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1. Introduction: importance of evidence on cost and benefits of WLC assessments and regulation to support EPBD implementation

About INDICATE LIFE

INDICATE LIFE is a 26-month project co-funded by the European Union's LIFE Programme, designed to generate urgently needed building whole-life carbon (WLC) data across Europe.

The project aims to develop whole life carbon baselines and limit values for a range of building typologies – including both new builds and renovations – in preparation for the implementation of the recently revised Energy Performance of Buildings Directive (EPBD).

Building on the achievements of the previous INDICATE project, which carried out pilot studies in Ireland, Spain, and the Czech Republic, INDICATE LIFE focuses on filling critical data gaps in Austria, Croatia, Italy, Luxembourg, and Hungary.

Objective of this report

The objective of this report is to collect evidence on the costs and benefits of WLC assessment and regulation, drawing on experiences from the INDICATE LIFE countries and beyond. By analysing real-world case studies, market practices, and early implementation experiences, the report aims to understand perceived drivers and barriers to assessing and reducing whole-life carbon, as well as address common concerns related to potential cost impacts and trade-offs between economic and environmental objectives. The analysis seeks to identify easy wins and demonstrate how a whole-life carbon (WLC) perspective can be implemented in a cost-effective manner. It also highlights the wider benefits, including improved design outcomes, reduced life-cycle costs, and driving innovation in low-carbon construction. Based on these insights, the report formulates policy recommendations to support the practical and ambitious implementation of WLC regulation.

Policy context

The importance of the building sector for achieving climate objectives has increasingly become a central focus of policymaking and industry action across the EU. While earlier efforts largely concentrated on improving the energy efficiency of building operations – notably reducing energy demand for heating and cooling – the perspective has progressively shifted towards a full life-cycle approach. This broader approach considers not only operational energy use, but also emissions associated with construction and renovation processes, the production and transport of materials and products, and end-of-life stages.

The lifecycle approach has become even more prominent in the context of Europe's more recent policy flashpoints, notably the need to deliver housing transformation at scale. Addressing the housing deficit in an affordable, sustainable, and efficient manner, while staying within planetary boundaries,

requires scaling up innovative construction and renovation methods, digitalised, data-driven project delivery, circular material flows, and low-carbon design. These measures can expand market capacity, improve quality, and reduce life-cycle costs. If implemented effectively, they also offer an opportunity to strengthen economic resilience and competitiveness.

The life-cycle perspective is now embedded in the EU regulatory framework. Under the revised Energy Performance of Buildings Directive (EPBD), adopted in May 2024, the disclosure of life-cycle greenhouse gas (GHG) emissions will become mandatory for new large buildings from 2028 and for all buildings from 2030. In addition, Member States are required to develop national roadmaps outlining how limit values for life-cycle global warming potential (GWP) will be introduced from 2030 onwards, following a steady downward trajectory consistent with the EU's climate-neutrality objectives.

The quality and source of carbon data are fundamental to accurate assessment. At present, the environmental information required for building life-cycle assessments (LCAs) is largely provided on a voluntary basis by manufacturers through Environmental Product Declarations (EPDs), which offer structured and third-party verified data. With the revised Construction Products Regulation (CPR (EU) 2024/3110), the provision of environmental information will progressively become mandatory, strengthening the availability and consistency of carbon data for materials and products.

A growing number of European countries have already introduced life-cycle carbon-based requirements for buildings ahead of the EPBD timeline. France, Denmark and the Netherlands have established limit values for global warming potential per square meter of new buildings as part of the permitting process. Sweden, Norway, Finland¹, Iceland and Estonia made WLC assessment mandatory for new buildings with limits to follow. Other Member States, including Spain, Czech Republic and Ireland, are currently preparing steps towards implementation of similar requirements². Germany is also being called upon to use the transposition of the revised EPBD to accelerate progress and to regain a leading role in life-cycle-optimised construction ahead of the deadline indicated in the EU directive.³

Although it is too early to draw definitive conclusions about the effectiveness of WLC requirements, given that many have been introduced only recently, valuable experience with life-cycle regulation already exists within Europe. This experience underscores the feasibility for remaining Member States to act by introducing life-cycle GWP disclosure requirements and establishing a clear pathway towards binding limit values from 2030 onwards.⁴ It also highlights the importance of embedding whole-life carbon considerations early in both policy design and

¹ Helsinki has adopted its own carbon footprint limit values for buildings within their planning frameworks, but these are separate from national WLC limit values which have not yet been finalised as of January 2026.

² INDICATE PILOT project: <https://www.indicatedata.com/indicate-pilot-about>

³ See e.g. BPIE/DGNB 2025 series on "[Relevance and costs of a life-cycle perspective on buildings](#)".

⁴ BPIE 2025: [Guidance and principles of a WLC framework](#). Deliverable 4.1. INDICATE LIFE.

project delivery, rather than treating them as an add-on at later stages, to ensure cost- and carbon-effective compliance.

At the same time, the construction industry has raised concerns that these new requirements, such as the need to conduct building LCAs and to adopt life-cycle-optimised construction practices, could lead to additional cost pressures. These concerns arise at a time when the sector is already facing rising material and energy prices, labour and skills shortages, data gaps, supply-chain disruptions and broader economic uncertainty.

Country overviews on LCA capacities and skills

In the INDICATE LIFE countries, the starting conditions for developing benchmarks and preparing WLC regulations vary considerably. This is due to numerous reasons, including differences in data availability, market maturity, building stocks, construction practices and broader contextual factors.

In Croatia, expertise in building life-cycle assessment (LCA) and whole-life carbon (WLC) remains limited to a small number of professionals. While accredited green building assessors are present in the local market, their experience is generally confined to a limited number of projects and often focused on the final design stage. Some designers have begun to integrate WLC considerations earlier in the design and planning phases or to seek advice from green building assessors, but WLC assessments are still typically carried out on a voluntary basis. Until recently, most practitioners relied largely on self-learning. Since 2022, LCA has been increasingly promoted through informal knowledge-sharing initiatives and few academic courses, such as green building programme at the University of Zagreb's Faculty of Civil Engineering. These efforts have attracted growing interest, particularly among students, although broader institutional and regulatory support frameworks remain underdeveloped. Consequently, there is strong demand for a national methodology, clear guidelines, and carbon database. Green buildings certified under recognised environmental assessment and rating systems, along with manufacturers beginning to develop EPDs, represent early developments and capacity-building efforts in the sector.

In Luxembourg, significant progress has been made in promoting energy efficiency, most notably through the Nearly Zero Energy Building (nZEB) standard. In comparison, WLC considerations have only recently entered policy discussions. The voluntary LENOZ certification ("Lëtzebuerger Nohaltegkeets-Zertifizéierung"), issued by the Ministry of the Environment, Climate and Biodiversity (MECB), includes an indicator on life-cycle environmental impacts. More recently, subsidies for WLC assessments in municipal construction projects have been introduced. INDICATE LIFE experts highlight that substantial capacity-building across the sector remains necessary, as architects, engineers, developers, and contractors, particularly small and medium size enterprises, may lack awareness, expertise, and access to low-carbon materials and tools.

In Italy, while some practitioners have extensive experience conducting building LCAs, WLC assessments are not yet widespread across the industry. A survey conducted by the Italian INDICATE LIFE team found that half of the respondents (14 out of 28) reported no experience with WLC assessments. Nevertheless, there

is growing recognition of WLC and LCA as both strategic and ethical necessities in the design and construction sector. Public procurement policy (Legislative Decree 36/2023) has further raised market awareness. However, public authorities still seldom require LCA analysis to assess environmental impacts of public building works, with limited in-house expertise within technical departments remaining a key barrier. For designers, engaging with WLC assessments is seen as an opportunity to enhance technical knowledge, justify design choices, and gain a competitive advantage in tendering processes.

There are currently no general certification requirements for commercial, residential, or public buildings in Austria, but subsidies are sometimes tied to relevant certificates. Municipal and regional regulations may also require certification and thus a life cycle assessment. Despite these resources, the Austrian INDICATE LIFE team concludes that training for stakeholders and capacity building is necessary to integrate WLC practices into daily planning and design processes.

Methodology and approach

INDICATE LIFE is primarily about collecting WLC data and case studies with the aim to establish initial benchmarks that reflect current national construction practices and building typologies. To facilitate the widespread implementation of carbon assessments, it is essential to understand their practical and cost implications, in order to ensure that these requirements do not hinder the uptake of WLC regulation or the delivery of low-embodied-carbon buildings. This report synthesises the key learnings from the INDICATE LIFE countries — Luxembourg, Austria, Italy, and Croatia — and, where available, compares them with the evidence from countries where WLC regulations are already in place. It provides a snapshot of market sentiments and insights from stakeholders involved in the project, drawing on anecdotal evidence rather than quantitative data, and is therefore not a fully representative analysis.

To enable comparisons despite the considerable diversity of construction practices and building typologies, market readiness and LCA expertise across the INDICATE LIFE countries, a qualitative cost-benefit analysis template was developed. Its purpose was to capture market insights and stakeholder perspectives on both the costs and the benefits of introducing a life-cycle perspective in buildings. Across the four INDICATE LIFE countries, a total of 41 case studies were collected (see Table 1 below). In addition, some national teams conducted interviews beyond the case study providers or developed hypothetical causal chains to qualitatively assess the costs and benefits of action versus inaction.

