, it legitimises the effort and motivates teams to follow through. Many successful implementations have a dedicated internal change leader or "BIM champion" who coordinates across departments, addresses obstacles, and celebrates quick wins to build momentum. Clear vision from leadership helps everyone understand the long-term benefits beyond the initial disruption.

> **Communication and engagement:** Change can be unsettling, so transparent communication and inclusive engagement are key. Introducing a new BIM-based process, for example, should be accompanied by an explanation of how it will address current pain points to gain staff buy-in. Also, involving end users early in the design of new workflows allows their feedback to shape practical solutions rather than imposing changes from above. European guidance, like the EU BIM Task Group handbook, emphasises "communicating the vision and building industry engagement," underlining that technical advances must be paired with consensus-building.

> **Pilot projects and phased rollout:** A common approach is to start with pilot projects as demonstrators for new methods. Pilots serve as learning exercises and proof-of-concept, allowing teams to work through kinks on a small scale. After evaluating results, the organisation can develop standard procedures and gradually extend the new approach to more projects. This incremental rollout manages risk and enables controlled refinement of methods and standards.

> **Updating processes and contracts:** Organisational policies and contract documents may need to be revised to institutionalise the Twin Transition. For example, a company's quality management system might be updated to include BIM requirements; procurement templates for hiring contractors could be adjusted to specify collaborative digital deliverables rather than traditional, siloed documents. Contracts with architects, engineers, and builders should align incentives with digital collaboration and sustainability outcomes.

> **Support and incentives for staff:** It's natural for some individuals to resist change, often out of fear of the unknown or concern about extra work. Proactive support can alleviate this. Providing helpdesks or BIM support teams, offering mentoring, and giving staff time to adapt and experiment with new tools can make a big difference. Recognising and rewarding efforts helps too. In some cases, bringing in external consultants for a transitional period helps organisations over the initial hump until new skills take root internally.

In essence, change management is about people more than technology. Over time, with persistent effort and positive reinforcement, a culture that values data-driven decision-making, sustainability, and continuous improvement begins to take hold. Organisations often report that once new digital processes are normalised, the culture shifts in positive ways. For example, younger professionals become more engaged, cross-disciplinary collaboration improves, and there's greater openness to further innovation once the benefits are seen. This cultural evolution is a hallmark of a successful Twin Transition. Digital and green thinking become embedded in daily practice rather than seen as external mandates. In turn, the industry becomes more attractive to new talent, especially young people motivated to work with high-tech tools and contribute to climate action.

FUNDING AND INCENTIVES TO ACCELERATE CHANGE

Adopting BIM and sustainable practices can entail high upfront costs, such as purchasing software licenses, hardware, training staff, redesigning processes, and collecting new data. Without support, these costs can be prohibitive for smaller firms or public bodies with limited budgets. Therefore, targeted funding and incentive schemes are often needed to overcome financial barriers and accelerate the Twin Transition. By coupling policy mandates with financial support, governments and clients can significantly de-risk the transition and encourage broader participation. Several approaches have been used in Europe:

> **National support programmes:** Some countries offer dedicated funding or tax incentives to encourage digital uptake and green innovation. Such programmes often focus on SMEs, recognising that larger firms might innovate on their own but smaller ones need help. On the sustainability side, many countries provide green building grants or rebates (for example, for achieving nearly zero-energy standards or using low-carbon materials). By tying these incentives to digital verification methods – e.g. requiring a digital model or DPP to claim a subsidy – policymakers indirectly push digital adoption as part of achieving environmental goals.

> **EU co-financing:** The European Union has been a significant source of co-financing to drive the Twin Transition. EU research and innovation programmes such as Horizon Europe, along with digital initiatives like Digital Europe, have funded numerous projects that develop new solutions for energy-efficient digital construction. The key is to better align these funding instruments with the digitalisation of the construction sector. Managing authorities increasingly recognise that investing in construction technology delivers both productivity gains and environmental benefits.

> **Procurement incentives:** Beyond setting minimum requirements, public clients also use procurement as a carrot for innovation. Some contracts offer higher evaluation scores for bids that exceed the basic digital or environmental requirements. For example, a bidder might gain extra points for proposing an innovative BIM–GIS integration , a qualitative award criterion permissible under the Most Economically Advantageous Tender (MEAT) framework of Directive 2014/24/EU, or for promising a higher reduction in carbon footprint enabled by digital optimisation. Additionally, innovation partnerships allow a public authority to partner with a company to develop a new solution (like a city working with a tech firm to create a digital twin for its infrastructure), with public co-funding for the R&D phase. These approaches create a market pull for advanced practices, and companies see that going above and beyond can win them work or rewards.

