ECTP Built Environment Decarbonisation Committee
ECTP Materials & Sustainability Committee

Joint Position Paper on Biobased materials:
Biobased materials, overview and projected progress towards 2040

This document was developed by the ECTP Built Environment Decarbonisation Committee and the ECTP Materials & Sustainability Committee.

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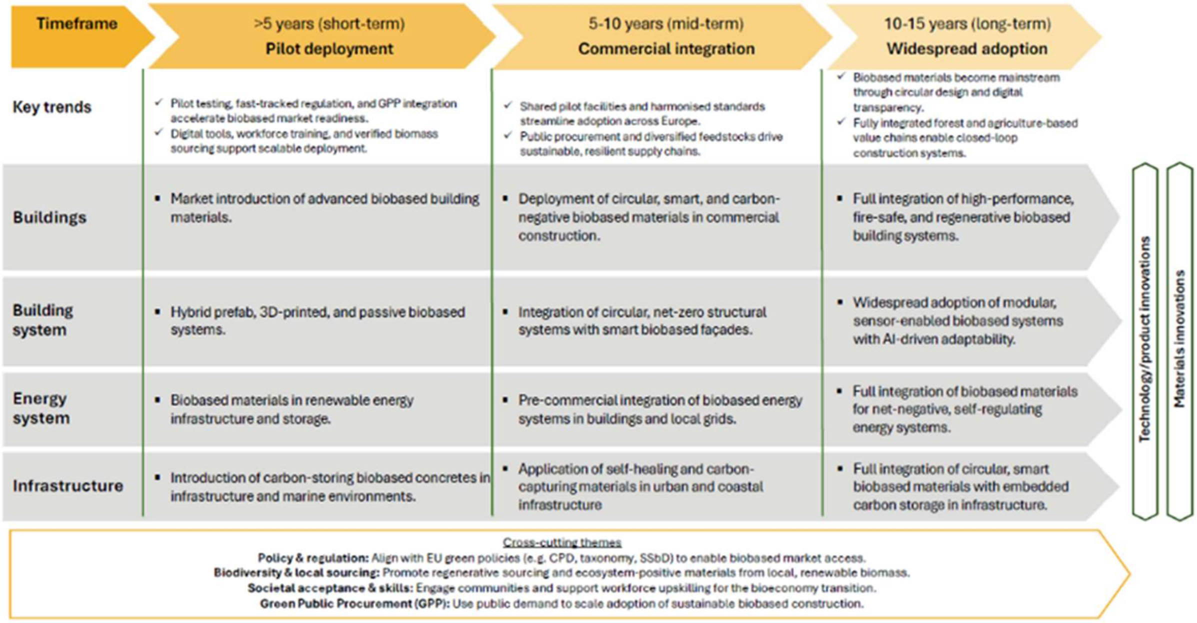
List of acronyms

BED Built Environment Decarbonisation (ECTP committee)
BIM Building Information Modelling
BIPV Building-integrated photovoltaics
CCS Carbon Capture and Storage
CLT Cross-laminated timber
CNEP Connecting Nature Enterprise Platform
CPP Circular Public Procurement
CPR Construction Products Regulation
CPD Continuing Professional Development
DPP Digital Product Passport
EAD European Assessment Document
ECTP European Construction and sustainable built environment Technology Platform
EED Energy Efficiency Directive
EIB European Investment Bank
EOTA European Organisation for Technical Assessment
EPBD Energy Performance of Buildings Directive
ESG Environmental, Social, and Governance
GHG Greenhouse Gas
HVAC Heating, Ventilation and Air conditioning
IAM-I Innovative Advanced Materials Initiative
LCA Life Cycle Assessment
M&S Materials & Sustainability (ECTP committee)
NbS Nature-based Solutions
NEB New European Bauhaus
NEBA New European Bauhaus Academy
NRL Nature Restoration Law
OITB Open Innovation Test Beds
SME Small and Medium-sized Enterprises
SSbD Safe and Sustainable by Design
TNFD Taskforce on Nature-related Financial Disclosures
TRL Technology Readiness Level
VOC Volatile Organic Compounds
WLC-GWP Whole life cycle -Global warming potential

Executive summary

This white paper provides an overview of the current status of biobased construction in Europe highlighting the importance of biobased materials in the construction sector and outlines a strategic roadmap for their broader adoption. The paper supports the definition of research, development and innovation strategies for biobased materials in the construction industry from a short term (coming 5 years), mid-term (5 - 10 years) and long-term (10-15 years) perspective. It highlights the need for upscaling, investments in skills and role of public procurement as an accelerator, in order to reach widespread adoption and is intended for all stakeholders involved in sustainable construction and construction materials.



Compiled by ECTP members from eight (8) countries, including insights and information from European material scientists, technology experts and EU professionals from both industry, research institutes and academia. The white paper is co-led by ECTP members TNO (Netherlands), StamTech (Italy) and VTT Technical Research Centre of Finland (Finland). It summarises input gathered from the expert meetings held in spring 2025, providing an overview of the current status of biobased materials in construction, identifying existing challenges, proposing solutions and outlining a strategic roadmap towards 2040 for future research on novel biobased materials across different application areas.

Biobased materials are increasingly recognised as essential in the construction sector due to their environmental, economic, and performance advantages. Use of biobased materials can significantly contribute to climate change mitigation through low-carbon, biobased and bioinspired solutions that reduce the reliance on fossil-based materials and processes. They enhance competitiveness by valorising local feedstocks, reducing dependence on critical raw materials from non-European sources, while fostering social involvement and collaboration along the supply chain. In addition, biobased materials serve as a long-lasting biogenic carbon storage, further reducing the sector’s carbon footprint and supporting biodiversity using diverse, reused, remanufactured and recycled feedstocks. Biobased materials possess excellent insulating, hydroscopic and self-healing properties enabling innovative construction solutions, offering both environmental and economic benefits. Their hydroscopic properties help to regulate indoor humidity, improving comfort and indoor air quality, which contributes to health and well-being. These benefits can be harvested as a sustainable complement in the material mix, part of hybrid materials or as alternatives, to traditional building materials with high carbon footprint.

The roadmap summarises key development trends, biobased material and technology developments and innovations currently happening and expected to evolve in 5, 10 and 15 years. Currently, biobased materials represent only a small fraction of total materials used in the construction sector. Globally, 2-10 % depending on the application and according to different calculations and statistics. Their uptake is uneven and region-specific. This includes timber, engineered wood products (e.g CTL), insulation made of hemp, flax, cellulose and emerging products like mycelium composites and bioresins. While biobased materials alone cannot fully replace conventional materials, their share can grow when using diversified feedstock base combined with end-of-use strategies, meaning reuse, recycling and the implementation of circular economy principles. This transition is not only technologically viable, but also environmentally necessary to meet EU and global climate targets. Continued investment in research and innovation, standardisation and capacity building will be essential to realise this at scale.

VISION

By 2040, the European construction industry will lead the transformation towards a carbon-neutral, circular and resilient built environment, powered by the widespread use of biobased materials that enhance competitiveness, sustainability and well-being.

1. Introduction

1.1 Background, context & policy framework

The construction sector plays a critical role in sustaining our quality of life and shaping Europe's environmental and economic future. Europeans spend 90% of their time in buildings and infrastructures. The construction industry gives us the roofs over our heads, the rails for our morning train commute, the bridge we use to cross the river and the infrastructure that gives us energy and water. It is the industry we call for repairs and for rebuilding after a disaster or war destruction. It is the second largest industrial ecosystem in the EU[1] accounting for about 9% of the EU's GDP and providing jobs for approximately 18 million workers across 3.3 million enterprises. With the right investments in innovation in the sector, aligned with the creation of profitable business cases, this industry can leverage its strengths and be a cornerstone of Europe's competitive advantage. Innovations in construction have a strong multiplier effect, boosting related industries like manufacturing, logistics, and energy.

The economical and social weights of the sector comes along with a heavy intensity resource-usage and therefore the construction industry is central to achieving the EU's green and digital transition goals.[2, 3]The construction of Buildings and infrastructures accounts for nearly 40% of global energy consumption and 36% of CO_2 emissions, consumes up to 50 % of all newly extracted materials and is responsible for over 1/3 of the EU's waste generation.[4]

Ambitious EU policies and initiatives and a rich regulatory landscape, address this social and environmental impact of construction. The sector must implement actions to increase its resource efficiency supporting the EU the Circular Economy Action Plan, which aims to reduce the EU's residual waste by 50%, and following the Waste Framework Directive (European Union, 2008), the Construction Products Regulation (European Union, 2011) and the announced Circular Economy act. The recast Energy Performance of Buildings Directive (EPBD) makes provisions relating to whole life carbon emission and starting in 2030 regressive Whole Lifecycle-GWP levels will be implemented for all new buildings (Roadmaps to be prepared in 2027). The Sustainable Products Initiative & Ecodesign Directive will pull products that are durable, reusable, repairable, recyclable, and energy efficient and a cascading principle with more stringent criteria on the hierarchical use of biomass may be introduced in future policies.

All of these are promoting a shift to material efficiency in the sector and the use of biobased or low-carbon materials. Beyond their role in lowering embodied emissions, biobased materials contribute to carbon storage over the long term and can support biodiversity when sourced and managed responsibly. Their specific material properties—such as hygroscopic behaviour and natural insulation capacity—open opportunities for innovative design solutions that complement conventional construction practices. Recognizing these needs, and in line with the shortage of critical raw materials, in 2024 the EC announced the construction as a priority sector for the development of advanced materials targeting enhanced wellbeing in buildings and increasing circularity and improved environmental performance.

National and Regional regulatory landscape are also evolving to implement and operationalise these advancements. France's RE2020 environmental regulation, in effect since 2022, sets a benchmark for reducing the carbon footprint of new buildings, while improving the energy performance and increasing resilience to climate change, particularly heat waves. In Finland, the new Building Act's[5] new requirements for low-carbon buildings and carbon footprint thresholds and has new demands for demolition materials and construction waste declarations. In practice it requires, for example, that a climate report and a material description to be drawn up when applying for a building permit.

The increased integration of biobased materials in construction aligns with these objectives, fostering a transition towards a greener, more resilient build environment. The coming update of the EU Bioeconomy strategy and the implementation of the Circular Economy action plan will strengthen the focus on the overall consumption of biological resources and investments in sustainable bioeconomy businesses. Also, the New European Bauhaus (NEB) initiative highlights consumer preferences towards the use of renewable materials. In this context, the Innovative Advanced Materials Initiative (IAM-I) plays a key role by promoting R&I in advanced and sustainable materials across Europe, supporting efforts to scale up bio-based solutions in construction.

1.2 Purpose of the Position Paper

Biobased materials—such as timber, wood pulp/ cellulose pulp, hemp and flax, —offer a promising solution to the sector's environmental challenges. These materials not only store carbon but also have lower embodied emissions compared to traditional building materials. Their use aligns with the EU's objectives to reduce greenhouse gas emissions, promote circularity, and enhance the sustainability of the built environment.

This white paper explores the role of biobased materials in transforming the construction sector. It examines how these materials can contribute to meet the EU's climate goals, drive innovation, and support the creation of a sustainable and competitive construction industry while boosting business opportunities in its supply chain. Recommendations are elaborated linking technical and market potential and barriers to support the innovation ecosystem, legislators and policy makers and accelerate market uptake.

This paper should be seen as a part of ECTP's broader expert views stated in position papers regarding Decarbonisation of the Build environment and on Sustainable construction materials.[6,7]

1.3 Definitions and boundaries

Biobased materials for construction are defined as materials derived from biomass, which includes renewable biological sources such as plants, trees, animals, fungi, marine organisms, micro-organisms, algae, and organic waste streams. According to the European standard EN 16575:2014, a biobased product is wholly or partly composed of biomass, which may have undergone physical, chemical, or biological processing. In construction, commonly used biobased materials include timber, bamboo, straw, hemp, cork and research focuses on new materials like mycelium and biobased insulation and load-bearing composites derived from agricultural and forestry residues.