INDICATE LIFE country	Number of case studies / respondents to the survey	Notes
Austria	13 case studies - 6 housing projects (4 are completed new builds, 2 in planning phase)	Includes cases from Germany

INDICATE LIFE country	Number of case studies / respondents to the survey	Notes
	<ul style="list-style-type: none"> - 3 offices - 1 mixed use - 3 logistics/production hall/office 	
Croatia	6 case studies	In total there are 38 certified buildings, but several could not be included due to non-disclosure agreements.
Italy	13 case studies ⁵ ; and additional 15 survey respondents	The template was adapted to better reflect market needs and to gather additional insights, including on current levels of knowledge of WLC and building LCA beyond the case study providers.
Luxembourg	9 case studies (5 public, 4 private buildings) <ul style="list-style-type: none"> - 3 schools - 2 offices - 2 mixed-use buildings - 1 single family house - 1 tiny house 	Additional causal loop diagram and scenarios for qualitatively assessing impacts / cost-benefits

Table 1, Overview of case studies collected and discussed

⁵ 3 did not perform an LCA/WLC assessment, 4 a partial one (only A1-3), 6 a complete LCA / WLC assessment, see Annex II of the [Italian Sub-Report on Cost-Benefit Analysis](#).

2. Findings on costs and benefits of WLC assessments and regulation

Costs and benefits associated with undertaking carbon assessments

In the INCIATE LIFE countries where no WLC regulation is yet in place, the motivation to carry out building LCAs unsurprisingly stems primarily from the pursuit of certification schemes in which an LCA is mandatory. Further drivers include companies' internal sustainability targets and requirements linked to green financing. Finally, building LCAs are also undertaken in the context of research projects.

The costs of conducting a building LCA are reported to range between 0.1% and 2% of total project costs, an assessment that corresponds with calculations in Denmark. However, this is a cost item that is likely to decrease as competencies increase and processes become more routine. Moreover, the use of BIM and standardised fee schedules are also described as important levers for reducing costs.

Challenges are identified regarding the workflow and new collaborations, which are required for building LCAs and to meaningfully include the findings in the planning process. Another challenge is the availability and robustness of environmental data. At the same time, the benefits are reported by all project teams: a substantial increase in knowledge, which is described across all case studies as highly valuable and enriching (see chapter on “material & design”).

The business case of conducting building LCAs: motivation and costs

Motivation to conduct a building LCA

When asked who commissioned the building LCAs, it became apparent in all INDICATE countries that there are several key motivations for doing so: for most projects a building LCA was commissioned by the client/project owner, with the purpose of **building certification** (all countries), which in turn require to meet certain criteria and provide transparent information on environmental impacts. Voluntary certification, which includes an assessment of the life cycle of buildings, was also an important element in frontrunner countries in order to build up expertise in the field of building LCA even before regulations were in place.

Some projects also pointed to **internal company sustainability goals and / or EU-Taxonomy alignment**.

Another motivation was to **build up internal expertise** in doing building LCAs; some projects that participated in the survey did the WLC assessment as part of a research project (AT, HR, LU). Some used it already for design optimization (e.g. LU, AT, HR), e.g. using the WLC assessment in early design process to compare alternative solutions and guide decisions on materials, structural systems, and building components.

Costs of conducting a building LCA

It was not possible to assess precise numbers of the costs for conducting a building LCA from the collected case studies. From the Italian survey, the overall responses suggest the building LCA assessment should be rated as a percentage of the total construction cost. Most of the respondents who provided a figure **estimated the cost to be between 0.1% and 2% of the total project cost**, with some suggesting costs up to 5% higher than the standard design costs.

From Denmark, a cost impact analysis which was performed in 2022 prior to the introduction of limit values in January 2023 found, that **consultancy costs for building LCAs were expected to be between 0.2 and 1.7% of total costs in year two, depending on building scale**⁶. A detailed time consumption table for different building uses and scales has been developed for the first seven years after implementation, applying progression of competencies and routines after higher initial costs⁷.

Cost was consistently correlated with the Gross Floor Area (GFA) and the difficulty of the assessment. Highly complex projects requiring detailed, custom-**specific data demand significant labour input**, a problem intensified by the lack of integrated digital tools, such as Building Information Modelling (BIM). Consequently, automated systems leveraging comprehensive databases are identified as essential for process efficiency and cost reduction. (IT): The **absence of standardised fee structures** for WLC/LCA services was consistently observed. Costs are determined through negotiation and vary based on the assessment's specific purpose, such as satisfying regulatory requirements, achieving certification, or conducting voluntary sustainability reviews. Collectively, the data indicate an increasing understanding of the financial commitment associated with WLC/LCA but also underscore that economic viability and scalability are critical factors limiting their broader application.

This is also a finding from a recently conducted study on the **costs of conducting building LCAs among 62 LCA practitioners in Germany**⁸. The analysis showed a broad variance in costs due to the lack of standardised fee structure. Respondents were able to indicate minimum and maximum fees, flat-rate fees or the average fee charged for an LCA. They were also asked about fees for advice on optimisation (e.g. comparing variants). The median lowest figure (minimum) is €7,000 and the median highest figure (maximum) is €15,000. For flat-rate fees, which are offered by 30% of respondents, the median is €7,000. **The study also shows that consulting fees for calculating the LCA depend heavily on the amount of work involved in acquiring data, the size and type of building and the number of variants.** Building information modelling (BIM) and digital twins are seen as ways to reduce costs. The need to standardise underlying data, simplify software and provide digital bills of quantities was also pointed out.

⁶ Nordic Sustainable Construction (2025): [Setting and Assessing Limit Values in Nordic Countries – Analysis of the different regulatory needs](#), p. 43

⁷ *ibid.*

⁸ BPIE/DGNB 2025a: Relevance and Costs of a Life Cycle Perspective on Buildings: [Market Data on Life Cycle Assessment in Germany](#).

What do you usually base the costs of life cycle assessments on? (multiple choice allowed)

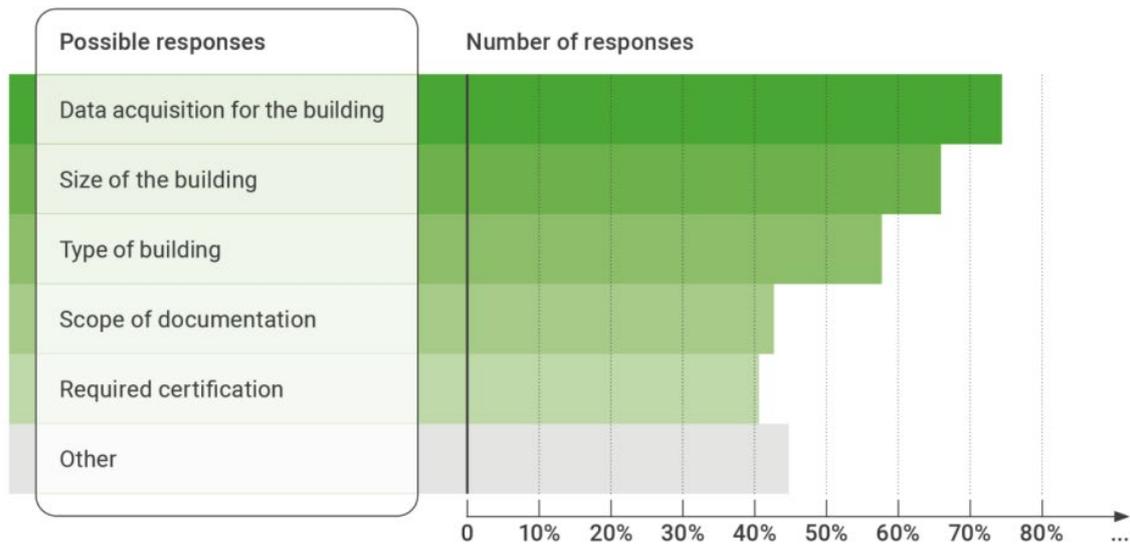


Figure 1: Cost drivers of building LCAs; survey from Germany (BPIE/DGNB 2025a⁹)

Workflow and collaboration

Two national INDICATE teams highlighted the resulting challenges regarding workflow and collaboration, when WLC assessments become a new part of the design process. **New forms of collaboration between stakeholders and workflows** with the planning team still need to be established and a lot of communication and moderation is needed to achieve a shared understanding of the project's sustainability targets among all stakeholders (AT, IT). A particular difficulty is finding the right timing, as assessments often begin after the design process has already started, while planners need quick decisions to move forward. In some cases, collaboration with the planning team can also be challenging (AT). Moreover, the **documentation effort** was perceived as still very high and bureaucratic (IT).

Availability and robustness of environmental data

A consistent challenge across all INDICATE LIFE countries is the limited availability and reliability of construction product data, as well as the lack of harmonised methodologies which together constrain the production of robust and high-quality building LCAs. Stakeholders report difficulties such as **incomplete, outdated, or inconsistent datasets, limited availability of local EPDs, and the underrepresentation of innovative or non-conventional materials**.¹⁰ Early-stage assumptions about quantities, design choices, and unfamiliarity with novel solutions can further reduce the accuracy and comparability of results. Surveyed experts frequently highlighted that generic

⁹ BPIE/DGNB 2025a: Relevance and Costs of a Life Cycle Perspective on Buildings: [Market Data on Life Cycle Assessment in Germany](#).

¹⁰ The lack of material quantities and information/guidance provided to WLC assessors by the clients can further increase the burden of WLC assessments, adding time and complexity to the process.

data often has to be used where product-specific EPDs are lacking, and that data gaps are particularly problematic for materials in emerging low-carbon or circular solutions.