> **Making the business case and private financing:** On the industry side, creating a strong business case for the Twin Transition is crucial to unlock internal investment. Sharing success stories builds confidence that these innovations pay off. At the same time, market demand and financing trends are increasingly favouring green and digital. There is a rising demand for "smart" and sustainable buildings, and investors are keen to finance projects that meet environmental, social, and governance (ESG) criteria. Assets with digital passports, smart building certifications, or proven energy performance can more easily attract green bonds or sustainability-linked loans. This creates a private-market incentive: developers who invest in Twin Transition measures may secure cheaper capital and future-proof themselves against regulations.

During this transitional period, well-designed funding schemes and incentives act like oil in the gears. Over time, as BIM and sustainable construction become standard practice, these additional incentives can be phased out, and market forces alone will drive further adoption. But in the critical years of transformation, combining mandates with grants, subsidies, tax breaks, and other support greatly accelerates the Twin Transition. It also helps ensure a just transition: that smaller firms, less developed regions, and workers with fewer resources are not left behind due to cost barriers or a lack of access to technology.

SOCIAL IMPACT AND CULTURAL CHANGE

The Twin Transition offers an opportunity to uplift the construction workforce and improve the industry's image. Embracing digital tools and sustainable practices can make construction jobs safer, higher-skilled, and more attractive to young professionals. For instance, routine tasks can be automated, allowing workers to focus on more engaging work, data-driven planning can improve on-site safety, and building for sustainability gives a sense of contributing to societal well-being. As Europe invests in green infrastructure and a wave of energy-efficient renovations, hundreds of thousands of new jobs can be created across all regions. Many of these emerging roles are higher-skilled and more future-proof, offering career advancement for construction trades workers. With the right training programmes, existing workers can be reskilled to fill these positions, turning the transition into an opportunity for career growth rather than displacement.

Culturally, as the construction sector becomes seen as a high-tech, environmentally critical field, it can attract a more diverse and enthusiastic talent pool. Young people, including more women, may be drawn to an industry clearly aligned with climate action and digital innovation. Already, initiatives like the New European Bauhaus (which links sustainability, aesthetics, and inclusiveness) are reframing construction as a creative and civic endeavour at the forefront of Europe's future. Over time, the hope is that the Twin Transition will not just meet technical targets but also result in a construction sector that is more inclusive, equitable, and respected in society. By prioritising training, supporting SMEs, and safeguarding affordability and worker welfare, Europe's construction industry can ensure that its transformation benefits all and leaves no one behind. In other words, the Twin Transition can become not just a technological upgrade, but a socially transformative process that delivers broad societal value.

The Twin Transition will not be delivered by tools alone. The construction value chain needs new competencies: LCA literacy and BIM-LCA workflow skills for designers; data management and quality assurance skills for project information managers; DPP and EPD verification skills for product manufacturers and notified bodies; and digital permitting and Taxonomy assessment skills for public authorities. Demand is expected to outstrip current training capacity in most Member States. University curricula are adapting unevenly. Continuous professional development (CPD) routes operated by professional institutions and EU programmes (Erasmus+, New European Bauhaus skills initiatives) are well placed to fill the gap, particularly for SMEs that cannot release staff for long courses. National BIM bodies and the EU BIM Task Group can support this by publishing common competency profiles, by curating reference learning paths, and by ensuring that public procurement language rewards qualified teams without becoming an SME exclusion mechanism.

7.3 \ GOVERNANCE AND IMPLEMENTATION SUPPORT

Effective governance and implementation support are essential to translating the Twin Transition's strategic objectives into consistent practice across the construction sector. Given the long investment cycles, fragmented value chains and uneven levels of digital maturity, policy measures require dedicated coordination structures and practical support mechanisms. Governance frameworks that combine clear institutional leadership with operational guidance help ensure that digital and sustainable practices move beyond isolated pilots and become embedded in routine processes.

NATIONAL COORDINATION AND INSTITUTIONAL FRAMEWORKS

At national level, many countries have established dedicated bodies or inter-agency programmes to manage the rollout of digital and sustainable construction practices. These initiatives often take the form of competence centres or observatories that act as central reference points for policy coordination, standard-setting, guidance and capacity-building.