This white paper highlights the diverse potential of biobased materials in sustainable construction. The scope of this study covers a broad range of biobased materials used in the following construction material application areas, focusing on biobased materials within four key areas:

- Buildings (e.g., structural components, insulation, panels, window frames, finishes)
- Building systems (e.g., piping, water management, HVAC)
- Infrastructures (e.g., road, bridges, tunnels)
- Energy systems (e.g., integrated renewable energy installations, energy storage, BIPV)

2. Current status of Biobased materials

Whereas up to the 50's of the last century biobased materials where widely used in construction, their application has reduced significantly in construction since then. In the last decade, biobased materials are regaining attention as sustainable alternatives in the construction sector, offering renewable, low-carbon solutions that align with climate neutrality goals. Derived from natural sources such as wood, hemp, straw and other biomasses, these materials can contribute significantly to reducing greenhouse gas emissions (GHG), promoting circular economy principles and enhancing the sustainability of buildings. Wood, one of the most widely used biobased materials, plays a critical role not only structurally, but also environmentally**.** As trees grow, they absorb and store carbon dioxide (CO_2) from the atmosphere. When harvesting the wood for industrial purposes, excluding combustion, this CO_2 remains stored in the wood. This CO_2 storage continues as long as the wood is used as a product contributing to long-term carbon storage in buildings. The CO_2 sequestration in wood can be calculated according to the calculation method derived from the standard EN 16449 'Wood and wood-based products - Calculation of sequestration of atmospheric carbon dioxide', developed by the European standards committee TC 175 WI. Wood, depending on the species, is a composition of cellulose (40-55%), hemicellulose (12-15%), lignin (15-30%) and other substances (2-15%). This determined that wood effectively consists of 50% carbon, 44% oxygen and 6% hydrogen. The calculation method is based on the atomic weights of carbon (12) and oxygen (16). Typical wood used for construction ranges between densities of 420-900 kg/m3 and stores 650-1400 kg CO_2/m^3. As an average , densities of 650 kg/m3 and 1000 kg CO_2/m3 may be used for comparison reasons. Actual wood-dependent data should be used for detailed calculations.

In recent years, significant effort is put in the development of biobased insulation materials and, as an example, close to 50 % of the insulation in Germany is biobased and national programs like in The Netherlands and regulation as implemented in France show the intention and political will of European countries to increase the percentage of "homegrown" construction materials based on plants like hemp, flax and seaweed. Furthermore, Developments in materials engineering and advanced materials open a wide range of promising opportunities for advanced bio-based materials in construction as e.g. lignin base glues, lightweight composites in the years to come.

2.1 In the market

Integrating biobased materials into construction practices aligns with the principles of a circular bioeconomy. By utilizing renewable resources and promoting the reuse and recycling of materials, the construction industry can significantly reduce its environmental impact and contribute to the Sustainable Development Goals (SDG).[8] In Europe, several biobased construction materials are gaining prominence due to their sustainability and performance benefits. In 2023, Europe contributed 25% to the Biobased building materials market. Wood dominated the biobased building materials market, followed by hempcrete, rammed earth and other materials (such as straw bale and cork).[9]

TABLE 1. MAIN BIOMATERIALS USED IN THE CONSTRUCTION SECTOR AND EXAMPLE OF SUPPLIERS IN EUROPE.

Material Type	Common Applications	Key Benefits	Some players
Wood & Engineered Wood	Structural framing, Cross-Laminated Timber, Glue-Laminated Timber, Plywood	Renewable, carbon-storing, versatile	Egger (Austria), Kingspan (Ireland), Pircher Oberland (Italy), Stora Enso (Finland), UPM (Finland), MetMetMetsä Group (Finland),
Hempcrete	Insulation and non-load-bearing walls	Carbon-negative, breathable	Tao Climate (Ukraine), Hempcrete UK (UK), IsoHemp (Belgium), Leipfinger Bader (Germany), (Germany), Chanvriers de l'Ouest (Fr) Cavac Biomatériaux (Fr) CÂNHAMOR (Portugal)

Straw-and Cellulose Based Materials	Insulation and walls	Cost-effective, biodegradable	Strawtec (UK), HempFlax (Netherlands)Maxit Strohpanel Germany), Aisti (Finland)
FFlax & Other Natural Fibres	Insulation, wall linings, and acoustic panels	Thermal & acoustic insulation, biodegradable	Bcomp (Switzerland), Hemplith Flex (Germany)
Mycelium-Based Composites	Insulation, interior panels, and packaging	Rapidly renewable, compostable	MycoWorks (France), Ecovative (Germany), Mogu (Italy),Mykor (UK), Grown Bio (Netherlands)
Algae-Based Materials	Bio-reactive facades, insulation panels	Energy-producing, sustainable	Algae Systems (Germany), SSC (Germany)
Cork-Based Materials	Flooring, insulation, wall panels, and cladding	Thermal, acoustic insulation, biodegradable	Corticeira Amorim (Portugal), Granorte (Portugal)
Agriculturaland Forestry By-Products	Particle boards, insulation, and wall panels	Utilizes waste streams, circular economy	AgroChem (Poland), BioBuild (France), EcoPanel (Spain), FiberWood (Finland)
Biobased Composites	Insulating panels, cladding, and flooring	Durable, sustainable	BioFiberTech (Netherlands), ULMA Architectural Solutions (Spain)
Biomass Ash	Partial cement replacement in cement, mortar, concrete, lightweight insulating blocks and plasters, high-performance concrete composites, alkali-aktivated binders and sustainable bricks	Durable, sustainable, performance, workability	Ecocem (France/Ireland), HeidelbergCement (Germany)
Biobased reinforcements	Fibres, sawdust, textiles and rebars	Durable, sustainable, biodegradable	Woodio (Finland)

The current market in Europe for biobased construction products mainly consists of wood and this trend is expected to continue until 2030. Rising product demand for manufacturing floorings, decking, windows, and doors in residential and commercial buildings is likely to have a positive impact on market growth. Raw materials that are essential for manufacturing wood-based panels, including fibre wood and timber, are procured from sawmills, log merchants, and recycled fibre brokers. In addition, in Europe, the growing demand for recyclable, lightweight, high-strength, and sturdy products in construction applications is expected to propel market growth. Besides, the increasing investments in the construction of new commercial spaces are likely to benefit this market. The application of wood-based panels in the construction industry was significant in 2022 (about 34% of the market share, which represents ~$14.7B). It must also be noted that the construction industry is the fastest-growing, owing to a rising focus on it to stabilize the economy.[10]

Recent advancements in wood-based construction have been made, particularly in the domains of structural and envelope systems. A primary focus is the role of wood in addressing the energy and carbon challenges facing the construction sector, since building energy demands constitute a substantial proportion of total energy consumption. Within this context, wood and other biobased materials are a promising alternative due to their lower embodied carbon and capacity for long-term carbon sequestration. There is also a growing adoption of **prefabrication** and **hybrid designs** that integrate wood with other materials. While these systems offer advantages in terms of efficiency and sustainability, they also introduce complexity in terms of building physics. Therefore, wood construction has a dual role, since it can be used as the main structure and also contribute to the building's thermal efficiency.[11,12]

Future demand for wood in the forest fibre industry has been best modelled in the 2010 EUWOOD study for DG Energy.[13] It assumes a 40% growth in volume demand by wood-using sectors by 2030, with strong demand in the building sector, to replace steel and cement. The PRIMES model, in contrast, forecasts the same growth by 2050.[14]

2.2 Current days usage of biobased construction materials

Wood is the most dominantly used biobased material used for construction purposes. Though data is quite scattered, typical data for a number of European countries is included in the Table 2.

TABLE 2 OVERVIEW OF USAGE OF BIOBASED MATERIALS WITHIN CURRENT DAYS PRACTICE.

Coun-try	**Total** (Mton)	**Mass for construc-tion** %/yr	**CO² * stored** Mton/yr	**Year**	**Main application area**
NL	2.9	4 %	45	'19	**Buildings:** 2934 kton wood (4.5 M m³), 0,4 kton straw, 35 kton Reed, 8 kton Bamboo
FIN	45	nd	69	'24	**Buildings & Infrastructure:** 10 Mm³ of sawn Timber in '24, domestic consumption 1.8 Mm³. Buildings & Bridges (e.g.: Bridge/ constructive beam. 637 timber bridges in Finland (4,4% of all)
ES	1,680	nd	2.6	23/24	**Buildings**: 850 kton (500 kton house, facade (wood), 200 kton Insulation (hemp, flax), 150 kton Flooring (bamboo)), **Infrastructure**: 450 kton (300 kton Bridge/constructive beam (wood), 00 kton road reinforcement (bio-composite), **Building systems:** 350 kton: 250 kton piping/tube (bioplastic) & 100 kton insulation (wool) **Energy systems** : 80 kton (50 kton PV/back plate (bio-composite), 30 kton battery separators (bio-aerogels))
PT	0,0015	3 %	0.002	'21	**Buildings:** cork for building insulation (~25ton), wood for floors and building structures
FR	19.5**	nd	30	22/23	**Buildings:** 20 Mm³ Lumber wood, mainly used construction industry (carpentry, cladding), joinery, packaging, cabinetmaking and cooperage. 10 Mm³ Industrial wood (used in outdoor landscaping (posts, fences, playground), paper and cardboard, packaging, construction (walls, floors, insulation) and furniture.
FR	0.181	nd	0.294	'22	**Buildings systems:** Fibers: Hemp as straw: 152 kton harvested, Hemp aggerates 18.7 kton, Hemp fibres 10.6 kton
GE	43.7**	nd	67.2	'19	**Buildings:** Coarse wood: 53.13 Mm³, Industrial wood: 11,73 Mm³, Old wood: 2,4 Mm³
GE	3.5 Mio. m³	9% (Volumw)	nd	'19	**Buildings systems:** Insulation materials: wood fibre (58%): 2.03 Mio. M³; cellulose (32%): 1.12 Mio. M³; other (10%): 0.35 Mio. M³ slab insulation (52%): 1.8 Mio. M³, blown-in insula-tion (24%): 0.9 Mio.M³, mat insulation (24%):0.8 Mio.m³
IT	nd	nd			**Buildings:** wood based pre-assembled: 2.8% of residential buildings, 8.5% of building stock. Furthermore Hemp-based building materials, Hemp brick, Lime/hemp, insulation panels
AUT	nd	24 % (all)		'18	**Buildings:** Dwellings existed in 2028 for 24 % of wood buildings (definition > 50% wood load carrying construction)

*nd no specific data   * CO_2 stored, approximated by assuming 1000 kg/m3   ** based on average density 650kg/m³*

2.3 Under development

Innovation projects are crucial for advancing new biomaterials in the construction sector since they accelerate the development, demonstration, and market adoption of sustainable, biobased materials. In recent years, European research has increasingly prioritized the development and integration of biobased materials within the construction sector, mainly funded by national and Horizon Europe programs, focusing on material innovation, system integration, and supply chain optimization. See Annex 1 for full table on recent and on-going related projects.

This analysis draws on the results of more than 50 EU-co-funded and national research and innovation projects that collectively explore the deployment of bio-based materials across the European construction sector. These projects, supported under Horizon 2020, Horizon Europe, CBE-JU and

Interreg frameworks, tackle the priority lines set by the European Commission's Green Deal, Circular Economy Action Plan and New European Bauhaus. Their combined portfolio illuminates the specific technological bottlenecks that still impede full market penetration, while demonstrating how a co-funding model accelerates proof-of-concept trials that individual companies could rarely finance alone.

The evidence shows that National and European support has enabled technology developers to:

- Validate novel composites, foams and engineered timber at pilot scale;
- Generate the first life-cycle and fire-safety datasets needed for future standards;
- Quantify carbon-storage benefits with emerging Level(s)-aligned LCA methods.

R, D &I project, span the whole range of TRL levels and can be typically categorized in the following aspects:

- Supply chain (wood, biobased ingredients)
- Advanced Materials development (mechanical properties, stability, aging, cost, ..)
- Product development (production aspects, design, ..)
- Demonstrators (TRL 7-8, buildings, bridges, ..)
- Context (culture, legal, skills,..)