Experience from frontrunner countries suggests that regulatory frameworks play a critical role in improving data availability and quality. Following the introduction of WLC regulations, these countries have seen a clear increase in the number of EPDs and a more structured approach to material data, while targeted initiatives such as dedicated funding for EPD creation (e.g., the Netherlands “White Spots Project”) demonstrate effective ways to address gaps. Overall, while sufficient and reliable data remains a precondition for widespread adoption of building LCAs, coordinated policy action, knowledge-sharing mechanisms, and **investment in data infrastructure can help overcome these obstacles and support the scaling of WLC assessments.**

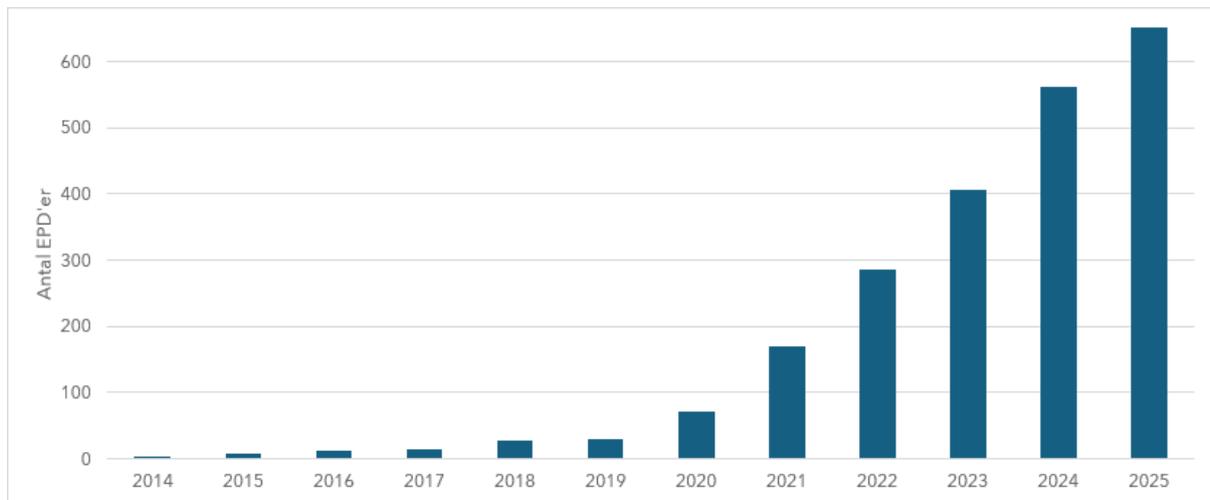


Figure 2: Number of EPDs in Denmark (EPD Danmark / Danish Technological Institute 2025)

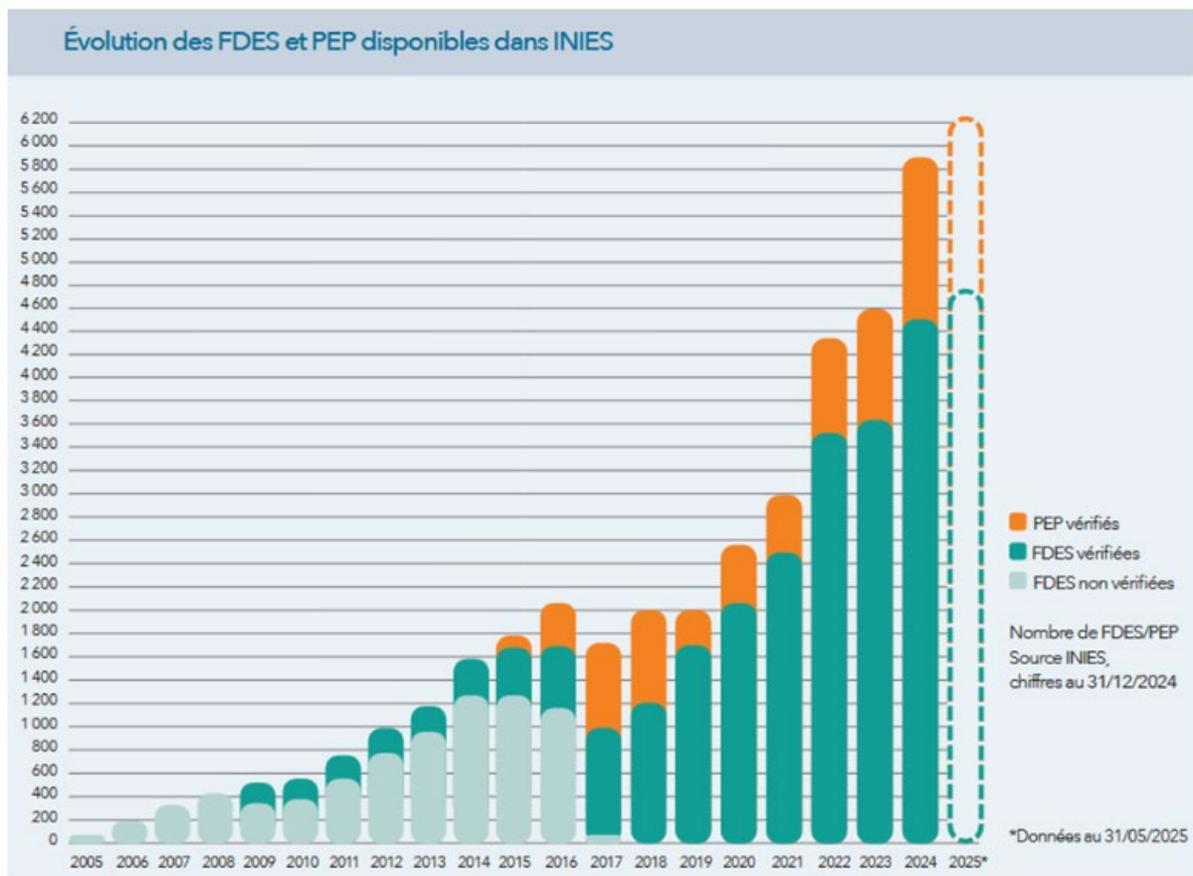


Figure 3: Number of EPDs (FDES & PEP) in France (Baromètre INIES 2025)¹¹

Figure 2 and Figure 3 illustrate the numbers of EPDs in France and Denmark¹². While Danish authorities note that it remains unclear whether the rise is directly attributable to the regulation (in effect since 1st of January, 2023), the respondent in France was confident that the increase is a direct result of regulatory requirements (in effect since 1st of January, 2022). As a result, France had to increase and double the number of EPD auditors¹³.

Benefits of conducting building LCA: knowledge & awareness, improved communication etc.

At the same time, a common denominator of the findings gathered in the case studies is that the enormous increase in knowledge regarding the parameters for optimising the design is a great benefit for planning teams and clients alike. By communicating the results appropriately, material and resource flows become understandable even for non-experts, contributing to a broader understanding of the impact and leverage of the construction industry on global warming. (AT): As an optimization tool for an ongoing evaluation of the planning process, architects as well as clients benefit from the knowledge gained in WLC assessments. Since a large portion of embodied emissions lies in the structural framework, calculations

¹¹ INIES 2025: [baromètre INIES 2025](#) (p. 3).

¹² Personal correspondence with Danish Technological Institute.

¹³ Interview with Jacques Chevalier, coordinateur INIES database, in July 2024.

carried out in early design phases can be especially helpful in rethinking fundamental decisions and setting the right course.

Voices from the national INDICATE LIFE teams:

“The calculation makes environmental impacts as measurable as costs—expressed in concrete numerical values. This shifts the discussion around emissions (and other indicators) away from gut feeling and toward data-driven decisions based on a solid foundation.” (AT, Case study 1)

“Furthermore, comprehensive assessments using standardized methods allow for the establishment of benchmarks in terms of climate neutrality. By communicating the results appropriately, material and resource flows become understandable even for non-experts, contributing to a broader understanding of the impact and leverage of the construction industry on global warming.” (AT, case study 4)

“The main advantage is the ability to make more informed design decisions based on objective data, allowing for a reduction in the environmental impact of the project. This benefits the Designer (greater project quality and innovation) and the client (better market positioning, alignment with taxonomies and ESG policies)” (IT, voice c, p. 9)

The learning process is long for the practical development of the calculation (data base and EPD availability, project data preparation, finding favourable tools and frameworks) but even more for the interpretation of the results. Improvement of knowledge is needed in the entire construction sector value chain. Most challenges are expected in streamlining the practices – development of the BoQ, responsibility for the selection of the construction materials and implementation of the construction works. (HR, case study 1)

It has been a grueling journey of a solitary woman. (HR, case study 1)

Personally, this was a completely new experience for me. I explored calculation procedures and studied the relevant literature and standards, working without the opportunity to exchange insights with Croatian experts—only with specialists from Slovenia. Through this process, I acquired substantial knowledge and hands-on experience that even today remains rare among professionals in Croatia. Analysing the results also provided me with a clear understanding of the challenges in this field, including limitations in existing calculation standards and certain software tools.

Overall, this experience has been invaluable in preparing for the requirements of ZEB buildings and the updated EPBD. (HR, case study 2)

Making decisions at the design stage is the most cost-effective way for the client to optimize, improve and, of course, increase the sustainability of the facility. However, this requires designers of all disciplines to be aware that everyone must act holistically in their field, including other knowledge and,

above all, to think lifelong. However, this often requires additional knowledge that the current generation of leading designers generally does not have, which is why learning and embracing new things is also an important factor in success. (HR, case study 5)

This is why the WLC is important in order to scientifically determine which solution is best and what discrepancies exist between the different results. ... it is increasingly important for local authorities to be able to communicate the impacts of their activities (mobility, infrastructure, construction, etc.) to citizens. A WLC therefore also enables the local authority to communicate and explain its impacts. (LU, case study 1)

Construction costs

Does WLC-optimised construction, or compliance with limit values, necessarily result in higher costs? This question remains central to the current debate. The available evidence points to a nuanced conclusion: both outcomes are possible. While low-carbon construction can entail additional costs compared to conventional buildings, these cost premiums are typically lower than perceived by the industry. Moreover, experience shows that low-carbon buildings can in some cases be delivered at equal or even lower cost, particularly when life-cycle carbon considerations are integrated into the development process right from the start. The latter is particularly encouraging, as it suggests that lifecycle-optimised construction can already achieve performance requirements and future limit values while simultaneously reducing overall project costs. With increasing experience, knowledge exchange and wider availability of low carbon solutions, green construction is expected to cost less over time.