Germany's BIM Deutschland, established in 2020 and jointly operated by the transport and housing ministries, illustrates this approach. It functions as a one-stop coordination platform for construction digitalisation, publishes guidelines aligned with European standards, provides training materials, co-funds pilot projects, and works closely with the national standards organisation to ensure the consistent use of open standards such as IFC for data exchange. This type of structure demonstrates how governance can operate simultaneously as a policy driver and as a practical support mechanism for industry.

Comparable initiatives exist in other Member States, including France's Plan BIM 2022, Italy's BIM Observatory, Finland's KIRA-digi programme and Spain's national digital construction strategy. By giving digital and green construction policy a clear institutional home, governments are better able to maintain momentum, coordinate stakeholders and ensure accountability over the long term.

EUROPEAN-LEVEL COORDINATION AND ALIGNMENT

National efforts are most effective when complemented by coordination at European level. To reduce fragmentation and promote convergence, public clients and policymakers from more than 20 countries formed the EU BIM Task Group in 2016. This pan-European network facilitates the exchange of experience and the alignment of implementation strategies across borders.

The EU BIM Task Group Handbook (2017) distilled shared lessons and best practices, enabling countries to learn from one another and converge around common principles, standards and procurement approaches. This form of multi-level governance has proven particularly valuable in creating a more coherent European BIM landscape and in supporting the broader Twin Transition through mutual learning rather than prescriptive regulation alone.

ADDRESSING ECONOMIC AND FINANCIAL BARRIERS

Beyond organisational coordination, implementation support also depends on addressing economic and financial challenges. The upfront costs of digital tools, training and low-carbon solutions, combined with uncertain returns on investment, can discourage adoption in a sector characterised by low margins and high competition. These barriers are especially acute for small and medium-sized enterprises, which often lack the resources to invest in new software, hardware or specialised expertise.

To mitigate these risks, many European governments introduced funding schemes, grants and incentive programmes aimed at supporting the uptake of digital technologies and sustainable construction practices. By absorbing part of the innovation risk, these programmes help create local reference projects and demonstrate the practical value of new approaches. On the sustainability side, financial incentives such as grants or tax rebates for green buildings are increasingly linked to digital verification methods, indirectly reinforcing the adoption of digital tools alongside environmental objectives.

Coupling regulatory requirements with financial support reduces the risk that innovation becomes concentrated among larger firms, ensuring that SMEs are not excluded from the Twin Transition due to cost constraints alone.

PUBLIC PROCUREMENT AS A LEVER FOR MARKET TRANSFORMATION

Public procurement plays a particularly influential role in driving change across the construction market. As major clients, public authorities are increasingly embedding digital and sustainability criteria into tender requirements, creating a strong demand signal for industry. Requirements related to BIM use, open data standards or life cycle performance encourage suppliers to invest in new capabilities that would otherwise remain optional.

In some cases, procurement frameworks go beyond minimum requirements by rewarding innovative digital and green solutions through evaluation criteria or bonus mechanisms. Innovation partnerships and pre-commercial procurement models further allow public authorities to co-develop new solutions with industry, sharing development risks and accelerating market readiness. Through these approaches, public procurement not only improves public project outcomes but also supports the broader diffusion of digital and sustainable practices across the sector.

STANDARDS AND INTEROPERABILITY

Interoperability is less a technical problem than a governance one. The standards exist - EN ISO 19650 for information management, the IFC schema for data exchange, Level(s) and EN 15978 for sustainability indicators - but they are adopted unevenly across Member States and across firms. Turning them into a genuine single market for construction data requires that the European Commission and national authorities treat digital interoperability as public infrastructure: specifying common semantic references, recognising a shared set of open exchange formats in regulation, and making procurement the lever that enforces them.

This also reframes the DBL, DPP and digital-permit debate. What is at stake is not the choice of any particular platform, but the coordination of a federated ecosystem (nationally hosted, semantically aligned, and cross-border by design), connecting project-level common data environments, municipal cadastres and registers of energy performance, and national DBL. Member States that invest early in this shared data layer, with clear mandates on access, quality and reuse, will unlock compliance, financing and innovation at the same time. Those that treat it as a vendor question will, by contrast, reproduce today's fragmentation at greater cost.

7.4 \ POLICY AND REGULATORY FRAMEWORKS

Clear policy and regulatory frameworks at both European and national levels are what translate Twin Transition ambitions into predictable obligations and investment signals. This section looks first at the national mandates and standards that have shaped BIM adoption and, more recently, whole-life carbon assessment, and then at how public-sector leadership (through procurement, exemplary projects and coordinated strategies) accelerates alignment across jurisdictions.