Whereas initial focus was on the supply chain, more emphasis is given to demonstrators and scale-up over the last couple of years. Overall, the European and national research projects reveal a solid and multifaceted commitment to the integration of biobased materials in construction. Increasing the low-TRL or fundamental research to near-market demonstrations reflect a strategic effort to position biobased construction not just as an environmental need, but as a competitive industrial solution. This transformation is sustained by a convergence of ecological innovation, regulatory alignment and a reinterpretation of material culture in the construction sector.

Trends and challenges stemming from these projects are further elaborated in chapter 3 and are used as the basis for the roadmap shown in chapter 4.

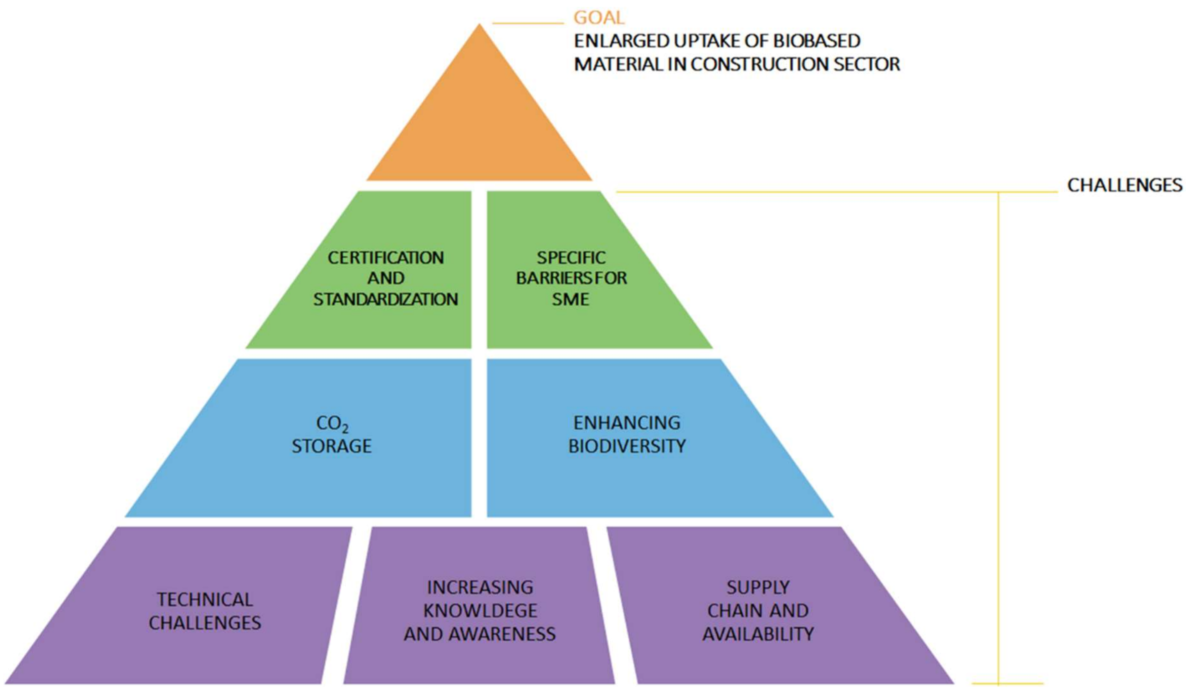
3. Challenges and solutions

Despite growing demand for sustainable solutions, the commercialisation of biobased materials faces persistent challenges. The construction sector is traditionally conservative and slow to adopt new materials due to rigid standards and a preference for familiar options. High initial production costs, underdeveloped supply chains, and limited economies of scale make biobased materials less price-competitive. Lengthy validation and certification processes deter investors, while a lack of committed large-scale buyers limits market pull. Technical hurdles, such as durability, fire resistance, and integration with existing systems, also remain. Overcoming these barriers requires coordinated policy support, targeted R&D, and investment to de-risk innovation and scale adoption.

While Section 2.4 highlighted the significant progress made in ongoing development projects, it is clear that further efforts are still necessary. Despite these promising advances, bio-based solutions are not yet ready to compete at an industrial scale. Achieving this will require continued research and development, substantial capital investment, and greater alignment of regulatory frameworks across markets.

The technical challenges encountered are not isolated to specific cases but are broadly applicable across the four thematic areas defined in the scope of this white paper: buildings, building systems, energy systems, and infrastructure.

The following section summarizes the key challenges observed across the thirty projects and identifies the priority research areas that are now considered essential for enabling successful market integration.



3.1 Technical challenges

Despite demonstrable progress, four technical dimensions continue to limit large-scale market uptake of bio-based materials in the construction sector: **long-term durability, fire-safety validation, high-performance bio-adhesive, and industrialization.**

Longterm durability – Trials show biobased materials can achieve long-term performance in controlled settings, though real-world durability remains a challenge.[15] Wood-derived components have limited service life [16,17] and hemp-lime exhibits environmental sensitivity, stressing the need for better additives.[8] Projects like **SuperBark** are developing biobased coatings with antifungal and weather-resistant properties based on bark-derived polyphenols, aiming to enhance the environmental resilience of wood and paper substrates. However, scalability and consistency of bark feedstocks remain challenges. [18]
Fire performance – Bio-foams show improved fire resistance,[19] but lack of standard tests and the continued need for extra fireproofing in timber structures hinder broader use, for hemp-lime materials[20], current European fire classification standards often fail to capture the influence of binder ratios and curing regimes, which significantly affect fire behaviour. This mismatch highlights the need for material-specific fire test protocols that reflect bio-composite variability under real-world conditions. Small gains in safety could yield major cost savings. **BioPhenom** project are addressing this gap by developing biobased intumescent flame retardants from biomass-derived phenolics and validating their performance in thermoplastics and wood. This includes designing for recyclability, but challenges remain in ensuring consistent fire resistance while maintaining disassembly and reuse potential.[21]

Performance of adhesives and additives -Biobased solutions offer competitive costs and reduced water use,[22] but performance under variable conditions needs validation.

Industrialisation and recyclability – Recyclable bio-elements are emerging,[23] yet performance drops in humid environments suggest a need for hybrid materials and smart monitoring.

In France, for example, one dwelling in fifteen is already timber built and highly efficient straw insulation products are on the market, demonstrating that technical feasibility can translate into real-world penetration when regulatory support is present.[24]Addressing these durability, fire-certification and adhesive-performance gaps is essential to convert demonstration prototypes into competitive market solutions.

3.2 Certification and standardisation

When introducing a new construction material, navigating the landscape of standards and certifications can be complex, particularly because existing standards may not apply. For example, if a novel building product—such as an innovative bio-based insulation material or a newly engineered concrete mix—is developed, there may be no established European standard to reference. In such cases, to achieve CE marking (a requirement for products sold in the EU), one viable path is to develop a European Assessment Document (EAD). Alternatively, manufacturers can refer to existing EADs. The full process, as well as a searchable database of EADs and European Technical Assessments (ETAs), can be found at the European Organisation for Technical Assessment's website. [25]
Under the Construction Products Regulation (CPR), all construction materials—whether traditional ones like clay bricks or modern systems such as prefabricated timber panels—must meet essential performance criteria.

These include:

- Mechanical resistance and stability
- Safety in case of fire
- Hygiene, health, and environmental protection
- Safety in use
- Noise protection
- Energy efficiency and heat retention
- Durability and serviceability

With the upcoming revision of the CPR, new criteria such as circularity and environmental footprint will be introduced, reflecting the growing emphasis on sustainability in construction.
In addition to European-wide regulations, national certification routes still play a role—especially for materials that are produced and used locally. For instance, clay bricks often fall under regional standards due to their high transport costs, making localized certification more practical and economically viable.

The scope of certification could follow the following principles:

- **European** certification or **National** certification?
- Certification of developed **product** or **system** certification?
- Collection of product/system data:
    - Field of application
    - Product/System Standard / EAD
    - Required product/system characteristics
    - Comparable products/systems available

Under CEN/TC 411 the forthcoming EN 17980 series is expected to provide a harmonised methodology for determining and reporting bio-based content across product categories, while the TÜV Austria "OK Biobased" scheme already enables manufacturers to obtain one- to four-star labels based on radiocarbon analysis (ASTM D6866).[26,27]

While the existing CPR/EAD framework provides a formal route to CE-marking, **several critical gaps remain for biobased construction products**:

- **Fire testing of novel composites** – Nanoenabled bioPUR foams have reached Euroclass B in laboratory conditions, yet **no harmonised EN fire test protocol exists for façade corner joints**. Until such a method is approved, certification proceeds on an adhoc basis, driving cost and time for each SME submission[28]

- **Facade applications of smart textiles** – New test procedures are needed to classify biobased smart textiles,[28] revealing major gaps in current standards for hybrid, multifunctional materials.

- **Biocontent- verification** – Ongoing updates to key standards aim to unify bio-content claims,[28,29] but most materials still depend on national approvals or unrecognised declarations, limiting cross-border acceptance.

- **Whole-lifecycle- carbon disclosure** – The 2024 revision of **EN 15804 +A2** makes reporting of **Global Warming Potential (GWP)** compulsory in EPDs from mid-2025, and 14 Member States already reference the **Level(s)** toolbox for transposition.[30] Nevertheless, current EPD templates seldom capture **biogenic carbon storage**, a key advantage of timber or mycelium based- systems. The CBEJU is therefore preparing a dedicated method to award separable CO_2 storage in WLC -accounts accelerating timber payback.[30]

- **Variability and small production volumes** – Biobased feedstocks vary by species, region and harvest season, producing significant scatter in density, moisture uptake and fire behaviour. Low industrial volumes exacerbate this variability, making it difficult to set representative characteristic values for the structural Eurocodes or for durability classes. As a result, **SMEs face costly, case by case testing**, even when using the BIOMAC SingleEntryPoint.[28]

Regulatory outlook

To bridge these gaps, industry stakeholders are lobbying for a **fast track route under CPR Article 113c**, with a CEN Workshop Agreement expected in Q4 2025. Meanwhile, the European Commission has signalled that future delegated acts will add **Circularity and Environmental Footprint** criteria—already piloted in Level(s)—to the CPR's basic requirements. The forthcoming "**GWP + Biogenic Carbon**" module will effectively mainstream carbon storage credits, but public tenders issued in 2025 should already **budget for third party EPD verification** to avoid retrofitting costs.

Health related criteria are also advancing: the German brochure *Living with Wood* already compiles VOC limits and product requirements, indicating a path to integrate indoor air quality into future CE-marking for biobased products.[31]

3.3 CO2 Storage and Credits

The construction value chain is rapidly moving from "low carbon" to **"carbon storing"** solutions. Demonstrators show that biobased components can turn buildings into verifiable carbon sinks, yet market uptake depends on robust measurement methods, fair accounting in Whole Life Cycle (WLC) assessments, and reliable credit-trading platforms.

The carbon emissions related to buildings and infrastructures are a crucial issue, especially because related to concrete, cement-based, ceramic and steel products, which determine a massive annual demand and extremely high process-related emissions.[32] Therefore, a valuable solution to achieve climate-neutral constructions can be the combination of circular economy principles (such as the reuse, recover, recycles of products) and the large adoption of biobased materials.[33]Indeed, biobased materials helps in carbon sequestration, by storing carbon in long lifespan products while the CO_2 is reabsorbed in forests or crops by plants regrowth.[34]
The scenario's starting point is an 80% CO_2 reduction by 2050. Based on standard factors and production data we estimate total emissions for the wood products sector for 2010 to be 20 Mt; direct emissions to be 3-5 Mt, indirect electricity emissions to be 7-9 Mt and transport emissions 6-8 Mt.[35]

Quantifying and verifying CO_2 storage in biobased construction materials remains a critical challenge, though structural timber currently offers the most established reference case, particularly through mass timber applications. At the neighbourhood scale, the integration of biochar-based systems contributes to localized carbon sequestration strategies, aligning with emerging models for distributed negative emissions. Methodological consistency is advancing through initiatives harmonized with the Level(s) framework, enabling life cycle assessments to feed directly into standardized environmental declarations while mitigating risks of carbon accounting overlaps. Broader decarbonisation potential is evident in the replacement of conventional materials with biomass-derived alternatives, contingent on robust end-of-life retention. Comparative life cycle analyses also suggest that novel biogenic composites, including fungal-based masonry units, can significantly outperform traditional materials in terms of embodied impact and regeneration efficiency.