Cost of WLC-optimised construction and compliance with limit values¹⁴

In Luxembourg, six case studies reported cost impacts, albeit without detailed quantification of cost items. Of these, four reported higher costs, two of which indicate only minor increases, while two projects reported cost-neutral results alongside demonstrable reductions in GHG emissions.¹⁵ The use of innovative materials and risk allowances were cited as reasons for the cost increases.

In the Luxembourg case studies, smaller projects tended to be cost-neutral, while larger and more complex projects showed cost increases. However, the limited sample size means that this tendency may not be representative. Another case study (an office complex, case study 3) illustrates that WLC insights can sometimes be overlooked due to short-term cost priorities and unwillingness to invest in higher upfront costs.

Case studies also reveal WLC assessment improves transparency and, when applied early, helps identify quick wins and avoid carbon lock-ins. Reuse strategies and avoiding over-specification of materials stand out as particularly effective measures, delivering substantial carbon savings while often remaining cost-neutral.

A qualitative cost-benefit scenario exercise carried out within the Luxembourg experts, including a causal loop scenario, shows that while the introduction of WLC reporting requirements slightly increases administrative burden and costs, these are generally balanced out by efficiency gains and innovation, learning and digitalisation.

In Austria, the evidence also presents a mixed picture regarding the costs: cases range from increased costs to cost-neutral outcomes, as well as higher upfront investments which resulted in lower lifecycle costs.

In Italy, the responses reveal a more nuanced outline of the economic implications of designing and constructing low-carbon buildings. Several respondents identified factors contributing to higher initial costs, including

¹⁴ See national sub-reports on cost-benefit reports including the case studies on the INDICATE LIFE website: [Resources — INDICATE](#).

¹⁵ see Table 1, [Deliverable 7.33: Luxembourg Sub-Report on Cost-Benefit Analysis](#); in three cases information on costs and GHG savings was not provided.

limited market readiness, limited availability of certified or recycled materials, and the need for additional professional training. Early-stage design decisions, iterative optimisation, and interdisciplinary coordination are also perceived as time-intensive and requiring specialised expertise.

Conversely, many respondents expect the current cost gap to shrink, or even disappear, as methodologies become standardised and supply chains adjust and mature. They stress that integrating low-carbon strategies early in the design process can deliver economic benefits over the building's life cycle, including lower operational and maintenance costs, improved design efficiency, and higher property value. Overall, the Italian data show a positive outlook, suggesting that these costs are generally transitional and context-dependent rather than inherent. Sustainable materials and optimised design are increasingly seen as an investment rather than a cost, and whole-life costing and life-cycle assessment is identified as key to reducing uncertainty and accelerating economically viable, low-carbon construction.

Voices from the national INDICATE LIFE teams:

“The design process does not entail higher costs, but choosing lower-impact materials can affect initial construction costs. Savings during the use phase (operation and maintenance) and a higher market value can offset these. In some projects, we have adopted prefabricated solutions and recyclable materials, reducing construction time and indirect costs” (IT, Voice i)

“Yes, today, on average, a low-carbon construction product costs more for the same functional performance. The main reasons are the choice of certified, recycled, and/or EPD-documented products, which often have a higher unit price than their conventional counterparts (also due to limited market uptake), as well as potential design modifications leading to reversible assembly solutions, prefabrication, or disassembly details, which can affect construction time and labour. However, these additional costs tend to be reduced if the project is optimised (design for low carbon) and the market broadens the supply of low-emission products, since they remain a predictable component. This is why I believe a WLC/LCA should always be accompanied by an LCC, which also helps to make an economic assessment of the project” (IT, voice m)

Reuse in general should allow us to reduce material costs, although for a first pilot project we are expecting to come out more or less neutral. Low carbon hollowcore planks might come at a cost premium. (LU, Case study 4)

“The extra costs it generates are very few, 3-5% more on the construction cost, but can be absorbed if there is an interdisciplinary design which integrates low carbon products” (IT, voice n)

By using less conventional materials, which are therefore less familiar to companies and construction companies still lack some knowledge, prices tend to increase, as the risk factor is calculated into the price. ... However, there is a significant benefit in terms of weight optimisation (by reducing the

number of materials, but also by calculating material requirements accurately, for example for foundations), and a reduction in both CO₂ emissions and costs has been observed. (LU, Case study 7)

In a joint study by the German Sustainable Building Council (DGNB) together with BPIE,¹⁶ LCA data from 28 DGNB-certified new residential buildings in Germany were analysed with respect to construction costs and lifecycle CO₂ emissions. **The study revealed no clear negative or positive correlation between low carbon and construction costs.** On average, low carbon buildings were marginally more expensive, costing about €220/m²GFA (gross floor area) more. However, **individual project analyses show that low carbon construction can often be less expensive than typical construction.** The data also indicate that buildings with lower operational CO₂ emissions do not necessarily incur higher construction costs; in many cases, lower-emission buildings also had lower construction costs.

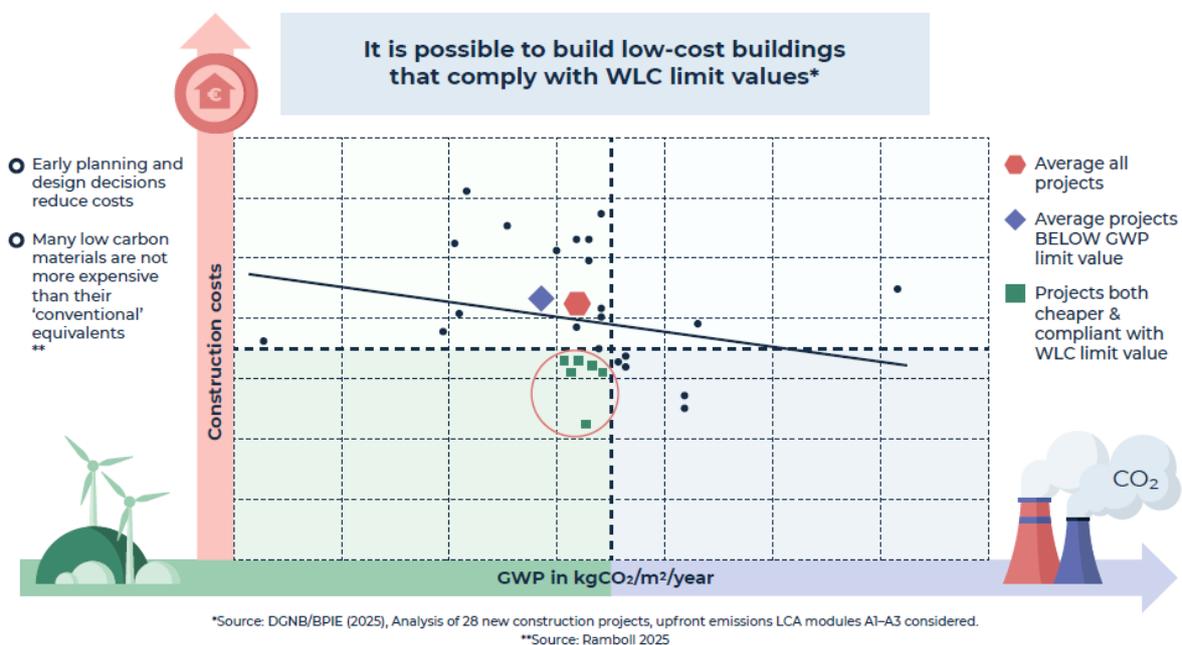


Figure 4: Cost implications of low carbon construction (DGNB/BPIE 2025)

If moving beyond upfront costs to consider the entire lifespan of the asset, operation and maintenance costs become increasingly relevant. Over a building's useful life, operating costs per square meter are often comparable to the initial construction costs. This study shows that more ambitious sustainability objectives can be achieved at the same cost.

Experience from frontrunner countries supports this conclusion. In Sweden, sustainability experts note that buildings with **30% lower emissions can already be delivered today at no additional cost**, suggesting that an early increase in

¹⁶ DGNB/BPIE 2025b: Life cycle-based assessment of buildings. [An analysis of 28 residential buildings with regard to climate impact and costs in Germany.](#)

ambition could enable a steeper and more effective decarbonisation pathway.¹⁷ Similarly, in Denmark, a cost impact analysis which has been performed in 2022 prior to the introduction of limit values, found that **the WLC thresholds expected to have an insignificant impact on construction costs**. The main additional costs identified related to consultancy and the conduct of life-cycle assessments, rather than to construction materials¹⁸.

Market evidence from the Nordic countries further indicates that low-carbon materials are not necessarily more expensive than their conventional counterparts. A 2025 Ramboll assessment finds that many low-carbon material alternatives are already cost-competitive.¹⁹ Looking ahead, a McKinsey survey from 2024 finds that demand for low-carbon materials is expected to grow strongly through 2030, as the public increasingly value lower emissions and clearer sustainability standards.²⁰ While green materials may continue to carry a modest price premium in the near term, these premiums are expected to remain manageable as supply scales up and technologies mature.

This positive outlook is reinforced by earlier findings of the Rocky Mountain Institute study from 2021²¹ from the US, which showed that substantial reductions in embodied carbon can be achieved at little to no additional upfront cost using materials and design strategies that are already available today.

¹⁷ Love Berger-Vieweg, Sustainability Specialist, Wingårdhs.
<https://www.krooktjader.se/hallbarhet/reduction-roadmap-sverige>

¹⁸ Nordic Sustainable Construction (2025): [Setting and Assessing Limit Values in Nordic Countries – Analysis of the different regulatory needs](#), p. 43

¹⁹ Ramboll (2025) [LCA White paper](#)

²⁰ McKinsey (2024): [Materials 'green' premia: Trends and outlook to 2030](#).