NATIONAL MANDATES AND STANDARDS

National mandates have been a decisive lever in bringing BIM and, more recently, whole-life carbon assessment into mainstream practice. A first wave, from the mid-2010s onward, focused on BIM for publicly funded projects. The United Kingdom required BIM Level 2 on centrally procured government projects from 2016. The Netherlands mandated BIM use on Rijksvastgoedbedrijf projects above a given value threshold, and the Nordic countries (Finland, Norway, Denmark, Sweden) aligned their public-client requirements around open, IFC-based workflows. Germany introduced a phased BIM roadmap for federal transport infrastructure between 2015 and 2020, reinforced by the establishment of BIM Deutschland as the national coordination body. Spain, Italy and France followed with staged requirements for public works, typically linked to project value and complexity, and Portugal is finally preparing its national BIM strategy.

In environmental terms, a second wave has begun to integrate environmental performance into the same mandates. France's RE2020, in force since 2022, requires whole-life carbon calculation and caps for new buildings, combining operational-energy limits with embodied-carbon thresholds that tighten progressively to 2031. The Netherlands has required the MPG (Milieuprestatie Gebouwen) environmental performance calculation for new residential and office buildings since 2013, with a maximum value tightened in successive updates. Denmark introduced mandatory whole-life carbon assessment for all new buildings in 2023, with a binding limit for buildings above 1 000 m² and a progressive tightening pathway to 2029. Finland and Sweden have put in place climate declarations for new buildings, and Germany, Belgium (Flanders) and Ireland are advancing comparable instruments. These national moves are converging with the recast EPBD, which from 2028 and 2030 will make whole-life GWP calculation and disclosure mandatory across the EU, effectively generalising what these front-runners have been piloting.

PUBLIC-SECTOR LEADERSHIP

The impact of digital and green policies is greatest when countries coordinate and learn from each other. To avoid a patchwork of divergent rules, the EU has promoted knowledge exchange. The EU BIM Task Group and the European BIM Handbook, for example, have helped harmonise BIM mandates. As a result, many national requirements now share common elements, making cross-border compliance easier for firms. This alignment reduces the risk that each Member State develops completely different technical standards or criteria for the Twin Transition.

Nonetheless, regulatory fragmentation persists. EU countries have not moved at the same pace in adopting digital and sustainable construction requirements. Some already mandate BIM or LCA for public projects, while others do not, leading to uneven implementation across the single market. For companies operating in several countries, navigating different regulations and compliance processes can discourage investment in new solutions, especially amid uncertainty about future rules. In the absence of clear, harmonised requirements, some market actors delay action on the Twin Transition.

A coherent policy and regulatory framework is therefore central to driving the Twin Transition. Strong laws and clear standards can counter reluctance and uncertainty by requiring the sector to advance together. Complementary support measures (funding, guidance, and public procurement rules) help those who may struggle to comply, including small firms and less developed regions. This unified approach levels the playing field, prevents actors from falling too far behind, and accelerates the transition by turning isolated innovations into standard practice across Europe.

7.5 \ POLICY RECOMMENDATIONS

Implementing the Twin Transition across Europe's construction sector requires coordinated action by policymakers at all levels. Building on the analysis of frameworks and enablers above, this section outlines strategic recommendations for the European Union and for national (as well as regional/local) governments to accelerate and mainstream the Twin Transition. These recommendations span legislation and regulation, economic incentives, standards and data infrastructure, and governance and educational initiatives. Crucially, they call for a multi-level governance approach: EU-level policy provides direction and consistency, while national and local measures tailor implementation on the ground. By acting in concert, European and domestic authorities can give the construction ecosystem a clear roadmap, the necessary resources, and a mandate to innovate.

EU-LEVEL ACTIONS AND FRAMEWORKS

> **Embed Twin Transition requirements in EU legislation:** The EU should continue embedding digital and environmental requirements into the legislative frameworks governing the built environment, with a focus on effective implementation. The recently adopted recast of the EPBD provides a stronger basis for integrating whole-life carbon considerations and for deploying instruments such as building renovation passports and digital building logbooks at the national level. In parallel, the revised CPR strengthens requirements for environmental and digital product information, creating the conditions for harmonised, digitally accessible data on construction materials. Together, these frameworks support a more coherent internal market and encourage the progressive mainstreaming of LCA and digital data across Member States.