Integrating CO_2 storage into whole life carbon (WLC) and Global Warming Potential (GWP) accounting is gaining traction through regulatory updates and national frameworks. The revised EN 15804 standard mandates GWP disclosure in environmental declarations, with several EU countries incorporating biogenic carbon into planning and policy instruments. Efforts to operationalise this recognition include new calculation modules that enable the deduction of net stored carbon from total building emissions, supporting the pathway toward carbon-negative performance over a building's lifecycle.

New regulatory frameworks are enabling biobased construction materials to access **carbon credit markets,** with long-term storage criteria now formally defined under EU legislation. Pilot initiatives are beginning to align carbon and biodiversity credits, generating early market signals that support the economic viability of climate-positive building products. Concurrently, simplified certification pathways are under development to streamline access to credit systems, encouraging stakeholders to adopt forward-looking pricing and contracting strategies aligned with established carbon benchmarks.

By coupling rigorous measurement with credible trading platforms, biobased construction can shift from incremental decarbonisation to **active carbon removal**, capturing new revenue streams while accelerating the EU's net zero trajectory.[36,37]

In ADEME is stressed that long life wood systems and straw infill should be prioritised because their biogenic carbon can remain locked up for centuries—directly matching CRCF permanence rules.[24]

3.4 Specific Barriers for SMEs in biobased material uptake

Small and medium-sized enterprises (SMEs) are key drivers in the adoption of biobased materials within the construction sector. These businesses often act as pioneers, developing innovative products and technologies that push the boundaries of sustainability in building materials. Due to their smaller size and flexible operations, SMEs are more agile and quicker to adopt new technologies, making them uniquely positioned to drive change.

However, to maximize their potential, SMEs need targeted support. One essential area is facilitating easier access to pilot-scale facilities, which are crucial for producing sufficient materials for testing and validating new materials as well as the actual test, an essential step before large-scale production can be initiated. Furthermore, SMEs often face financial challenges in covering the high costs associated with the production of the materials needed as well as certification, testing, and regulatory compliance. Therefore, dedicated grants and funding opportunities are vital to reduce these financial barriers.

Collaboration with research institutions, such as universities and research centres, is another important avenue of support. By partnering with these organizations, SMEs can tap into valuable expertise, access advanced research, Research Infrastructures and Technology Infrastuctures, and stay ahead of emerging trends in biobased materials. Additionally, international collaboration platforms, such as METABUILDING[42] can help SMEs scale their products globally, creating new market opportunities and expanding their reach.

Equally important is fostering a supportive environment that encourages risk-taking and innovation. A culture that views failure as a learning opportunity rather than a setback can enable SMEs to push boundaries without the fear of failure stifling their progress.

Ultimately, SMEs have a pivotal role to play in advancing biobased material adoption. Their flexibility, innovation, and willingness to experiment make them essential players in the transition to more sustainable construction practices. With the right support structures in place, SMEs can overcome existing barriers and contribute significantly to the widespread use of biobased materials in the industry.European SMEs are the principal source of innovation in biobased construction, yet they confront a combination of **scale-up, certification and finance barriers** that larger incumbents can more easily absorb.

Moving from laboratory composites (TRL 4) to market ready components (TRL 7, 8) requires pilot and demonstration facilities that few SMEs can afford to build inhouse. Typical capital expenditure for a continuous extrusion or resin infusion line exceeds **€3–6 million**, well above the debt capacity of most startups.

- **Open Innovation Test Beds (OITBs)** – **BIOMAT** offers **five open pilot lines** with mentoring, while **BIOMAC** consolidates regulatory, LCA and safety services behind a Single Entry Point.[38]
- **Exploit4InnoMat** expands access with **nine additional pilot lines for façade envelopes**, cutting prototyping cost by **≈ 25 %** and compressing development time.[39]
- **Persistent gap** – The European Investment Bank's 2023 study shows that only **18 % of bio-construction SMEs obtain bank loans without personal guarantees**, largely because pilot assets cannot serve as acceptable collateral.[40]

Product buyers and warranty providers increasingly demand proof of performance in full-scale assemblies. In BUILT's demo-house network allows SMEs to install TRL-7 prototypes under monitored real-climate conditions, de-risking insurance claims and accelerating certification.[39] However, geographical coverage is uneven and slots fill quickly.
Regional **Innovation Hubs** (e.g., **BioUptake**) link SMEs to investors, corporate off takers and research centres. Empirical data show that firms embedded in such hubs reach commercial launch **twice as fast** as isolated peers, thanks to shared testing infrastructure and investor road shows.[39]
Collateral hurdles: Traditional lenders require personal guarantees or asset pledges that young firms cannot meet. The EIB recommends blended finance under Invest EU and regional guarantee schemes such as NRW.BANK-Bio.[40]
Certification expenses: Conformity testing and third-party audits for CE-marking typically cost €40 000–50 000 per product line. While BIOMAC offers subsidised packages, the demand exceeds current voucher budgets.
To overcome these hurdles, SMEs require a intensive package of support. First, the high CAPEX costs of pilots cale can be reduced through match funded equipment leasing schemes and continued expansion of shared pilot lines under the CBE-JU voucher call scheduled for October 2025. Further reductions can be found with proper aligning of innovative equipment producers and their renting and leasing programmes and integrating those into these schemes. Second, certification remains disproportionately expensive: an average product line needs about €40 000 for conformity testing and third party audits. An EU-wide voucher programme—building on the current BIOMAC and BIOMAT subsidies—should be scaled to meet this demand.

EuropaBio estimates that the bio-economy start-up ecosystem could generate up to one million new jobs by 2030, provided that scale-up bottlenecks are addressed through dedicated SME finance instruments.[41]

Equally crucial is risk sharing finance. Because conventional lenders still treat pilot assets as poor collateral, new portfolio guarantee instruments and blended finance loans under the Invest EU window, complemented by the Circular Bioeconomy Fund, will be essential to unlock capital. Fragmented technical and regulatory expertise can be addressed by strengthening the one stop helpdesks embedded in OITBs[42] and by deepening the mentoring functions of regional innovation hubs. Finally, the time it takes to bring products to market can be shortened by widening access to real climate demonstration houses; extending the InBUILT model to additional clusters in Central Eastern and Southern Europe would ensure that SMEs across the Union can validate their technologies close to target markets.

For small and medium-sized enterprises, the interplay of technical validation, certification complexity, skills shortages, knowledge gaps and upfront capital needs still forms a dense barrier to scale. High prototype costs collide with fragmented standards; limited workforce expertise slows manufacturing scale-up; and patchy market awareness erodes demand pull. Addressing these constraints demands an integrated policy bundle: streamlined, risk-based certification pathways; expanded open-innovation test beds with embedded training; blended-finance instruments that treat pilot assets as bankable collateral; and public procurement that rewards verified carbon and biodiversity performance. Implemented together, these measures convert today's multi-layered hurdles into a sequenced growth ladder that SMEs can realistically climb.

3.5 Supply chain and availability

The European biotic raw material sector is at the heart of the bioeconomy providing means to tackle global challenges by replacing fossil-based raw materials with sustainable, renewable raw materials sourced in Europe. Forests cover 42% of the EU's land area. The forest-based sector is a key enabler for a low-carbon, biobased society. The sector consists of different sub-sectors: woodworking; furniture; pulp and paper manufacturing and converting; wood-based biorefineries; and printing; as well as forest owners, managers and forestry. The value chains produce a wide range of products ranging from wood construction products, packaging, furniture, paper and pulp products, and hygiene articles to bioplastics, biocomposites, carbon fibres, textile fibres and biochemicals. Furthermore, forests provide biodiversity and many ecosystem services that are of importance for human well-being and health, including clean air and water and recreational activities. In addition, forest and forest products are a renewable resource, and therefore there is a need to include long-term sustainable measures in forest management. Forests are also fundamental to the mitigation of the effects of climate change.[43,44]
However, the availability and optimal use of biomass feedstock remains a key challenge: current use of wood in construction accounts for only a small fraction (approx. 4%) of total EU wood production, while short-cycle agricultural materials like straw, hemp, and flax—despite their faster renewability—are generally limited to non-structural applications.

Biobased products are derived from renewable biological resources, primarily from plants but also including animal products, microorganisms, algae, and aquatic biomass. In line with the scope of this paper, the emphasis is placed on plant-based feedstock, with forests and agricultural residues representing the main resource base for scaling biobased construction.
Feedstock constraints and opportunities extend across the four thematic areas addressed in this white paper—buildings, building systems, energy systems, and infrastructure—highlighting the need for a holistic, EU-wide and lifecycle-based strategy. This includes promoting underutilised biomass sources such as agricultural residues, aquatic biomass, and forestry by-products, and developing sustainable criteria and systemic models for biomass optimisation.

The WOODSTOCK[45] project supports this transformation by unlocking the potential of wood as a circular carbon sink. By developing advanced fractionation and separation technologies, WOODSTOCK enables the use of hardwoods and low-value wood assortments in new high-performance products, such as biobased adhesives, composites, and coatings. This contributes to diversifying raw material supply, increasing value retention, and reducing dependence on fossil resources, all aligned with the goals of the New European Bauhaus and the EU Bioeconomy Strategy.

According to European Commission models, wood production is projected to rise from 500 Mm^3 in 2010 to 540 Mm^3 in 2050 in a low production increase scenario, or 750 Mm^3 in a high production scenario, which includes an increase in domestic production of forest biomass for energy. The EUWOOD study is partly in line with the European Commission high production scenario assessment, but differs in the analysis on supply and demand. The net annual increment in the volume of timber in the EU forests 2010 was 620 million cubic metres from which about 60%, or roughly 410 million cubic metres, is harvested.[43 43]
The forest-based sector in Europe provides society with a wide variety of products and services, ranging from paper, packaging, tissue paper, furniture, carpentry and construction materials made from solid wood and wood based panels to textile fibres, biofuels and special chemicals. Today it contributes some 8% of the EU's total manufacturing added value and sustainably manages forests covering 35% of the EU's landmass. It also provides income for about 16 million forest owners and supports 3-4 million industrial jobs. [43]

The most significant sub-sector of forest-based industry in Europe is the woodworking industry, which in 2009 had a turnover of over €180 billion and 2.4 million employees in 365,000 small and medium-sized companies. The woodworking sector includes sawmilling (15%), wood construction products (37%) and furniture manufacture (48%). The second largest sub-sector is the pulp and paper industry, with a total turnover of €81 billion in 2010, employing 224,000 people in some 700 enterprises. Healthy and resilient forests are a prerequisite for a sustainable supply of raw materials to the forest-based sector as well as for other goods and services provided for society by forest ecosystems (including carbon sequestration, clean water, erosion protection, biodiversity, aesthetic landscapes and recreation). [43]

As climate-change-driven droughts and pest outbreaks intensify, diversifying feedstock sources and forest management regimes becomes critical; EuropaBio underscores that integrating secondary feedstocks and captured-carbon streams can simultaneously relieve land-use pressure and safeguard raw material security.[46] EuropaBio's latest feedstock review estimates that integrating recycled and captured-carbon feedstocks could supply up to 35 % of the sector's carbon demand by 2040, cushioning the volatility of agricultural biomass markets.[46] RMI analysis further shows that mobilising currently under-utilised agricultural residues would provide a technical potential of 55 Mt yr^{-1}, sufficient to meet projected demand for biomass-derived insulation and composite panels.[47]

In 2016, the total wood production of the EU27+UK was 507 million m³, with the most productive forest regions in Europe being the Nordics (Sweden and Finland) and the DACH-region (Germany, Austria and Switzerland), which together account for at least 50% (235 million m³) of the total annual average roundwood production of 458 million m³ (average 2011-2021).[48] Based on an assessment by Metabolic, approximately 4 % of this wood is currently used for construction purposes, the remainder being used for fuel wood or paper production, whereas 90 % of the engineering wood is produced in the DACH region.