²¹ RMI 2021: [Reducing Embodied Carbon in Buildings. Low-Cost, High-Value Opportunities](#).

GHG savings, materials and design choices

Case studies confirm that WLC assessments and scenario comparisons help identifying the most effective GHG reduction opportunities available. Carbon reduction strategies include the use of alternative materials, such as timber and low-carbon concrete mixes, as well as reuse and lean construction approaches, for example avoiding basement floors or cellars where possible. Importantly, even in projects that are already conceived as low-carbon, such as timber-based structures, significant additional emission reductions can be achieved through design optimisation. While load-bearing structures represent the most effective lever, other elements such as the building envelope, windows, and fire safety components (including fire doors) also play a substantial role in determining overall life-cycle emissions.

Insights from Italian case studies

In Italy, despite the operational challenges mentioned above, such as limited expertise, tools and data, there is a broad consensus that making WLC assessments mandatory could catalyse a cultural and professional shift within the design community, fostering stronger interdisciplinary collaboration and promoting sustainability knowledge. Stakeholders generally agree that, when conducted robustly and integrated into the design process, WLC assessments can significantly reduce the environmental impact of buildings by informing early-stage design choices, guiding material selection, and promoting long-term thinking. Overall, the main strategies adopted by designers concern the use of local products, as described in *IT case study 3* (rice by-products) and in *IT case study 4* (hemp and recycled laminated steel), prefabricated solutions (*IT case study 3 and 11*), circular economy models that take into account the durability and the end of life process of materials (*IT case study 13*), and bioclimatic approaches for reducing energy demand (*IT case study 2*). While no exact numbers for GHG savings were given, the combination of different strategies concerning the material choices, particularly with regard to concrete mixtures, can allow to reduce the GHG emissions by 25-30% (*IT case study 13*).

Insights from Austrian case studies

In a similar vein, the main benefits reported in Austria was the ability to identify the main levers for emission reduction and to better understand carbon hotspots, which helps architects to focus on areas where carbon efficiencies are most needed and to make informed decisions in future projects. Projects that compared different design scenarios reported estimated GHG reductions of between 45% and 60%, although it should be noted that these figures are estimates provided by survey participants and are not based on a harmonised methodology.

For example, constructing a multi-storey residential building using a timber structure can reduce life-cycle GWP per square meter of gross floor area (GFA) by about half compared to conventional construction practices (AT case study 4). Even within projects already planned as timber construction, targeted optimisation was found to reduce fossil emissions by further 15 % compared to conventional timber solutions (AT case study 6). Another key insight is that the material composition of floor slabs and exterior walls due to their large surface area has a significant influence on a building's overall CO₂ balance (AT case study

3). One case study also illustrated that fire safety requirements can lead to higher carbon footprint of timber-frame buildings. (AT case study 3).

Overall, WLC assessment enabled many Austrian projects to improve building design, have a more targeted material selection and reuse, improved material efficiency, fossil fuels free heating systems, and choosing renovation over new build.

Insights from Luxembourg case studies

In Luxembourg, seven of the nine cases reported reductions in GHG emission as a direct result of the WLC assessment (see Luxembourg [report](#)). Several projects were able to reduce the lifecycle carbon footprint by cutting unnecessary material use and design complexity. Common measures included eliminating basements where feasible and minimising finishes, avoiding high-carbon elements without compromising functionality and often delivering both carbon and cost benefits.

Project teams increasingly shifted toward low carbon materials and circular solutions. Conventional concrete structures were replaced by timber systems or low-carbon mixes, including the reuse of components, e.g., steel beams or façade elements, from donor buildings. This shift demonstrates the strong potential for circularity and material substitution to significantly reduce embodied carbon.

Performance was further improved through early-stage optimisation and monitoring. Variant testing enabled teams to compare design options and steer projects towards lower-carbon solutions, avoiding carbon lock-ins. The inclusion of carbon performance requirements in tender documents, alongside verification through EPDs, helped ensure that design goals were carried through to implementation.

For example, case 4 (an office and cultural building) used WLC to drive reuse strategies and low-carbon material choices, while case 5 optimised structural design and material selection, achieving up to 64% carbon savings. These examples confirm WLC's role in enabling effective climate mitigation and innovation.

Insights from Croatian case studies

In Croatia, case studies similarly showed that the selection of structural system and construction materials has the highest impact on the WLC result, with concrete, gypsum and steel having the highest contribution. The assessments also highlighted the significant impact of building envelope components, windows, and internal elements such as fire safety doors. When developing optimisation scenarios, both the selection of materials and the assumed service life of each building element were found to be critical in determining overall WLC performance.

In the previously mentioned DGNB/BPIE study analysing 28 certified buildings in Germany, it clearly showed that the material qualities of the support structure represent the greatest lever for reducing embodied emissions.²²

²² BPIE/DGNB 2025b: Life cycle-based assessment of buildings. [An analysis of 28 residential buildings with regard to climate impact and costs in Germany.](#)

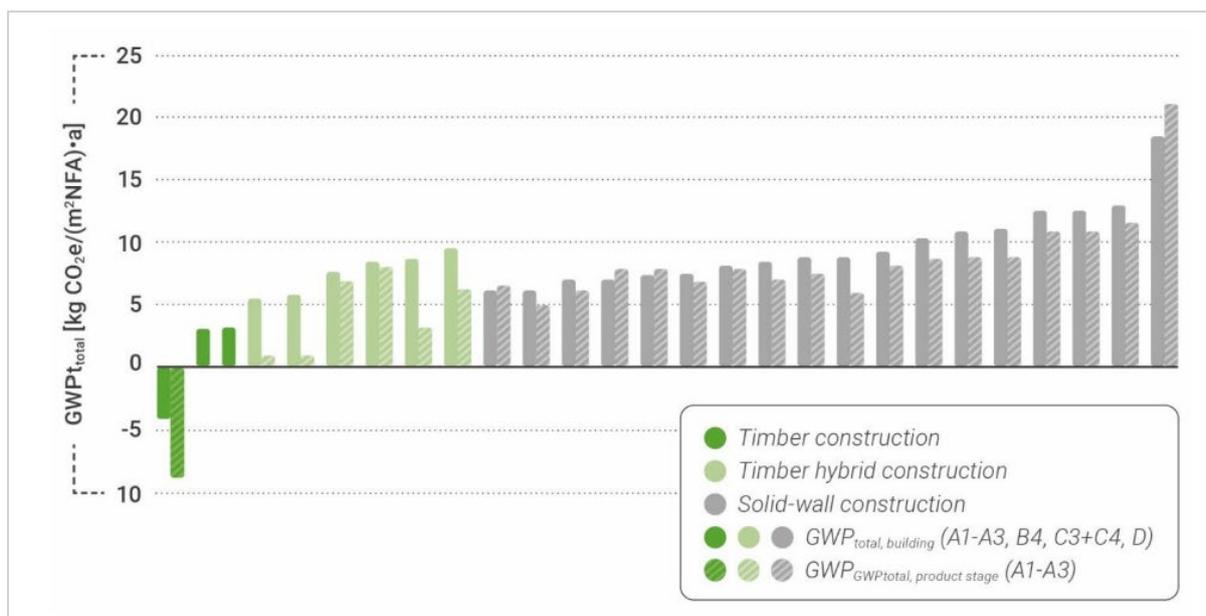


Figure 5: CO₂ emissions over the life cycle of a building and for the product stage of a building depending on the construction method of the structural framework (DGNB/BPIE 2025b²³)

Voices from the national INDICATE LIFE teams:

“The timing of emissions is crucial for achieving climate goals. In new construction, upfront emissions play a particularly central role:

Assessments clearly show that significantly more emissions are generated during the production and construction of buildings than during their later operational phase. This is partly due to the high energy efficiency of modern buildings and the ongoing decarbonisation of energy sources. On the other hand, emissions from the production and construction are not only increasing in relative terms compared to the use and operation of buildings, but also continuing to rise in absolute terms.

Low operational emissions cannot compensate for high emissions from the production and construction — they can at best obscure them.

If the goal is climate neutrality by 2040, there is simply not enough time left to offset a steep emissions’ increase from production and construction with a flat curve in operation over the building’s life cycle.

To make this visible in life cycle assessments, it is essential to evaluate each phase individually and define corresponding threshold values.” (AT, case study 3)

²³ BPIE/DGNB 2025b: Life cycle-based assessment of buildings. [An analysis of 28 residential buildings with regard to climate impact and costs in Germany.](#)

Renovation instead of new construction resulted in approximately 60% lower material-related emissions (around 1,330 tCO₂e) while remaining cost-neutral compared to new construction. (AT, case study 8)

At the material level, the LCA helped to highlight differences in construction methods. The analysis began with the structural framework. Initially, a timber construction was chosen, but due to stringent fire safety requirements and cost-saving considerations, it was replaced by a reinforced concrete skeleton structure. Nevertheless, the LCA allows for demonstrating the impact of mass reductions (e.g., through hollow core slabs or higher concrete grades), recycled concrete, and—where feasible—CO₂-reduced concrete. (AT, case study 12)

“Life cycle assessments contributed significantly to reducing CO₂ emissions on this project and helped to make the right decisions regarding construction methods.” (LU, Case study 7)

“Cutting-edge solutions were adopted for constructing the building, including the use of low-carbon foundations and industrial flooring, Class III/B and III/A cement, and recycled aggregates. Using these carefully selected materials has allowed for a 30% and 25% reduction, respectively, in CO₂ emissions compared to traditional mixtures.” (IT, Case study 13)

Other benefits: industry innovation, real estate value, local economies and supply chains

Reducing the carbon footprint of buildings is not just about climate change mitigation. Low-carbon buildings deliver a wide range of additional benefits, including regulatory future-proofing and better management of transition risks, driving innovation and demand for low-carbon solutions, local job creation, and improved carbon literacy across the value chain. They can also enhance occupant health and well-being through the use of healthier, more sustainable materials. Importantly, evidence increasingly shows that low-carbon buildings can be delivered at costs comparable to conventional construction, with any marginal upfront costs often recouped through lower operational and maintenance expenses over time. This makes low-carbon construction directly relevant to the objective of delivering high-quality and affordable housing. Design decisions made at the earliest stages of a project have a decisive impact on a building's long-term value, performance, and return on investment, meaning that there is a need for a whole-life cost and value perspective. While the evidence base supporting these conclusions is growing, accelerating the transformation of the market will require more data, wider adoption of life-cycle assessments, and a larger pool of robust, comparable case studies.