> **Use public procurement and funding programmes:** The EU should use its substantial funding programmes and its influence over public procurement to drive the Twin Transition. For example, EU-wide Green Public Procurement criteria can be strengthened to require life cycle sustainability measures and the use of BIM for projects receiving EU funds. In practice, this means that if EU money is financing a new public building or infrastructure project, the project must use BIM and provide environmental data (e.g., an LCA, material passports, etc.) as part of its deliverables. The European Commission can also set targets or issue guidance on the use of BIM and LCA in public projects, as some Member States have national BIM mandates. On the funding side, EU financial instruments and the Sustainable Finance Taxonomy criteria should prioritise investments that exemplify the Twin Transition. For instance, the Taxonomy's provisions for construction could be updated to include digitalisation requirements (such as requiring a digital building logbook or sensor integration) alongside strict energy/carbon limits.

> **Develop common standards and data infrastructure**: Beyond regulation, the EU should spearhead the development of common standards, open data platforms, and interoperability frameworks to support the Twin Transition. Building on the work of CEN and ISO, the Commission can facilitate Europe-wide adoption of standardised product data templates and ontologies for construction products, so that material properties and sustainability metrics are described consistently across the single market. The EU can also coordinate the creation of a European DBL framework, defining a common data structure and governance model to ensure that logbooks across countries remain compatible. A push to roll out DBLs at scale should be a priority. For example, policymakers could require that all new buildings (and major renovations) include a DBL, mandated by the EPBD or similar legislation.

> **Support capacity building and innovation networks:** EU institutions should continue investing in the human and institutional capacity needed for the Twin Transition. Programmes such as Erasmus+ and the Blueprint for Sectoral Skills can fund curriculum development in green construction and BIM at universities and trade schools. Under the Pact for Skills, a dedicated construction initiative could retrain workers in digital and sustainable methods. The Commission could also establish an EU-wide Twin Transition knowledge hub or observatory to collect best practices, case studies, and toolkits, making them accessible to stakeholders across Europe. Finally, Horizon Europe calls and other EU R&D initiatives should address specific challenges that remain, such as automated LCA integration in BIM, AI for circular design optimisation, 3D printing with low-carbon materials, and advanced recycling technologies.

NATIONAL AND LOCAL IMPLEMENTATION

While EU-level frameworks set the overall direction, it is at the national and local levels that policies must be implemented in detail and tailored to the context. Member States are urged to develop comprehensive national Twin Transition strategies for construction, aligned with EU targets but responsive to local industry conditions. These strategies should set clear milestones for 2030, 2040, etc., and articulate the policy measures to achieve them in a "whole-of-government" effort. Key recommendations for national and local authorities include:

- **Adopt and enforce ambitious building regulations:** National governments should rapidly integrate Twin Transition principles into their building codes and standards. This means requiring new buildings to meet nearly zero-emission or positive energy standards and, increasingly, to calculate and report their whole-life carbon footprint. Alongside carbon, codes should promote circularity, for instance, by requiring a minimum percentage of recycled content in building materials or mandating "design for disassembly" for large projects to facilitate future reuse. Member States can draw on the Level(s) framework for guidance in setting these performance indicators. Digital compliance should be embedded as well: as electronic permitting systems roll out, authorities can require BIM models as part of permit submissions (especially for complex projects) to improve transparency and later facility management.
- **Set "Twin Transition" roadmaps and public-sector mandates:** Government leadership is often best demonstrated through clear roadmaps and exemplary mandates, particularly in public procurement. Many EU countries have published BIM implementation roadmaps for public works. Member States that have not yet done so should establish timetables for requiring BIM and digital collaboration in publicly funded construction – ideally by 2030 or sooner for significant projects. These roadmaps should also include goals for integrating sustainability, such as requiring LCAs and circular practices in public projects on a similar timeline. At the local level, city authorities and public clients can lead by example: mandating BIM for municipal projects, using digital twin technology to manage city assets, and incorporating green criteria into all public tenders.
- **Invest in training and capacity at all levels:** National governments should invest in education and training programmes to equip people with the skills needed for the Twin Transition. This involves updating university and vocational curricula and also funding apprenticeships and professional courses in digital and green construction. Public administrations themselves need upskilling – for example, procurers and permitting officials must learn to handle BIM data and sustainability assessments. Setting up national or regional "digital construction innovation hubs" can provide ongoing training and support to both public and private stakeholders (building on the model of BIM competence centres). Local governments can collaborate with industry associations to run workshops for contractors and SMEs on how to comply with new digital processes or sustainability requirements.
- **Foster innovation and share best practices:** Authorities should encourage pilot projects and demonstrators that showcase Twin Transition principles in action. This could mean funding a pilot programme for circular, BIM-managed public building projects in each region, or creating "living labs" where new digital-green techniques are tested. By documenting and publicising the outcomes of such pilots, best practices can be replicated.
- **Support SMEs and ensure inclusivity:** Smaller companies and less developed areas will need support to participate fully in the Twin Transition. National strategies should include support mechanisms such as vouchers or grants for SMEs to get started with digital tools, tax incentives for companies investing in staff training, and easy-access advisory services (e.g. a web portal for technical support on BIM implementation).