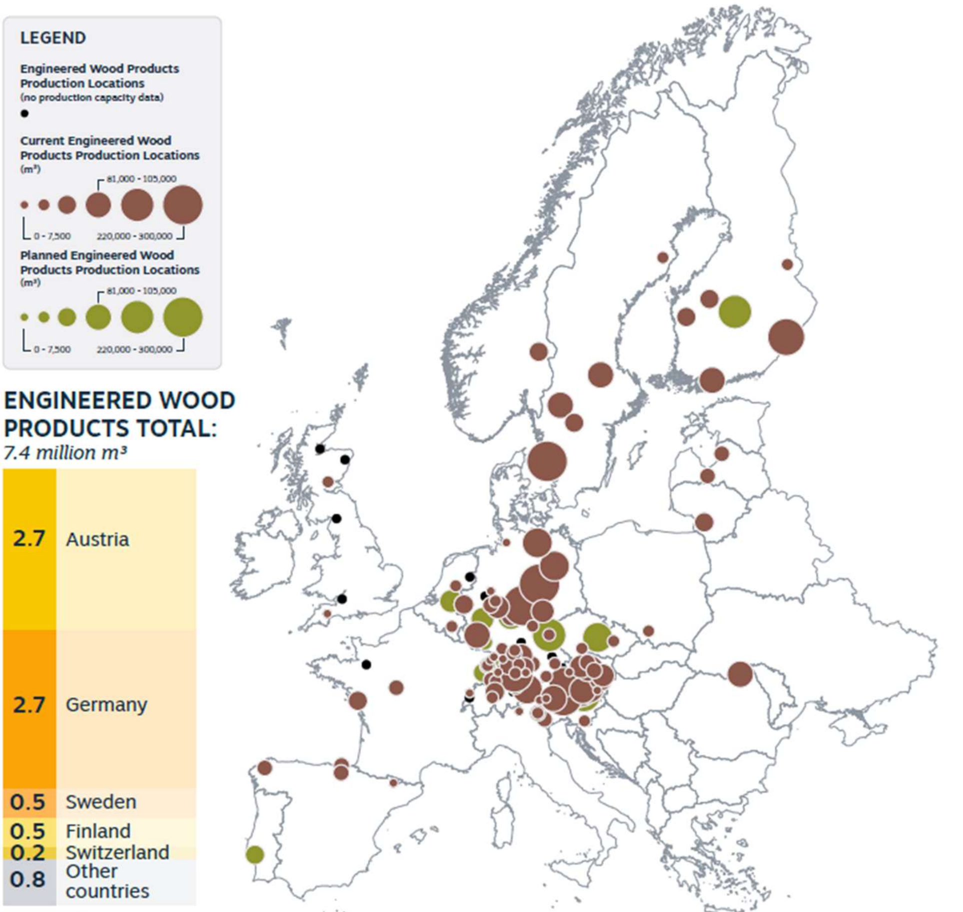


Figure 13 *EWP production locations and capacity.*

Planted forests represent around 7% of the world forest area and contribute 36% (1.2 billion m3) of the annual requirements in roundwood. As global demand for biomass grows, interest will grow in species that offer the possibility of different end uses: for fibre production, for reassembly of larger solid wood items, for energy production and, for those rich in raw materials, perhaps for the chemical industry. Hardwood species will prevail in southern Europe, while further north, softwood alternatives will be favoured. Northern and central Portugal, northern Spain and a portion of France, Italy and even Greece will grow eucalyptus (whenever climatically possible). Poland and other Eastern European countries have a huge potential for short-rotation forestry on former farmland; they could use new hybrids of eucalyptus that are capable of withstanding frost. Across Europe, favourable conditions and the available area have the potential to add almost 3 million hectares of plantations (40% eucalyptus and 60% other species) in the next 30 to 40 years.[49]

Whereas trees may take 30-60 years to grow to be ready for harvesting to become construction materials, several short cyclic or seasonal materials, including waste streams of agriculture, are being used in modern day construction (straw, hemp, flax, etc). Whereas their applications are generally limited to non-load carrying applications, the introduction of biocomposites based on biobased fibres and biobased matrices might lead to a significant increase in the use of biobased materials for the construction of buildings and infrastructures.

As an example, typical data from The Netherlands on crops used for construction materials is included below. No Europe wide overview is currently known, but it is recommended to compile such an overview in order to obtain better insight in the long term possibilities.

TABLE 3. DATA ON CROPS, USED OR USABLE FOR CONSTRUCTION MATERIALS IN THE NETHERLANDS.

	ha.	percentage of total land area	percentage of arable farming land area	percentage of total land use for biobased building materials	ref
Netherlands, incl. water	4,200,000				CBS
Netherlands, land area	3,300,000	100.0%			CBS
Netherlands agriculture (arable & livestock farming)	2,236,317	67.8%			CBS
Arable Farming	1,200,000	36.4%	100.0%		CBS
Total area of crops for biobased building materials	7,422	0.2%	0.6%	100%	NABB
Flax fibers	3,499	0.1%	0.3%	47%	NABB
Hemp fibers	3,330	0.1%	0.3%	45%	NABB
Miscanthus	593	0.0%	0.0%	8%	NABB
Potential agricultural farming for biobased building mat. by 2030, i.e. miscanthus, bulrush	50,000	1.5%	4.2%	673%	NABB
Area wheat already grown, the "waste" material straw has potential in the building industry	96,298	2.9%	8.0%	1297%	NABB

Data compiled from: CBS, www.cbs.nl and NABB, Nationale Aanpak Biobased Bouwen - Building Balance

While growing needs for biobased arise, the need for a true holistic, EU-wide and whole life cycle approach becomes clear. It is important to develop and apply scientifically sound sustainable criteria for using biomass. There is a need to put effort on systemic modelling and integrated approaches to optimize the biomass use in EU and focus on development and use of underutilized sources of biomass such as waste, forest and agricultural residues, aquatic biomass etc.

3.6 Enhancing Biodiversity

Everyone and everything in society depends on nature: all humans and all businesses need a healthy planet to survive and prosper. However, nature and biodiversity are in freefall – combined and intertwined with the climate and pollution crisis, our planet is in a perilous condition right now with

Rising global temperatures further accelerate biodiversity loss, disrupt ecosystems, and intensify resource scarcity. At the same time, natural disasters are becoming more frequent and severe, resulting in increasingly devastating impacts. This underscores the urgent need for coordinated action that addresses both climate change and the protection of nature.

Transforming our businesses and economic systems to work with, and for, nature will help to reverse these negative trends. Aligned with net-zero and circular approaches, a clear transition along industry verticals in construction amongst other sectors is necessary for meaningful positive impacts on Biodiversity.

Useful activities along the construction sector value chains help to preserve existing, restore devastated and add new habitats. Related projects suggest to reduce nature-negative impacts (by identifying and reforming environmentally-harmful policies, subsidies and activities), increase nature positive actions (by establishing policies, subsidies and finance to support nature restoration and regeneration and invest in nature-based solutions and enterprises) and act towards transformative change (by long-term actions towards systems-wide change include better approaches for valuing nature and measuring progress beyond GDP.)

Biobased construction can deliver positive ecological co-benefits—provided that material sourcing and project design are handled responsibly.

In the construction sector, enhancing biodiversity requires reducing dependence on virgin raw materials. Increased use of side and secondary biomass sources—such as agricultural residues, post-consumer wood, or forest management by-products (e.g. thinning wood and deadwood that pose wildfire risks)—can reduce land-use pressures while supporting safe and circular material flows. Recovered fibres and organic waste streams can be processed into insulation, boards, or biocomposites, reducing extraction impacts and contributing to biodiversity-positive outcomes.

Advances in clean material chemistries are simultaneously reducing toxicity across construction value chains.[50] In forestry, mixed-species management practices are improving ecological diversity and resilience[17], supported by fully traceable digital chains from forest to building that ensure alignment with certified enrichment plans.[51]At landscape scale, biodiversity monitoring systems are providing real-time insights into the ecological impact of biobased infrastructure[52], while circular carbon products demonstrate dual benefits for soil carbon storage and biological activity.[53]

Habitat gains in urban fabric through application of Nature-based Solutions (NbS) – A 2024 **JRC Urban Biodiversity** survey records **twelve EU cities** that now require *Biodiversity Net Gain* at planning stage; Paris and Milan already mandate green roof coverage of **up to 45 %** of roof area.[54] Green infrastructure integrated early in BIM workflows helps developers meet these obligations and retain eligibility for green bond finance under the EU Taxonomy *Do No Significant Harm* screen. The EU Nature Restoration law (NRL), EPBD, TNFD, CNEP and EED support the strategic implementation of NbS in urban areas and on building surfaces and guidance on nature-related risks, Nature based Enterprises grow in number and size as part of the construction industry.

Advances in **sustainable material chemistries** have enabled the removal of harmful substances in construction products, significantly improving environmental performance in downstream ecosystems. Mixed-species forestry practices have demonstrated positive impacts on ecological diversity and operational resilience[17] Digital traceability systems from forest to construction ensure alignment with certified forest management plans focused on biodiversity enhancement. At the landscape scale, real-time monitoring of ecological indicators is beginning to provide data on the broader biodiversity impacts of biobased infrastructure.

Research also suggests, that mixed-species timber stands sequester up to 20 % more carbon than monocultures while improving resilience to extreme weather events, linking biodiversity gains directly to climate-mitigation performance.[55]

Achieving these biodiversity benefits consistently will require systemic changes along the supply chain:

- **Traceable, mixed species forestry** – Prebook FSC or PEFC timber from stands managed for structural diversity; use Basajaun style digital ledgers to verify origin and management credentials in procurement files.

- **Nontoxic formulation rules** – Adopt GREENLOOP's additive free rubber and GREENLOOP/SUPERBARK biophenol flame retardants as reference chemistries in project specifications; conduct leachate assays as part of CE marking dossiers.

- **Soil positive circular flows** – Specify biochar or lignin rich soil amendments where excavation spoil is reused onsite; couple with VIBES type monitoring to report soil health gains.

- **Early stage biodiversity mapping** – Embed habitat mapping and net gain targets into the concept design phase through BIM plugins; doing so reduces redesign risk once planning authorities apply net gain conditions.

- **Disclose baseline biodiversity** – Under the Taxonomy Regulation, developers must publish a baseline survey or forfeit *sustainable finance* status. Budget early for third party ecological audits to safeguard bond eligibility.

By integrating traceability, clean chemistry, and ecosystem monitoring into mainstream construction workflows, biobased materials can move beyond "less bad" to **"nature positive"** outcomes—meeting both climate and biodiversity goals in a single investment cycle. Initiatives like GoNaturePositive[56] EU provides frameworks for aligning construction practices with nature-positive principles, while pilot projects in Italy[57] have demonstrated how forest-based supply chains, managed through ecosystem service certification, can enhance biodiversity and local economies.

3.7 Increasing Knowledge and Awareness

Awareness of biobased solutions—and of the carbon value they embed—remains patchy across Europe's design and construction community. A 2024 survey by **Wood4Bauhaus** shows that only **34 % of practising architects** can correctly cite biogenic carbon factors, despite the network's outreach to 60 organisations in 28 countries.[58] This knowledge gap matters: the forthcoming **Energy Performance of Buildings Directive (EPBD) revision** will oblige designers to disclose **Global Warming Potential (GWP)** figures at building permit stage from 2026, making carbon literacy a core professional competence.[59]

Targeted initiatives are beginning to close the gap. The **SNUG** project has developed a gamified configurator for bio-insulation and aims to train **1 000 architects by 2026**, lowering the entry barrier to whole life carbon (WLC) design.[60] In parallel, **RECONSTRUCT** is piloting a block chain enabled digital product passport (DPP) that feeds real time material data into **6DBIM dashboards**, giving project teams live feedback on embodied emissions and circularity.[61] Early adopters who embed such WLC codification into mainstream Revit or Archicad workflows are already negotiating **green lease premiums** with institutional landlords.

Yet the diffusion of these tools is uneven. Many small studios lack the Continuing Professional Development (CPD) hours—and sometimes the licensing budget—to adopt advanced LCA plug-ins. Low DPP adoption also hinders circular-design practice, as material provenance and end-of-life routes remain opaque.