Innovation and competitiveness

A relevant argument in support of an early and ambitious introduction of WLC regulation is its potential to boost industry competitiveness and create lead markets. The so-called *Porter Hypothesis* suggests that properly designed environmental regulation can stimulate process innovation, enable domestic industries to become lead-market providers, and ultimately deliver economic benefits²⁴. On a project level, the case studies analysed in the report provide some early evidence, that employing low-embodied carbon solutions does not necessarily result in any additional costs, and that costs can even be reduced when applied to the design phase.

On the level of the construction value chain, this dynamic has not yet been comprehensively assessed. Nevertheless, evidence from early adopters and market signals point in a consistent direction. For example, Concular, an online marketplace for reused construction products, notes that demand for secondary building materials comes predominantly from France and Denmark due to WLC regulations already in place²⁵. The regulations enable circular construction practices, which in turn reinforce low carbon solutions and compliance with the WLC limit values.

The Nordic Sustainable Construction, which supports closer alignment of WLC policies among the Nordic countries, has likewise established working groups of low-carbon and circular construction practices as a priority area for co-operation

²⁴ Jänicke, M; Jacob, K. (2004): [Lead Markets for Environmental Innovations: A new Role for the Nation State](#). In: Global Environmental Politics: 4,1.

²⁵ Handelsblatt 2025: "[CO₂-Grenzwerte sind keine Bedrohung, sondern eine historische Chance](#)" (EN: *CO₂ limits are not a threat, but a historic opportunity*); Concular Website. <https://concular.de/>

and harmonisation.²⁶ Beyond prioritising the reuse of materials, components and systems, the Declaration of Nordic Ministers for Construction and Housing also recognises the importance of preserving the existing building stock by prioritisation of retrofit and refurbishment over new build. This trend is increasingly supported by data collection and a growing body of case studies on adaptive reuse, heritage preservation, and urban regeneration²⁷.

Further evidence is provided by the qualitative cost–benefit scenario assessment conducted by the Luxembourg INDICATE LIFE team. The analysis indicates that a stringent and well-designed introduction of WLC regulation can enhance competitiveness. In particular, such regulation contributes to the achievement of several Sustainable Development Goals, including innovation, material reuse, and material efficiency²⁸ (see Figure 4, Luxembourg cost–benefit report).

Real estate value increase

From the Italian survey, most respondents identified several indirect benefits beyond immediate environmental outcomes (23 respondents, 5 remain uncertain about additional advantages). Over half of the respondents highlight an increase in the market and real estate value of buildings, particularly when WLC/LCA assessments are integrated into sustainability rating systems (e.g. BREEAM, LEED, DGNB) or connected to Environmental, Social and Governance (ESG) frameworks. Respondents also emphasise the potential for privileged access to financing instruments, such as green bonds or favourable loan conditions, as well as the reputational gains for clients and designers who adopt transparent sustainability practices.

In Austria, the main benefit of WLC assessment is that it makes environmental impacts and sustainability as measurable and tangible as costs - expressed in concrete numerical values. Investors and developers also benefit from the added value of the project through WLC assessments, as the utility value of the building increases with the right investment decision. This is also positively acknowledged by certification systems, such as DGNB.

Risk mitigation and management

WLC serves as an essential management tool to ensure compliance with the decarbonisation pathway as acknowledged by the Austrian stakeholders. Furthermore, comprehensive assessments using standardised methods allow for the establishment of benchmarks in terms of climate neutrality and ensure transparency already from the early planning phases. The importance of providing robust and transparent evidence of the carbon footprint of buildings cannot be understated. To date, risk factors resulting from climate change and the transition to a low-carbon economy are not fully integrated into mainstream real estate risk assessment and management frameworks. Some of the reasons include the uncertainty around the decarbonisation trajectory of the sector, including the effective low carbon strategies; and the fact that industry-led low carbon transition and climate roadmaps are not considered as reliable reference

²⁶ Nordic Co-operation 2023: [Nordic commitment to low carbon construction and circular principles in the construction sector – common effort and common gain](#).

²⁷ [Making Better Use of Existing m² | Nordic Sustainable Construction](#)

²⁸ Luxembourg [Sub-Report on Cost-Benefit Analysis](#). Deliverable 7.33; see Figure 4.

scenarios by asset and portfolio managers due to data gaps, inconsistent metrics and protocols.

Local economies, supply-chain accountability

The Italian survey highlights the benefits related to carbon literacy, improved supply-chain accountability and local economic growth. In particular, respondents pointed to the engagement of small and medium-sized enterprises in low-carbon construction processes, such as prefabricated solutions, as a key opportunity. The qualitative cost-benefit analysis, carried out in Luxembourg, also identified positive impacts on industry development, innovation, and infrastructure. Beyond that, the Luxembourg analysis mentioned health and wellbeing due to the use of more sustainable materials (see Luxembourg report, Figure 4).



3. Discussion and recommendations

For the first time, the EPBD introduces EU-wide requirements addressing the life-cycle global warming potential (GWP) of buildings. While this marks a significant step forward, concerns remain that WLC requirements could increase costs and complexity in a sector already under economic pressure. In this context, a better understanding of the real costs, benefits, and practical implications of WLC assessments is essential to ensure their effective and proportionate implementation and to support the delivery of low-carbon buildings at scale. At the same time, these policies are still at a very early stage, with many measures only now coming into force, leaving limited scope for robust evaluation of their effectiveness or their impact on industry practices. Nevertheless, early experiences already offer valuable insights that can inform implementation and future policy design.

Learnings:

Below is a summary of learnings, drawing on evidence from the INDICATE LIFE countries and complemented by insights from frontrunner markets and the literature:

- In the absence of mandatory WLC regulation, building LCAs are primarily driven by voluntary market initiatives. These include requirements under building certification schemes, corporate sustainability targets and reporting, green finance criteria, and participation in research or pilot projects.
- Where support policies, guidance and capacity-building measures are lacking, the level of expertise varies widely and progress often depends on a small number of highly motivated professionals rather than being systematically embedded across the sector.
- The cost of conducting a building LCA is reported to range between 0.1% and 2% of total project costs, in line with experience from Denmark. These costs are expected to decrease over time as expertise grows, workflows become more routine, and enabling tools such as BIM and standardised fee structures are more widely used. Key challenges remain the integration of LCA into existing planning processes, the need for closer collaboration across disciplines, and the availability and robustness of environmental data. At the same time, project teams consistently report significant benefits, particularly an increase in knowledge and decision-making capacity, which is seen as highly valuable.
- Regarding construction costs, the evidence points to a nuanced picture. While WLC-optimised buildings can involve additional costs in some cases, these are often lower than anticipated. Several projects demonstrate that low-carbon buildings can be delivered at equal or even lower cost, especially when life-cycle carbon considerations are integrated early in the design process. This suggests that compliance with current and future carbon limit values is already achievable today without systematic cost penalties.
- WLC assessments identify the carbon hotspots and the main levers for GHG reduction, notably load-bearing structures, building envelopes,

windows, and fire-related components, as well as material choices, reuse strategies and lean design approaches.

- Reducing the carbon footprint of buildings delivers wide-ranging benefits beyond climate mitigation, including regulatory future-proofing, innovation, job creation, improved health and well-being, and better management of transition risks. Low carbon buildings are increasingly being achievable at costs comparable to conventional construction, therefore they can meaningfully contribute to delivering high-quality and affordable housing, especially from a whole-life cost and value perspective

Recommendations:

- **Mainstreaming carbon assessment:** with a clear and ambitious timeline set by the EPBD for disclosure requirements and the introduction of limit values, it is important that governments and professional bodies invest in mainstreaming building WLC assessment early on. This can include linking tax or financial incentives to WLC, promoting green public procurement, and facilitating knowledge sharing by experienced market players. Examples include training courses for suppliers, competence building within professional networks, and solution-oriented exchanges through associations. Life cycle assessment should also be embedded in continuing professional education offered by professional organisations and other training institutions.
- **Stakeholder engagement:** early and ongoing consultation with market participants is crucial. Frontrunner countries show that exchanges such as roundtables help build industry support and capacity. This engagement is essential for jointly preparing national roadmaps in line with the EPBD timeline (deadline: early 2027).
- **EPD availability and product transparency:** construction product manufacturers should invest in providing EPDs, especially for innovative products not yet covered by CPR standards. The benefits of product LCAs, such as marketing of green credentials and meeting customer demand, should be clearly communicated within the industry.
- **Reducing EPD costs:** associations and EPD programme operators should develop guidelines and standardised templates for collecting company foreground data and life cycle inventory data. This would support smaller companies in providing the necessary information and ensures that product LCA providers have a reliable data base. Industry association tools for product LCAs can further reduce costs and scale the production of EPDs.
- **Digitalisation and seamless information flow:** the mandatory application of Digital Product Passports (DPP) will make the data related to construction products easily accessible for all construction sector stakeholders. Connecting product-level data with a harmonised Digital Building Logbook system will integrate with building-level information, enabling more efficient and accurate WLC assessments.
- **Transparency in building WLC assessment consulting services:** professional associations should define standard services in order to bring

transparency to the scope of services covered by a building life cycle assessment, thereby enabling customers to compare the various cost items.