By implementing these strategic actions, policymakers will foster an environment where the Twin Transition can flourish. Clear regulations will define goals and minimum standards, while governance structures and funding will help those who need support to comply. Technical standards will enable solutions to scale across borders, and training and cultural change will align people and organisations with the new objectives. Ultimately, the goal is to transform Europe's built environment in a cohesive, innovative, and fair way, using digital technology to drive sustainability and harnessing the sustainability imperative to modernise the industry.

8 \ CONCLUSIONS AND OUTLOOK

The central argument of this handbook is that the green and digital transitions in the built environment are inseparable. Climate and circularity targets will not be met without digital instruments that make environmental performance measurable, verifiable and comparable, and digitalisation will fall short of its promise unless it is explicitly oriented towards those environmental outcomes. BIM, LCA, EPDs, DPPs and Digital Building Logbooks are not parallel tools - they are the data backbone that allows one integrated approach to the built environment.

The European regulatory framework reviewed in the previous chapters points in the same direction. The recast EPBD, the Construction Products Regulation, the Ecodesign for Sustainable Products Regulation, the EU Taxonomy, CSRD/ESRS and the strengthened ETS, RED and EED each articulate a piece of the same agenda: operational performance, embodied carbon, product traceability, transparent reporting and a price signal for emissions. Their shared horizon is 2030, and their coherence depends on treating the data layer as common infrastructure.

The analysis presented in this handbook points to four challenges that will determine the pace and equity of the Twin Transition in the built environment: the absence of technical and semantic interoperability across platforms; unresolved questions of data ownership, access rights, and privacy; high implementation costs that fall disproportionately on SMEs; and fragmented stakeholder collaboration across a disaggregated value chain. Each requires a different response - standards work, privacy-preserving technology, targeted financial support, and governance structures that create genuine incentives for data sharing - and none is resolved by regulation alone.

Underlying all four is a more fundamental condition: the construction industry has historically adopted new practices not through mandates, but through compelling evidence. A renovation project that generates quantified cost savings, a deconstruction scheme where DPP-linked material records enable the resale of reclaimed components at a measurable premium, a public building where an operational logbook demonstrably reduced maintenance expenditure - these are the proof points that turn isolated early adopters into mainstream practice. The CIRPASS-2 pilots, expected to publish results by 2027, and the first wave of mandatory DPPs for priority product groups will generate precisely this evidence. Public clients who engage now - embedding DPP and DBL requirements in near-term procurement projects - will not only be building the sector's early experience base. They will be shaping the standards and implementation guidance that govern the transition for the decade ahead.

The practical implication is sequencing. The sector needs to bring BIM, LCA and DPP and other digital workflows into routine practice before the binding milestones of 2028–2030 arrive, build the EPD and skills capacity that today's supply does not yet provide, and use public procurement as the main lever to align investment with the transition. What follows in this chapter distils that message into a short outlook on what needs to change and where progress is most likely.

The EUBIM Task Group is well placed to accelerate convergence: by publishing shared reference data models, by piloting joint DPP/DBL demonstrators, by supporting SME uptake, and by keeping the Twin Transition framing at the centre of national BIM strategies.