3.8 Developing Skills and Expertise

Integrating biobased materials in the building faces skills and expertise barriers through the value chain of construction. The identified barriers could be summarised as follows:

- Lack of knowledge of the technical properties of bio-based materials and their specifies: Bio-based construction materials offer distinctive advantages—hygrothermal regulation, low embodied carbon, and circular potential—but their full integration requires a deeper understanding of their technical characteristics. One core barrier is designers' and engineers' limited understanding of bio-based materials' unique hygrothermal behaviour, fire resistance, mechanical performance, and ageing properties. Unlike conventional materials, these materials exhibit dynamic moisture exchange and variability in density and strength, making accurate modelling challenging. Architects and engineers should be able to confidently prescribe these materials and reinforce reliance on biobased materials.

- Insufficient training on these materials in architecture and engineering schools: There is very limited inclusion of bio-based materials in foundational training at architecture and engineering schools. Academic institutions have a key role to play in preparing future professionals for sustainable construction, and many are already integrating sustainability modules into their curricula. However, the inclusion of bio-based materials remains limited in most engineering and architecture programs. This presents a valuable opportunity: incorporating topics such as life-cycle thinking, renewable resource management, and bio-based construction systems can empower students to innovate and lead change.
- Low implementation know-how among contractors and artisans due to a lack of skilled and trained workers: Workers and contractors are essential to the successful deployment of bio-based materials, and their interest in sustainable construction is growing steadily. However, specific technical training is still needed to handle unique aspects such as moisture-sensitive assembly, non-standardized formats (e.g. straw bales, hemp blocks), and compatible sealing techniques. Training practioners will improve confidence, better execution and client satisfaction.

The transition to bio-based construction is being slowed by a significant human-capital deficit. Both the CBE-JU skills-gap analysis and the HISER workforce survey converge on the same figure: the sector is about 25 percent short of specialised labour able to design, manufacture and install bio-derived components.[62,63] Shortages are most acute in advanced robotics for automated sorting, fire-safety engineering for novel foams, and LCA data management for whole-life-carbon accounting.
Targeted training initiatives are beginning to close this gap. iCLIMABUILT operates 9 open pilot lines that combine hands-on residencies with MOOC-based theory, enabling SMEs to cut time-to-market by roughly 30 % while up-skilling staff on real equipment [64] National programmes reinforce this momentum: Italy has earmarked €75 million from its Recovery Plan for circular-construction training, while Sweden reimburses 50 % of wage costs for workers who re-skill into bio-construction roles.

The New European Bauhaus Academy (NEBA), launched in 2024, further strengthens this effort by providing transdisciplinary training across design, engineering, and sustainability domains. NEBA builds regional training ecosystems by linking VET providers, universities, and industry in hands-on learning hubs focused on circularity, digitalisation, and inclusion. By embedding NEBA modules into existing curricula and offering modular lifelong-learning paths, the initiative accelerates workforce readiness and fosters a cultural shift towards regenerative construction practices.[65]

Yet recurring training costs remain a barrier. The CALIMERO project warns that without ongoing public support, SMEs may see labour expenses rise as they struggle to retain newly certified staff.[66] Evidence from firms that have created in-house "bio-based academies" shows a 12 % improvement in retention, suggesting that continual learning budgets can pay for themselves through lower turnover.

Another innovation that ensures implementation is work place adaptation. Current practices need to be drastically changed to accommodate the novel building materials and building for circularity. Engaging the current and future workforce and co-develop the materials and practices with their involvement maximises the chance of these innovations being applied in the sector.

3.9 Cost considerations and Economic viability

Although unit prices for many bio-based products have declined sharply in recent years, three cost factors still shape adoption decisions.

Production efficiency remains central, with improvements in manufacturing throughput offering significant potential for reducing overall costs and improving return on investment.[67] Operational expenditure compared to petrochemical alternatives also plays a role; biobased additives and components can offer competitive performance while lowering long-term costs for industrial users.[22] However, price volatility in biomass feedstocks and logistical challenges still contribute to higher initial costs, which may be mitigated through scaling, improved logistics, and long-term procurement agreements.

Additional costs arise in the waste phase: demolition typically incurs landfill fees that HISER's 80 % end-of-life material recovery can largely avoid, materially improving net present value for refurbishment projects.[68]

Several strategies are emerging to improve cost-effectiveness. Substitution of fossil-based inputs with biobased alternatives can offer direct material savings and reduce compliance burdens.[69] The monetisation of stored or avoided carbon presents a growing opportunity in carbon-regulated markets, adding measurable value to building portfolios that use biobased systems. Operational synergies can also be achieved by situating production facilities close to biomass sources, thereby cutting both raw material and transport costs. The use of modular and mobile production units offers flexibility and reduces capital exposure, making it easier to scale production in line with regional demand. Finally, green public procurement policies that include life-cycle carbon and biogenic content criteria help create a predictable demand environment, which supports investment and lowers financing costs.

When viewed collectively, supply-chain resilience, standard alignment, credible carbon accounting, biodiversity safeguards and ongoing technical innovation converge to strengthen the business case for biobased construction. Stable feed-stock pathways and harmonised testing protocols lower transaction costs, while carbon-credit frameworks and nature-positive metrics open new revenue streams and de-risk investment. These converging factors reduce pay-back uncertainty, improve access to both conventional and green finance, and position biobased products as competitive options rather than niche alternatives.

4. Future perspective and R, D & I Needs

4.1 Roadmap towards 2040

VISION: *By 2040, the European construction industry will lead the transformation towards a carbon-neutral, circular and resilient built environment, powered by the widespread use of biobased materials that enhance competitiveness, sustainability and well-being.*

This roadmap is based on the insights and information collected from ECTP member organization and stakeholders (Section 7) and it outlines a transformative vision for the European construction sector. Biobased materials are expected to play a central role in achieving a carbon-neutral or even carbon-negative, circular and resilient construction industry. With the growing pressures related to climate change, resource scarcity and strict emissions regulations, there's a clear push to move away from fossil-based and critical raw materials towards **regenerative, renewable alternatives.** In general, the next 15 years will be marked by intensified emphasis on competitiveness, sustainability and digital integration across the built environment. The construction industry will increasingly demand materials that not only reduce environmental footprints but also deliver multifunctional performance, from self-healing to indoor health improvement. However, realizing this vision requires overcoming a range of existing barriers and advancing targeted research, development, and innovation (RDI). Common barriers across all application sectors include:

Innovation and market:

- High risk and cost of first-of-a-kind innovations and demonstration plants

- Valley of death in technology development (difficulty moving from lab to market)
- Unclear value proposition for emerging products
- Overdesigned products lacking optimization and clear advantages over existing solutions

Technical and performance:

- Performance and durability concerns
- Lack of end-of-life options for products

Regulatory and standardization:

- Standardization and certification gaps
- Fragmented regulation and lack of harmonized standards

Economic and environmental concerns:

- Cost competitiveness, low-volume productions
- Shortages of long-term safety and environmental impact data
- Uncertain market demand from conservative construction sector

The European construction industry is undergoing a transformation towards sustainable material choices driven by policy, market demand and technological innovations. On the **policy front**, EU is playing a central role through initiatives such as Circular Economy Action Plan (CEAP) within the European Green Deal, which targets high-impact sectors like construction and buildings to promote resource efficiency, material reuse, modular design and waste reduction. In addition, Renovation Wave Strategy is implemented in line with circular economy principles.[70] EU's Green Public Procurement (GPP) framework incentivises the procurement of sustainable construction materials by public authorities across member states, aiming to reduce emissions and promote circularity.[71,72] Both the Letta[73] and the Draghi[74] reports emphasize the importance of strategic public procurement will be for European industry. CIRCUIT EU project, funded by Horizon Europe, is advancing the integration of GPP within the transport infrastructure sector (roads, bridges, tunnels) having pilots in countries like Croatia, Spain, the Netherlands, Slovenia and Italy.[75] European Environment Agency's (EEA) report in 2024 has analysed that the future of the EU buildings system is being shaped by a complex interplay of policy, socio-economic, environmental, and technological drivers. Strong policy direction is essential to guide the transformation towards a sustainable and climate-resilient built environment. Urbanisation, an ageing population, and changing household patterns are increasing the demand for adaptable and energy-efficient living spaces, while rising inequality and post-COVID digital lifestyles are reshaping how people live and work. Environmentally, buildings must both adapt to climate change and drastically cut emissions, yet progress is limited by slow renovation rates and resource scarcity. Technologically, while digitalisation is helping improve building performance, innovation in building-specific environmental technologies has slowed.[76]

Market demand is also accelerating the shift. Regulatory frameworks, growing demand for certified sustainable materials, and financial incentives for circular practices are reshaping industry priorities. Consumer preferences are changing and there's growing demand for buildings that offer good indoor air quality, water conservation and resource efficiency. The trend is clear with increasing number of green building projects across the EU. Green certifications like LEED, BREEAM, and Net Zero Carbon are gaining traction, propelling the use of biobased construction materials.

Technological advancements are enabling more sustainable construction practices. Chapter 6.1 provides an overview of the current technological innovation landscape, highlighting that biobased construction materials vary significantly in their maturity, as reflected by their respective technology readiness levels (TRLs) across key material categories. Thermal insulation materials have seen significant advancements over the years. Currently, wood fiber, cellulose, straw, and hemp are widely deployed and commercially available, reaching Technology Readiness Levels (TRL) 8–9. In the development and demonstration stages, mycelium-based insulation, sheep wool, and other agricultural residue-based solutions are at TRL 5–7. Notably, some commercial mycelium-based insulation panels, such as those offered by companies like Ecovative (Mycofoam), are now entering the market, providing sustainable, fire-resistant, and biodegradable insulation solutions at TRL 6–8.

In the area of panels and boards, straw and wood-based panels are commonly used in the market, achieving TRL 8–9. Agricultural residue boards and panels with biobased resins show promise but are still scaling up, currently at TRL 5–7.

In the area of adhesives, coatings, and composite materials, several EU-funded projects are advancing bio-based and circular alternatives. These projects generally target TRL 4–5, focusing on critical performance aspects like fire resistance, thermal stability, reversible bonding, and non-toxic formulations, often using lignin, bark extracts, or other natural polymers. A flagship success in this field is the LigniOx project, which has now reached commercialisation. Funded under Horizon 2020, LigniOx, developed lignin-based polycarboxylate dispersants as superplasticisers for concrete and other building materials—marking a key transition from research to market deployment, and providing a sustainable alternative to petrochemical-based additives.

Biobased foams from starch, tannins, and mycelium are emerging, with limited pilot-scale deployment at TRL 4–6. Natural fiber composites, such as flax or hemp-reinforced materials, are entering early deployment, particularly in prefabrication, reaching TRL 6–8. Meanwhile, lignocellulose thermoplastics and hybrid biocomposites are under development, facing integration and performance hurdles, and are at TRL 4–6. Other biobased building elements, including doors, windows, and interior components with partially biobased content, are seen in demonstration projects and early commercial use, achieving TRL 6–7.

These advancements highlight the growing potential and market integration of biobased materials in sustainable construction.