- **Research and knowledge sharing:** further research is needed to understand the factors contributing to cost-effective, WLC-optimised construction. Exchange platforms, mutual learning opportunities, and feedback mechanisms should be established to support innovation and wider adoption of best practices.
- **Systematic collection of evidence:** even though the benefits of WLC assessment and regulation are increasingly recognised, current evidence remains largely anecdotal. Long-term, systematic data collection on market impacts, costs, demand, and resident well-being is necessary. This should include national research initiatives and comprehensive European-level projects.

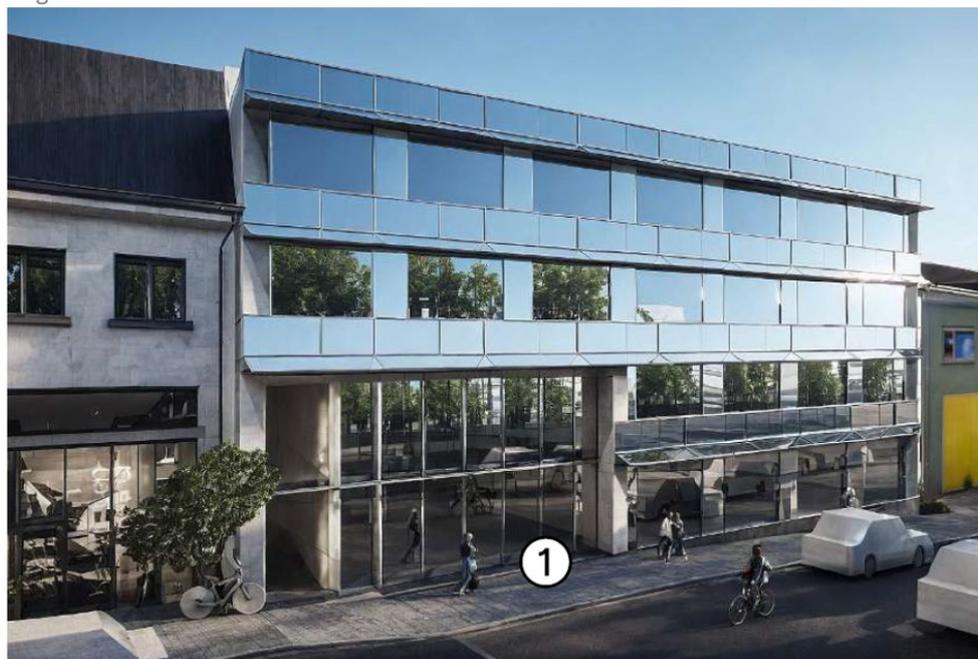


4. Annex: Highlights from INDICATE LIFE case studies on WLC assessments

The national INDICATE LIFE teams in Croatia, Luxembourg, Italy and Austria have compiled a total 41 (13 IT, 9 LUX, 13 AT, 6 HR) case studies for their national cost-benefit reports. Based on a common template, the case studies provide insights into the motivation for conducting a WLC assessment, the impact on GHG reductions, the selection of designs and materials, and other benefits and challenges. Below is a selection of these case studies, focusing on the key findings. The full versions, which are included in the national sub reports on cost-benefit, can be accessed at the INDICATE project website²⁹.

Not all case studies included all the information. Therefore, the selection criteria were 1) availability of quantified GHG savings, e.g. if the WLC assessment included a comparison between different options and with a view of optimizing design; 2) insights into project cost increases or reductions due to the changes in the design; and / or 3) other interesting insights gained from conducting a WLC assessment.

BAMD – New office 3000m2 building and dance center in Luxembourg (LUX, case study 4)



Commissioned by the Client ABP. The project is a pilot project for Luxembourg's Low Carbon Roadmap. The Client is active in developing their own understanding of the carbon topic and providing the first built examples on where this can be integrated. The Design Phase is approved as of December 2025.

²⁹ <https://www.indicatedata.com/resources>

Emission reduction & material choices	<ul style="list-style-type: none"> • Preliminary LCA has helped to choose slab option (reclaimed steel plus low carbon hollowcore planks). • Reuse has been acknowledged as a key strategy. • Steel reuse is estimated to save 35kgCO₂e/m². • Low carbon version of the hollowcore planks saves 15-25kgCO₂e/m². • Reuse of mechanical and engineering plant (MEP) items saves 40kgCO₂/m².
Costs	<ul style="list-style-type: none"> • Reuse in general should allow us to reduce material costs, although for a first pilot project we are expecting to come out more or less neutral. • Low carbon hollowcore planks might come at a cost premium
Other learnings	<ul style="list-style-type: none"> • Sometimes conflicts between circularity and carbon arise (i.e. removable concrete precast basement walls vs. lean low-carbon walls today).

Two-story school building (LUX, case study 7)	
<p>The case study is a two-storey school building, commissioned by a local authority. It is constructed from wood with bio-based insulation. Particular attention has been paid to using healthy materials, given that the building is intended for young children. It consists of traditional classrooms, social and educational facilities, communal areas for interaction, and additional facilities such as toilets and technical rooms.</p>	
Emission reduction & material choices	<ul style="list-style-type: none"> • 97,30 To CO₂e were saved compared to a traditional construction. • By not building a basement, a further 65% was gained. • Optimising exterior walls has resulted in a reduction of 7 kg CO₂/m². • Optimising interior partitions has resulted in a reduction of 16 kg CO₂/m². • Optimising floors and slabs has resulted in a reduction of 20 kg CO₂/m².
Costs	<ul style="list-style-type: none"> • An increase of around 25-30% was observed on this project. • However, there is a significant benefit in terms of weight optimisation (by reducing the number of materials, but also by calculating material requirements accurately, for example for foundations), and a reduction in both CO₂ emissions and costs has been observed.

Other learnings	<ul style="list-style-type: none"> • Designing a project using WLC calculations provides a better understanding of the different materials: we focus more on the manufacturing process, but above all on the EOL process. • Human well-being was also the guiding principle throughout the project • The client has been made aware of the issue and, thanks to WLCs, can demonstrate the merits of sustainable construction.
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Tiny house prototype (LUX, case study 5)	
	
<p>The tiny house prototype for the Ministry of Tourism is to be used as a standard design by communes who want to provide tourism housing. From preliminary design to implementation planning in just six months (2023).</p>	
Emission reduction & material choices	<ul style="list-style-type: none"> • LCA was only done for the structure, with a focus on optimisation. • 37% of carbon reductions were achieved through improved design. • 64% savings would be achieved if in addition low carbon products (XCarb, lowest carbon CLT) would be chosen.
Costs	<ul style="list-style-type: none"> • We did not carry out a side by side cost and carbon assessment. But in discussion, none of the solutions adopted were considered to be impacting the budget negatively.
Other learnings	<ul style="list-style-type: none"> • The missed opportunity for this project is not to have been able to share more of the collaboration

approach and solutions with a wider audience. We don't learn enough from each other by carrying out these assessments which slows down the process

Mixed-use building in Belval (LUX, case study 9)



This mixed-use building includes offices and retail on the ground floor, one office block and residential blocks. Underground car park is planned. The project is located in Belval (Luxembourg). Total gross floor area is around 30.000 sqm. It will be delivered in 2026. The developer BPI Real Estate commissions the WLC of this building to be certified with the voluntary “Low Carbon Building Initiative” label.

Emission reduction & material choices

- Compared to a conventional building with standard construction methods, the project (which is designed with a predominantly timber structure) achieves an estimated reduction of around 30% in embodied carbon.
- In addition, the optimization measures introduced during design, such as reducing the concrete volume of the piles and selecting materials with a lower carbon footprint, are estimated to have generated a further 5–10% reduction compared to the project's initial baseline.

Costs

- The project incurred an acceptable cost increase, but low-carbon materials were selected based on a cost/carbon study conducted in parallel with the WLC prior to execution by the project manager.

<p>Other learnings</p>	<ul style="list-style-type: none"> • The WLC assessment brought several additional benefits. It increased awareness among the project stakeholders about embodied carbon and highlighted the importance of considering it right from the early design stage. • The process also generated valuable lessons for future projects, in terms of data collection, supplier engagement and design decisions. • Finally, it helped foster more constructive dialogue within the team and with manufacturers, strengthening a culture of low-carbon construction.
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European Stability Mechanism (ESM) building in Rue Alcide de Gasperi, Luxembourg (LUX, case study 3)



New construction project for an office building in Kirchberg. This is a complex comprising three separate buildings. The buildings are planned to be constructed from concrete and steel and will feature a high proportion of glazed surfaces. Owner: Administration des bâtiments publics. Architect: E2MN & Robert Neun

<p>Emission reduction & material choices</p>	<ul style="list-style-type: none"> • In terms of materials, WLC has not changed the materials themselves. However, the quantities of concrete used have been reviewed. Thus, the topics of conventional concrete, recycled concrete and low-carbon concrete were discussed very early on in the planning process. • The order of magnitude of possible savings when using and integrating low-carbon concrete would be greater than 1,000,000 kg CO₂
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	<p>equivalent (compared to a basic variant for which the quality of the concrete is 'standard' and is based on environmental data from the years 2020-2022).</p> <ul style="list-style-type: none"> • The subject of carbon neutrality for the operational side was also discussed: however, the large proportion of glazed surface area (>50%) leads to greater energy loss in winter (more heating) but, above all, drastically increases cooling requirements. It quickly became clear that even if the roof surface were entirely covered with PV modules, it would not be able to cover the energy requirements and thus become carbon neutral.
Costs	<ul style="list-style-type: none"> • The various possibilities for improvement (less glazing, better sun protection, geothermal heat pumps instead of just air/water heat pumps, etc.) have often been rejected because of cost. Even though the solutions are more economical and environmentally friendly in the long term, the short-term financial aspect has been prioritised (district heating, air/water heat pumps, etc.).
Other learnings	<ul style="list-style-type: none"> • A WLC enables the local authority to communicate and explain its impacts. • Specifically, for the present project, it was interesting to explain the limitations of the chosen architecture (large glazing façade). The WLC made it possible to nuance the arguments that had been put forward and to scientifically prove the qualities and limitations of the planning.