LIST OF ACRONYMS

AEC - Architecture, Engineering and Construction
ADPe - Abiotic Depletion Potential (elements)
ADPf - Abiotic Depletion Potential (fossil resources)
ADPm - Abiotic Depletion Potential (minerals and metals)
AI - Artificial Intelligence
AP - Acidification Potential
BAMB - Buildings As Material Banks
BEP - BIM Execution Plan
BIM - Building Information Modelling
BREEAM - Building Research Establishment Environmental Assessment Method
CEAP - Circular Economy Action Plan
CEN - European Committee for Standardization
CERIS - Civil Engineering Research and Innovation for Sustainability
CI - Circularity Indicator
CIRPASS - Collaborative Initiative for a Standards-based Digital Product Passport
CPR - Construction Products Regulation
DBL - Digital Building Logbook
DBP - Digital Building Permit
DoP - Declaration of Performance
DoPC - Declaration of Performance and Conformity
DPP - Digital Product Passport
EPBD - Energy Performance of Buildings Directive
EPD - Environmental Product Declaration
EP / EPf / EPm / EPt - Eutrophication Potential (total / freshwater / marine / terrestrial)
ESG - Environmental, Social and Governance
ESPR - Ecodesign for Sustainable Products Regulation
ETP-fw - Ecotoxicity Potential (freshwater)
EU - European Union
EUBIM - EU BIM Task Group
GHG - Greenhouse Gas
GIS - Geographic Information System
GTIN - Global Trade Item Number
GWP / GWPt / GWPf / GWPb / GWPl - Global Warming Potential (total / fossil / biogenic / land use and land use change)
HTP-c / HTP-nc - Human Toxicity Potential (cancer / non-cancer)
HVAC - Heating, Ventilation and Air Conditioning
IBU - Institut Bauen und Umwelt
IFC - Industry Foundation Classes
ILCD - International Reference Life Cycle Data System
IRP - Ionising Radiation Potential
IST - Instituto Superior Técnico
LCA - Life Cycle Assessment
LCC - Life Cycle Cost
LCI - Life Cycle Inventory
LCIA - Life Cycle Impact Assessment
LEED - Leadership in Energy and Environmental Design
MP - Material Passport
NZEB - Nearly Zero-Energy Building
ODP - Ozone Depletion Potential
PCR - Product Category Rules
PDT - Product Data Template
PM - Particulate Matter
POCP - Photochemical Ozone Creation Potential
QR - Quick Response (code)
RE2020 - Réglementation Environnementale 2020 (France)
REACH - Registration, Evaluation, Authorisation and Restriction of Chemicals
SME - Small and Medium-sized Enterprise
SQP - Soil Quality Potential
WDP - Water Deprivation Potential
XML - Extensible Markup Language

REFERENCES

BAMB Consortium. (2019). Buildings as Material Banks (BAMB2020): Final project results (Horizon 2020 Grant Agreement No. 642384). https://www.bamb2020.eu/

CIRPASS Consortium. (2024). CIRPASS – Collaborative initiative for a standards-based digital product passport: Final deliverables. Horizon Europe. https://cirpassproject.eu/

CIRPASS-2 Consortium. (2024). Digital product passport in large-scale demonstrators. Horizon Europe. https://cirpass2.eu/

Circularise. (2023). The 9 R-strategies for a circular economy [Explainer]. https://www.circularise.com/

Demo-BLog Consortium. (2025). The business case for digital building logbooks: Woningpas [Factsheet]. BUILD UP. https://build-up.ec.europa.eu/en/resources-and-tools/publications/business-case-digital-building-logbooks-woningpas

Directive (EU) 2024/1275 of the European Parliament and of the Council of 24 April 2024 on the energy performance of buildings (recast). (2024). Official Journal of the European Union, L series, 8 May 2024.

Dodd, N., Donatello, S., & Cordella, M. (2021). Level(s) – European framework for sustainable buildings: User manual (Parts 1–3) and technical reports. Joint Research Centre, European Commission.

ECO Platform. (2024). Digital EPDs and interoperability. https://www.eco-platform.org/

Ecorys, & EASME. (2020). Study on the development of a European Union framework for digital building logbooks: Final report for the European Commission, DG GROW. Publications Office of the European Union.

EN 15804:2012+A2:2019. (2019). Sustainability of construction works – Environmental product declarations – Core rules for the product category of construction products. European Committee for Standardization (CEN).

EN 15978:2011. (2011). Sustainability of construction works – Assessment of environmental performance of buildings – Calculation method. European Committee for Standardization (CEN). (Revision under development as prEN 15978-1.)

EN ISO 19650 (series). Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM). CEN/ISO.

EN ISO 23386:2020. (2020). Building information modelling and other digital processes used in construction – Methodology to describe, author and maintain properties in interconnected data dictionaries. CEN/ISO.

EN ISO 23387:2020. (2020). Building information modelling (BIM) – Data templates for construction objects used in the life cycle of built assets – Concepts and principles. CEN/ISO.

EU BIM Task Group. (2017). Handbook for the introduction of Building Information Modelling by the European Public Sector. https://www.eubim.eu/handbook/

European Commission. (2019). The European Green Deal (Communication COM(2019) 640 final).