Sector-specific insights on trends, applications and barriers

Buildings

The building sector demands multifunctional, high-performance and climate-resilient materials. Demand is growing for materials that not only meet technical performance needs, but also improve sustainability, health and energy efficiency. At the same time, the use of advanced technologies in the in material development and production is becoming more prominent.[77] Key trends and applications:

- **Multifunctional materials:** E.g. biobased materials with combined structural, thermal, or sensing capabilities, in addition to non-toxic fire retardance or pollutant capture.
- **Smart materials:** Self-sensing materials for structural health monitoring and adaptive performance. Self-healing materials to extend lifespan and reduce maintenance.
- **Indoor health:** Finishes to improve indoor comfort and health e.g. air-purifying, humidity-regulating coatings
- **Carbon-negative materials:** Composite materials integrating environmental remediation functionalities e.g., capturing pollutants such as CO_2 in marine or urban environments. Carbon capture and storage (CCS) systems integrated into construction materials, Carbon-negative construction materials (e.g., CO_2-absorbing composites like Ecorestore)
- **Biobased binders:** Mortars and concretes manufactured with alternative binders to Portland cement such as lignin- and algae-based solutions.
- **Biobased insulation materials:** E.g. foam-formed panels from lignocellulose side streams
- **Biobased building components:** E.g. Insulation panels, structural panels, 100% biobased paints and coatings, films made from wood, bark, lignocellulosic residues, and agricultural by-products
- **Biobased CLT:** Scale-up of current cross-laminated timber (CLT) usage and development of fully biobased CLT

Barriers:

- low durability, susceptibility to moisture and mould
- Lack of standardised testing data on durability and safety.
- Cost competitiveness vs. traditional cement and steel.
- Lack of data on long-term safety and performance.
- Supply chain uncertainties

Building systems

Modular and prefabricated systems are evolving through the **integration of advanced biobased composites and hybrid materials**. Key trends and applications:

- **Prefabricated modules:** Incorporating lignocellulosic materials, integration of biomaterials with 3D printing and additive manufacturing technologies
- **Functionalised building envelopes:** Walls, roofs, windows, and façades with passive energy control features e.g. temperature-regulating surfaces.
- **Hybrid material systems:** E.g., combining biobased cores with structural composites. C-Biotech company is developing biobased sandwich panels comprising a C-Hemp skin and a mycelium core aiming to the industrial scale production. Metsä wood has introduced hybrid sandwich wall elements combining concrete with Kertoâ LVL (laminated veneer lumber).
- **System-level design:** for circularity and adaptability in retrofits.

Barriers:

- Compatibility with other materials and elements.
- Re-useability (circular potential)
- Compatibility challenges with existing building codes, certification and insurance frameworks.

Energy systems

Biobased materials are contributing to **energy-efficiency, renewable energy infrastructure systems and carbon capture technologies**. Key trends and applications:

- **Energy Storage and Control Enclosures for Minigrids**: Thermal insulation and energy-buffering systems using bio-foams from agricultural side streams (e.g., Granarium Technologies).[78]
- **Integration with Energy Systems**: Renewable composites in district heating and HVAC networks.
- **Lightweight biocomposites:** For sustainable renewable energy components e.g., floating solar and biobased wind turbine component
- **Insulations in energy networks:** Using hemp, straw, mycelium for thermal and acoustic insulation.
- **Biomaterials supporting carbon capture and storage (CCS) infrastructure**: For example lignin—a key biorefinery by-product—offers strong potential for both biobased resins and energy storage, helping decarbonise renewable energy systems. VTT's LigniSmart technology[79] enables the environmentally friendly isolation of kraft lignin, producing less chemical waste than conventional methods. This lignin is particularly suitable for hard carbon production used in Li-ion battery anodes.
- **Energy-smart buildings:** Integrating energy generation in the building system, Nature based Solutions (NbS) for reducing energy footprint of the Heating Ventilation and Air Conditioning systems (HVAC) and primary energy need such as green roofs and walls, integrating solar panels into the design, integration into the electrical grid.

Barriers:

- demonstration of long-term reliability for critical energy applications under real operating conditions
- Full life-cycle assessment (LCA) and, nexus analysis (climate, water, land use)
- Continued cross-sector R&D, involving construction, material scientists and energy system stakeholders

Infrastructure

Biobased material innovations are supporting resilient, adaptive and building infrastructure for more sustainable infrastructure in marine and urban contexts[80]. Key trends and applications:

- **Smart materials:** Smart infrastructure embedding Nature-based Solutions providing for example CO_2 capture, self-healing, self-sensing/heating materials. An example is microbial self-healing solutions meaning bio-concrete with embedded bacteria[81], which heal cracks and enhance strength by precipitating calcium carbonate in BioCrete [82] and MicrobialCrete projects.[83] Systems are being piloted in structural elements like bridges and pavements. [84]
- **Green infrastructure:** Green bridges and structures utilizing lignocellulose-based composites and asphalt with biobased replacements or additives. For example in EU project Smart Circular Bridges, three bridges were built from bio-composites containing natural plant fibers and biopolymers to create load-bearing structures.[85]
- **Biobased asphalt**: PHBV (poly-3-hydroxybutyrate-co-3-hydroxyvalerate) a bacterial biopolymer has been explored as a biopolymer modifier in bitumen. [86]In addition, CHAPLIN R&D program has been exploring lignin as a partial or full binder replacement in asphalt.[87]
- **Coastal and marine structures:** Coastal /marine restoration infrastructure combining biobased materials with CO_2 capture (e.g., coastal defence, artificial reefs). For example Botanical concrete is been examined as a new green material for artificial reef in BCARE EU project.[88]
- **Concrete additives:** LigniOx, lignin oxidation technology for versatile lignin dispersants for mortar and concrete.[89]

Barriers:

- public perception and social acceptance
- high initial investment cost
- Limited long-term performance data for large-scale deployment

Key RDI needs -Biobased materials for construction evolving in the next 5-10-15 years

The transition to biobased materials in construction is both urgent and achievable, but it requires a phased (from pilot projects to full market integration) and well-supported rollout combining pilot projects, regulatory alignment, standards adaption, finally market integration. A 10-15 year timeframe is considered realistic for achieving widespread market adoption, with early momentum already seen in niche sectors. While this is ambitious, it is feasible with coordinated actions in funding, standardisation, demonstrations and public procurement.

To accelerate the adoption of biobased materials in construction, **key technological and material innovations** are needed to improve durability, reproducibility, and long-term performance in harsh and diverse environments. Improvements in biocomposites and hybrid systems, such as cellulose-based materials integrated with captured CO_2, can offer multifunctional materials, including structural support and environmental remediation. Enhancing properties like fire resistance, UV stability, water resistance, and mechanical strength through innovative treatments is essential.

Improving the industrial scalability and digitalisation of biobased materials requires the development of advanced manufacturing processes that maintain low carbon footprints throughout production. Bio-additive manufacturing (bio-3D printing) offers a promising pathway, enabling precise, material-efficient fabrication of complex components while reducing waste and energy consumption. Scaling up these technologies will require robust process control, integration with digital design tools, and compatibility with diverse biobased feedstocks to ensure both environmental and economic sustainability. High investment costs are typically involved, and if the market acceptance or performance of a new product is uncertain, it can be challenging to find someone willing to take the risk. Additionally, new biobased chemicals are not always compatible with existing processes or products, which may necessitate significant investment in product development and modifications to production lines. Furthermore, obtaining lignin with desirable chemical functionalities directly from biomass using traditional fractionation technology is difficult. Novel technologies are not yet employing sustainable or scalable processes.

Ensuring a reliable, EU-based, and high-quality supply of biobased feedstocks is foundational to the sector's sustainable growth. Robust supply chain logistics and security of raw material supply are critical enablers for wider adoption. Clear, harmonized guidelines for CO_2 footprint calculation and evaluation are needed to create the playing field. The development of first-of-a-kind case products can lead the way accelerating certification processes and supporting faster update and market adoption.

Fostering a sustainable and predictable supply of raw materials

- Strengthening EU primary supply chain of raw materials for sustainable value chains by increasing the availability of raw materials from forestry, agriculture, and waste streams to support sustainable value chains
- Optimise utilisation of local biomass through integrated value chains, focusing on EU-sourced underutilised biomass raw material
- Increasing material characterisation by efficient detection, sorting and separation in order to enhance reproducibility and homogeneity in the properties of the final biobased materials for construction. Manage variability and seasonality with predictive analytics and flexible supply chain logistics

Advancing resource-efficient and flexible processing technologies for raw materials

- Flexible processing systems: design modular, adaptable systems (analogous to oil refineries) that can adjust to variable inputs while maintaining consistent output quality. Variability of biobased feedstocks properties and variability of fraction properties based on fractionation technology
- High-quality outputs: Development of resource efficient, advanced processing for raw materials, also to increase their durability and reproducibility of long-term properties
- Minimisation and valorisation of wastes and residues to improve circularity of the construction sector and reduce environmental impacts by converting process residues into valuable secondary products
- Fast feedstock assessment: enable real-time analysis and classification of raw materials to adjust production parameters dynamically

Innovations from raw materials into new products and applications

- New biobased products: development of next-generation materials with competitive advantages such as better insulation, light-weight or climate-regulating properties
- Market-driven product design: A couple of clear winners where there is either a price advantage, a performance advantage or value that is generated by the product (such as more square meters) but not in the product.

- Competitive performance: achieve the same technical performance as those offered by the current (non-biobased) solutions
- Clear value propositions: emphasise added-value not just in product but also in delivered out comes (e.g. energy savings)

Closing material loops by maximising the recycling of products, buildings and infrastructure

- Efficient end-of-life recovery: Increasing material recovery by efficient detection, sorting and separation with improved technologies (AI, robotics etc.)
- Reuse and recycling technologies adapted to complex, durable or miniaturised products, e.g for hybrid solutions
- Developing and integrating methods for assessing and optimising cost and benefit in recycling
- Designed for circularity: promote design for dismantling and disassembly principles in buildings and building systems to enable reuse and repurposing of components

To accelerate the widespread adoption of biobased construction materials, **a focused and strategic effort is essential across several key areas**. First, developing **clear and harmonised standardisation and certification** frameworks is critical. Biobased materials vary greatly depending on their feedstocks and production methods, which leads to significant differences in performance. Without tailored standards that ensure safety, durability, and consistent quality, architects and builders face risks and uncertainties that limit their use. Existing efforts to **measure biobased content and certify geographic origin** are important steps, but a unified approach, one that also addresses carbon footprint assessment with transparency and consistency, is urgently needed. This framework will build trust among stakeholders and smooth the path for new products to enter the market. At the same time, it is vital to improve the core performance attributes of these materials, especially fire resistance, mechanical stability, and long-term durability, so they can meet existing building codes and regulations. To do this effectively, production technologies must be scaled up to industrial levels without compromising cost efficiency, making biobased materials competitive with traditional construction options. Equally important is their seamless integration into current construction systems and regulatory codes, which requires close alignment between manufacturers, regulators, and the construction sector.

Policy and regulatory support will play a decisive role in this transition. Governments can stimulate demand and competitiveness through targeted financial incentives such as tax reductions and subsidies for biobased materials. Clear, enforceable targets for their use, particularly in public infrastructure and buildings, will create reliable markets and drive large-scale adoption. Carbon pricing mechanisms should also recognise the unique carbon sequestration and low-emission potential of biobased products, reinforcing their environmental value. Streamlining certification and testing processes will help innovative materials reach the market faster, while increased public funding for research and development will cement biobased materials as a strategic priority within sustainable construction agendas.

Beyond these core actions, several cross-cutting themes will enable success. **Digitalisation** offers powerful tools to enhance material quality and performance through improved data collection, predictive analytics, and real-time monitoring. Digital twins, AI-driven models, and lifecycle assessment integration can accurately predict lifespan and environmental impact, supporting better decision-making across the supply chain. Alongside these tools, adopting **Safe and Sustainable by Design (SSbD)** frameworks ensures that new materials avoid unintended ecological harm and support circularity from the earliest stages of development. Material passports and transparent traceability systems help close loops and foster accountability across value chains. Demonstrating the environmental advantages of biobased materials is also crucial. Their ability to reduce CO_2 emissions and capture carbon can be quantified and highlighted in Whole Life Carbon (WLC) assessments, helping to justify their use over conventional construction materials. These environmental benefits, combined with improvements in production and performance, create a compelling case for transformation.