**Multi-functional redevelopment Ex SAIRO area, Imperia, Italy
(IT, case study 11)**



The project concerns the redevelopment and repurposing of the Ex SAIRO area in Imperia, a historic industrial complex dating back to the early 1900s and protected by the Superintendency. The intervention is funded through the PNRR (PINQUA – Mission 5, Component 2). It involves transforming the site into a mixed-use urban hub: recreational and sports areas, coworking and social service spaces, temporary housing for students and athletes, and subsidised housing.

GPA S.r.l. Developed the architectural, structural, and systems design with an integrated approach that combines preservation, technological innovation, and urban regeneration. The executive project was approved in 2024, and construction is currently underway, with an expected completion date of 2026.

<p>Emission reduction & material choices</p>	<ul style="list-style-type: none"> • The assessment led to prioritising materials with recycled content and that are easily recyclable, and incorporating prefabricated elements to reduce construction time and site impacts
<p>Costs</p>	<ul style="list-style-type: none"> • The solutions adopted increased construction costs, primarily due to the use of materials with a lower environmental impact. However, economic benefits are expected in the medium to long term thanks to reduced maintenance costs and greater operational efficiency.
<p>Other learnings</p>	<ul style="list-style-type: none"> • The WLC/LCA assessment represents a fundamental decision-support tool in the design process. It enables transparent communication to the client about the

environmental benefits of the choices made, thereby enhancing project quality and contributing to the designers competitiveness in sustainability-focused tenders and calls.

Torri Risorsa, Milan, Italy (IT, case study 3)



The Torri Risorsa project is located in the Moncucco-Barona district of Milan. It aims to regenerate (both urban and social) the residential public buildings owned by Aler Milano at Via Franco Russoli no. 14-16-18-20.

The project was driven by the tenants, who collaborated with the designers to translate their needs into socio-urban practices. The operation is divided into two phases: energy refurbishment, through the use of technologies with a very low environmental impact, which improve the thermal performances of the façade, and the definition of shared spaces, such as green areas and community kitchen gardens on flat roofs, promoting socialisation and sharing.

Emission reduction & material choices

- Natural materials derived from rice processing waste, such as husks, straw, and natural lime, as well as dry solutions have been prioritised for the energy refurbishment, and combined with timber, to build structural elements.
- Most vertical surfaces have been prefabricated off-site.

Costs

- It was the first WLC assessment in the context of the INDCIATE LIFE project; costs have not been assessed.

Other learnings

- The project has transformed 3,301.56 m² of impermeable surfaces into hanging and edible gardens, actively involving 400 tenants,

	<p>associations, private entities, universities and a social cooperative that will manage their maintenance. The roof gardens are divided into different areas according to their function, including kitchen gardens, orchards, hedges, lawns, and relaxing zones with various plant finishes.</p>
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Tirana24, Milan, Italy (IT, case study 7)



Residential building in Milan, Piazza Tirana 24, developed over nine above-ground floors and one basement level, with a total floor area of approximately 2,700 sqm and 36 apartments. The structure is reinforced concrete, featuring load-bearing columns and slabs; the envelope consists of hollow blocks with an external EPS insulation system. Windows are made of PVC with double glazing; internal partitions are constructed using dry methods. In the basement designated for garages, the walls are made of concrete blocks. The project also includes green areas and external landscaping.

Emission reduction & material choices	<ul style="list-style-type: none"> • Not quantified
Costs	<ul style="list-style-type: none"> • Not quantified
Other learnings	<ul style="list-style-type: none"> • The objective is to also create a data repository that enables the designers to guide design choices towards more virtuous solutions, or to provide clients with informed consultancy that also takes into account economic and social sustainability aspects.

Zavrtnica residential building (HR, case study 3)



The Zavrtnica project is a complex of 4 residential buildings, only one of which is the subject of this research. The residential building in its designed state consists of 23 floors with three underground floors that form a garage. It has a total of 126 apartments. The ground floor consists of a lobby with business premises, while the next floor is intended for MEP installations. The investor is private. The building is surrounded by a balcony on each floor. The designer is 3LHD, it was their motivation to conduct a building LCA.

Emission reduction & material choices

- In a scenario where we eliminated an entire basement floor, the value would drop from 830 kg CO₂eq/m² to 740 kg CO₂eq/m². It is necessary to consider that the basement floors in the design solution have a footprint 4 times larger than that of the building itself, so it is possible that in a more proportionate solution the difference would not necessarily be so large.

Costs

- The investment cost were not taken into account since the life cycle assessment was rough estimation and was self-initiated.

Other learnings

- By eliminating one or two underground floors in additional scenarios, the learning was to make the 'big ticket' moves that make the biggest difference.
- It is necessary to say that without a regulatory framework it is not possible to carry out life cycle cost analyses in an official way or to deem them valuable. The investor must be aware of the importance of the analysis, and this can be streamlined only when introduced as legal obligation.

Timber construction Vis-à-Vis, Austria (AT, case study 3)



Image: Vis-à-Vis in March 2025, Photo: Hertha Hurnaus

Participatory Realization of a Climate-Neutral Demonstration Building – “City of the Future” Research Project at the Intersection of Climate Neutrality, Affordability, and Multi-Story Timber Housing

In the urban development area Village im Dritten, the timber construction project Vis-à-Vis is being developed as a scalable, climate-neutral pilot project through a participatory process. As an exemplary model in the planning and construction sector, it aims to demonstrate how climate protection measures can be harmonized with affordable multi-story housing.

Emission reduction & material choices

- comparing 4 structural variants (Timber-hybrid construction (planned), Reinforced concrete skeleton, reinforced concrete solid construction, Best Case (maximizing CO₂ storage potential))
- Six of the eight above-ground floors of Vis-à-Vis (GK5 with escape level above 22 meters) were constructed using structural timber construction.
- Due to redesigns based on structural, economic, and fire safety considerations, the CO₂e storage capacity of Vis-à-Vis was reduced. However, compared to a conventional reinforced concrete building, approximately 45% of CO₂e emissions were saved.

Costs	<ul style="list-style-type: none"> • The additional cost of implementing "Vis-à-Vis" with a timber-frame exterior wall is approximately 10% higher compared to a conventional reinforced concrete building of the same scale.
Other learnings	<ul style="list-style-type: none"> • Another central insight was that the material composition of the floor slabs and exterior walls, due to their large surface area, has a significant impact on the building's overall CO₂ balance. • Due to firesafety the constructed building had a higher carbon footprint than the planned (LCA conducted for both) • A key milestone was the fire safety testing of the timber-frame exterior wall element through a fire experiment. This test enables the use of this structural wall element in future projects.

ZWEI-NULL-EINS, Austria (AT, case study 4)



The construction project is a privately financed residential building with eight floors, 49 apartments, and a ground floor area with commercial spaces (likely office use) and storage areas located at Ottakringer Straße 201. The entire ground floor is expected to be constructed in reinforced concrete. The seven floors above are planned as timber construction, using cross-laminated timber (CLT) ceilings and load-bearing CLT interior walls, as well as prefabricated timber frame exterior walls including windows and finished timber façade. The balcony and loggia slabs will be made of precast concrete elements. A Klimaaktiv Gold certification (Austrian certification) is being pursued.

Currently (as of December 2025), there are existing structures on the construction site, and the exact demolition date is still undecided.

On the ground floor, a façade made of reused bricks from the hall to be demolished is planned, and on the seven floors above, a ventilated timber façade.

Emission reduction & material choices	<ul style="list-style-type: none"> In conventional construction practices in Austria, approximately 500 kg CO₂e per square meter of gross floor area (GFA) are emitted during the construction of a multi-storey residential building. By constructing the building as a structural timber construction, this value can demonstrably be reduced by around 50%, meaning that approximately 1,000 tonnes of CO₂e are saved during the production and construction of the building.
Costs	<ul style="list-style-type: none"> No significant changes to the project budget are currently known.
Other learnings	<ul style="list-style-type: none"> For buildings, considering the entire life cycle is essential. Especially in re-use, repurposing, or transformation of existing structures, there is significant potential to reduce emissions.

Bad Vöslau Kammgarnhof, Austria (AT, case study 6)	
<p>A new neighborhood with various residential buildings is being developed in Bad Vöslau. Two of the buildings are four-story timber constructions and are part of the research project “3x0=0”, which aims to achieve climate neutrality in all life cycle phases A, B, and C.</p> <p>One building is situated above a continuous underground garage and is designed as a structural timber construction starting from the ceiling above the garage. The second building is planned without a basement and will be constructed on stilts, thereby minimizing the proportion of components in contact with the ground and maximizing the use of timber construction.</p>	
Emission reduction & material choices	<ul style="list-style-type: none"> Since the buildings were already planned as timber constructions, the potential for further CO₂ reduction was not as significant as with other construction methods. However, through targeted optimizations, it was possible to reduce fossil emissions by approximately 15% compared to conventional timber construction.
Costs	<ul style="list-style-type: none"> No cost estimates available
Other learnings	<ul style="list-style-type: none"> From our perspective, the greatest advantage lies in using the assessment continuously throughout the planning process as a tool for optimization. The insights gained can benefit both clients and architects.

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