European Commission. (2020a). A Renovation Wave for Europe – Greening our buildings, creating jobs, improving lives (Communication COM(2020) 662 final).

European Commission. (2020b). Circular Economy Action Plan – For a cleaner and more competitive Europe (Communication COM(2020) 98 final).

European Commission. (2021). ‘Fit for 55’: Delivering the EU’s 2030 climate target on the way to climate neutrality (Communication COM(2021) 550 final).

European Commission. (2025a). CPR Working Plan 2026–2029. DG GROW. https://single-market-economy.ec.europa.eu/sectors/construction/construction-products-regulation-cpr/harmonised-standards_en

European Commission. (2025b). European Strategy for Housing Construction. DG GROW. https://single-market-economy.ec.europa.eu/document/download/8e22818b-71f7-4e68-921c-2c65d458c6c6_en

European Commission. (2025c). The European Affordable Housing Plan. https://housing.ec.europa.eu/european-affordable-housing-plan_en

Ferreira, M. T., Arantes, A., & Costa, A. A. (2025). Environmental optimization and benchmarking of walls through a BIM plugin. Architectural Engineering and Design Management.

Ferreira, M. T., Costa, A. A., & Silvestre, J. D. (2022a). Integrated sustainability assessment using BIM. Acta Polytechnica CTU Proceedings, 38, 116–123.

Ferreira, M. T., Silvestre, J. D., Costa, A. A., & Bohne, R. A. (2022b). Integrating Level(s) LCA in BIM: A tool for estimating LCA and LCC impacts in a case study. In ECPPM 2022 – eWork and eBusiness in Architecture, Engineering and Construction. CRC Press/Balkema.

Institut Bauen und Umwelt (IBU). (2024). ecoPortal / IBUdata: Database of Environmental Product Declarations. https://ibu-epd.com/

ISO 14025:2006. (2006). Environmental labels and declarations – Type III environmental declarations – Principles and procedures. International Organization for Standardization.

ISO 14040:2006. (2006). Environmental management – Life cycle assessment – Principles and framework. International Organization for Standardization.

ISO 14044:2006. (2006). Environmental management – Life cycle assessment – Requirements and guidelines. International Organization for Standardization.

ISO 21930:2017. (2017). Sustainability in buildings and civil engineering works – Core rules for environmental product declarations of construction products and services. International Organization for Standardization.

ISO 22057:2022. (2022). Sustainability in buildings and civil engineering works – Data templates for the use of environmental product declarations (EPDs) for construction products in building information modelling (BIM). International Organization for Standardization.

Madaster Foundation. (2024). Madaster Platform: Circularity Indicator and Material Passports. https://madaster.com/

Passoni, C., Marchetti, L., & Marini, A. (2024). Twinning the path of digital building permits and digital building logbooks – Diagnosis and challenges. Developments in the Built Environment, 20, 100441. https://doi.org/10.1016/j.dibe.2024.100441

Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment (EU Taxonomy Regulation). (2020). Official Journal of the European Union, L 198, 13–43.

Regulation (EU) 2024/1781 of the European Parliament and of the Council of 13 June 2024 establishing a framework for setting ecodesign requirements for sustainable products (ESPR). (2024). Official Journal of the European Union, L series.

Regulation (EU) 2024/3110 of the European Parliament and of the Council of 27 November 2024 laying down harmonised rules for the marketing of construction products (Construction Products Regulation, revised). (2024). Official Journal of the European Union, L series, 18 December 2024.

Saheb, Y., Ossenbrink, H., & Szabo, S. (Eds.). (2020). Definition of the digital building logbook: Report 2 of the study on the development of a European Union framework for digital building logbooks (EUR 30231 EN). Publications Office of the European Union.

Santos, R., Costa, A. A., Silvestre, J. D., & Pyl, L. (2020). Development of a BIM-based Environmental and Economic Life Cycle Assessment tool. Journal of Cleaner Production, 265, 121705. https://doi.org/10.1016/j.jclepro.2020.121705

van Capelleveen, Guido & Vegter, Dennis & Olthaar, Matthias & Hillegersberg, Jos. (2023). The anatomy of a passport for the circular economy: a conceptual definition, vision and structured literature review. Resources, Conservation & Recycling Advances. 17. 200131. 10.1016/j.rcradv.2023.200131.

Woningpas. (2025). Flemish Digital Building Logbook. Vlaams Energie- en Klimaatagentschap. https://woningpas.vlaanderen.be/

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