Several key technologies and supporting actions powers this transformation. **Advanced biorefineries** make it possible to use the entire biomass feedstocks efficiently, supplying sustainable raw materials for building components. While, breakthroughs in biotechnology are enabling the creation of novel biofabricated materials with enhanced properties and even improved biodegradability. Low-carbon thermochemical conversion routes enable the efficient production of building blocks. Integrated reuse and recycling technologies support circular economy and SSbD frameworks guiding the material development. Digital technologies, from lifecycle assessment tools to real-time monitoring, further optimise material management and performance. To ensure lasting success, additional themes must be taking into account. Circular economy principles should guide design for reuse, recyclability, and biodegradability, closing material loops and reducing waste. Certification schemes that consider biodiversity and ecosystem compatibility are needed for materials used in sensitive environments such as coastal or urban areas. Resource efficiency remains a priority, emphasising the renewable nature of biobased inputs and minimising land use and depletion of resources. Equally, public acceptance and workforce readiness require attention—education, outreach, and adapting workplace practices are essential to foster acceptance and proper use of these new materials. Rigorous environmental impact assessments, embedded throughout the lifecycle, guarantee truly sustainable deployment. Finally, strategic public infrastructure and collaboration frameworks can catalyse progress. **Public procurement policies** that mandate sustainability criteria and lifecycle-based carbon accounting will generate significant demand. Science-based certification programs, like BREEAM, offers net-zero construction targets, offer useful models. **Innovation hubs** that bring together researchers, industry, and policymakers can accelerate development and deployment through collaborative efforts. Together, these actions form a comprehensive pathway toward mainstreaming biobased construction materials—delivering safer, greener, and more sustainable buildings for the future.

Time horizon +5 years (2025-2030): De-risking innovation and building foundations for biobased construction materials emphasis on demonstrations and niche market update

This period focuses on demonstrations, niche market adoption, foundational capacity building and enabling conditions for scale-up and pilot plants. Biobased materials will expand primarily through pilot projects, public showcases and niche markets such as lignin-based coatings and adhesives. Local governments and early adopters, especially SMEs, will play a vital role in pioneering and validating these technologies. Several near-market innovations are expected to become commercially viable within this timeframe, including lignin- and tannin derived bioresins, adhesives and coatings, flame retardants from lignin and tannin, wood protection and building materials based on industrially available tree bark waste, acoustic /insulation panels and vegetated roofs using agriculture residues (such as straw) and secondary raw materials from wood processing (such as cork, wood chips, biochar). These materials may serve different purposes in green roof systems ranging from insulation and water storage to drainage. Biobased construction chemicals, such as those based on the LigniOx process and its products used as high-performance concrete and mortar plasticizers. These technologies represent emerging niche markets in the construction sector, focused on specialized applications like adhesives, flame retardants, insulation, and coatings. They leverage **underutilised biobased feedstocks** such as lignin, tannins, bark, and agricultural residues, offering sustainable alternatives with added functional benefits. While still in early adoption phases, they hold strong **innovation and growth potential** within a circular, low-carbon built environment. These developments will help to position biobased materials as credible and scalable alternatives to conventional construction products.

Efforts will focus on de-risking innovation by expanding the use of European Assessment Documents (EADs) and validating technologies at pilot scale. Harmonizing life-cycle data and advancing early CEN Workshop Agreements will support this process, alongside aligning verification tools with the Level(s) framework. Regulatory frameworks will evolve to encourage the adoption of biogenic CO_2 storage, structural timber, biochar, and novel biogenic composites, while policies promoting biodiversity net gain and sustainable chemistry formulations will progress to support sustainable construction. At the same time, fragmented standards, high costs, and uncertain market demand can be addressed through targeted market alignment initiatives. Early incentives like green public procurement and EU-backed Single-Entry Points will ease market access. SME entry barriers will be reduced via expanded Open Innovation Test Beds, EU-wide voucher programs, blended finance instruments, and the growth of regional innovation hubs. Demonstration projects and training programs will raise awareness and build skills, while digital tools, including BIM plug-ins, will enable full traceability, integration, and lifecycle monitoring. Sustainable forest management and mixed-species forestry with traceable sourcing will be strengthened, and emerging carbon credit markets will facilitate early monetization of carbon storage potential. Finally, biobased solutions will be systematically embedded into construction design and policy, supported by digital integration tools that improve monitoring and decision-making.

Time horizon 5-10 years (2030-2035): Production upscaling, market integration and streamlined standardisation

This timeframe will focus on large scale production and achieving full market integration of credible, available biobased material alternatives, that co-exist with the conventional construction materials and products. Established harmonized standards and certification schemes should be established, embedding biobased materials into mainstream construction practices and integrating biobased composites into public infrastructure such as housing, roadworks and coastal protection. Wider market adoption is expected for the materials introduced in the earlier timeframe (2025-2030).

The focus will be on upscaling of industrial production, and achieving market maturity for biobased construction materials. Priorities will include the development of market-ready, high-performance materials and products with certified performance, scaling-up industrial manufacturing processes, and ensuring alignment through standardised testing, certifications and building code compliance. However, key challenges remain such as limited industrial-scale production capacity and underdeveloped recyclability and performance of biobased materials in humid environments and hybrid environments. In addition, variability in natural material properties requiring case-by-case certification, and unclear carbon accounting mechanisms in building LCAs remains fragmented.

To address these challenges, solutions and milestones will include demonstrator buildings and infrastructure showcasing mature biobased systems, bio-adhesive and additive optimization to enhance durability and weatherproofing, and standardized fire-testing protocols for hybrid and nano-enabled materials adopted under CEN. Circularity and carbon storage modules will be included in CPR (Construction Products Regulation) revisions, and mainstreamed EPD templates will include CO_2 sequestration and VOC thresholds. Public tenders will require verified LCA/EPD data, creating predictable demand, and novel circular hybrid composites from biobased materials with embedded smart monitoring will be developed.

Key areas of focus will include reliable carbon accounting, economic viability, and diversification of raw material portfolios. Lifecycle carbon storage is expected become standard in green building certifications, ESG metrics, and public procurement scoring. Biobased materials with long-term storage value, such as mass timber and straw-based insulated panels, will be actively traded on voluntary and compliance carbon markets. Biochar-based systems will be deployed at the neighbourhood level for distributed carbon sequestration and soil regeneration. Standards will ensure the retention of stored carbon at end-of-life through reuse, cascading use, or permanent storage options. Industrial adoption of fungal-based and other high-efficiency, regenerative composites is anticipated for widespread use in non-load-bearing components.

Sector-wide standardisation, transformation of supply chain, and measurable biodiversity outcomes will also be prioritised. Biobased solutions will be widely deployed across urban and infrastructure projects, with performance tracked using real-time ecosystem monitoring. Compliance with baseline biodiversity surveys will become a prerequisite for access to sustainable finance. Principles of sustainable chemistry, biodiversity tracing, and habitat-positive land use will be embedded in product declarations and procurement templates. Biochar and lignin-rich amendments will become standard for soil restoration in urban developments and rewilding of brownfield sites. Furthermore, biodiversity, carbon, and circularity credits will begin to apply, supported by certification frameworks for hybrid materials.

Time horizon 15 years (2035-2040): Growth of market share and regulatory shift

Over the next fifteen years, the focus will be on achieving market maturity and systemic integration for biobased materials, making them the default options in sustainable construction. Regulatory frameworks at EU and global level will increasingly prioritise biobased materials over fossil-derived counterparts, driven by lifecycle performance, carbon sequestration potential and circularity targets.

Key challenges include the systemic lock-in of conventional materials in parts of the market, the need for ecosystem-level impact validation (biodiversity, emissions, air quality), and the maturation of full life-cycle integration (design, demolition, reuse). To address these challenges, the following solutions and milestones are pursued to be developed and achieved:

- full CPR and Eurocode harmonization for biobased categories
- established EU-wide EPD schemes incorporating biogenic carbon and indoor health criteria
- the routine use of digital twins and BIM tools to simulate biobased performance across the life cycle.
- Circular public procurement (CPP) within GPP and carbon-accounting building passports will mandate sustainable sourcing of biobased materials
- Development of integrated construction ecosystems characterised by resilient local supply chains, reuse markets, and SME clusters.
- Widespread use of biodiversity-enhancing materials, such as load-bearing and carbon-negative elements, in infrastructure and building systems.

By this period, biobased buildings will be recognised as long-term carbon sinks throughout their life cycle, actively contributing to EU net zero targets. Coupled carbon and biodiversity credits will become common, enabling compound financial returns and ecosystem restoration. Full digital ledgers will trace carbon flows from forest/farm to building and through reuse loops. Cement, steel, and ceramic replacements will reach maturity using biomass- or waste-derived carbon-storing materials. Carbon storage will become a reliable, bankable revenue stream in construction financing, with simplified certification and monetization processes.

Biobased construction will focus on systemic renewal, multi-benefit infrastructure, and biodiversity as a value driver. Biodiversity net gain will become a core value proposition, quantified and verified across entire projects. Nature-positive construction materials and designs will generate stackable credits—carbon, biodiversity, and water regulation—monetized via integrated marketplaces. Forest-based supply chains will be managed to enhance species richness, climate resilience, and local livelihoods, aligned with ecosystem service certification schemes. Continuous biodiversity monitoring data will feed into adaptive building and landscape management, closing the loop between design, performance, and ecosystem outcomes. Biobased enterprises will become a mature industry segment, with biodiversity-enhancing practices embedded in construction training, insurance, and risk models.

It is expected that in the future SMEs will operate seamlessly within a fully integrated ecosystem of innovation, finance, certification, and market access platforms, enabling rapid product scaling and diversification. Risk-based regulatory regimes will be fully harmonized, with streamlined approval and certification accelerating innovation cycles. Europe-wide digital infrastructure will support transparent material provenance, performance tracking, and circularity at scale. Sustainable forest and biomass supply chains will underpin a circular bioeconomy, with significant shares of feedstock coming from recycled streams. Advanced biorefineries and biobased manufacturing hubs co-located near feedstock sources enables optimized supply chains and reduce emissions.

To be able to achieve transformation of construction industry to more biobased utilising industry, the workforce should be agile and commit to continuous learning, with biobased construction expertise embedded in mainstream higher education programs. A cultural shift towards regenerative construction practices will become mainstream, with a strong emphasis on ecosystem services, biodiversity net gain, and circularity. Biobased materials will become standard in construction, with cost parity, or even advantage, over fossil-based alternatives achieved through mature supply chains and optimized, scale-up material production. Carbon and biodiversity credits will be integrated into financial markets, creating strong incentives for large-scale adoption of biobased materials and products. Green procurement policies and voluntary market mechanisms will actively support biobased product demand, enabling long-term investment and innovation in the construction sector

The **roadmap** summarises the key development trends, biobased material and technology developments and innovations currently happening and expected to evolve in 5, 10 and 15 years. As of 2025, biobased materials represent only a small fraction of total materials used in the construction sector globally, 2-10 % depending on the application and according to different calculations and statistics available. Currently, their uptake is uneven and region-specific. This includes timber, engineered wood products (e.g CTL), insulation made of hemp, flax, cellulose and emerging products like mycelium composites and bioresins. While biobased materials alone cannot fully replace conventional materials, their share can grow when using diversified feedstock base combined with end-of-use strategies, meaning reuse, recycling and the implementation of circular economy principles. This transition is not only technologically viable, but also environmentally necessary to meet EU and global climate targets. Continued investment in research and innovations, standardisations and capacity building will be essential to realise this at scale.

Timeframe	>5 years (short-term)	5-10 years (mid-term)	10-15 years (long-term)
Key trends	✓ Operational pilot plants & real-climate testing: expanded OITBs, demo houses, and validation under real conditions ✓ Regulatory fast-tracking: wider EAD use and CEN protocol acceleration for CE marking ✓ Sustainability in procurement: GPP criteria integrating LCA, circularity, and biobased metrics ✓ Digital tracking tools: rollout of WLC tools, digital passports (blockchain), and BIM integration ✓ Workforce upskilling: targeted training to address labour shortages ✓ Verified biomass supply: mixed-species forestry with traceable sourcing	✓ Europe-wide access to fully functional, shared pilot facilities accelerates market entry ✓ Harmonised standards & certification: standardised fire-testing (CEN), CO_2 accounting, and EPD templates including sequestration and VOCs adopted ✓ Sustainable procurement: public tenders require LCA/EPD data; biodiversity, carbon, and circularity credits integrated ✓ Diversified feedstocks: broad use of biomass, including recycled and carbon-captured inputs, supports resilient supply chains	✓ Bio-based materials are standard in construction ✓ Europe-wide digital infrastructure supports transparent material provenance, performance tracking, and circularity at scale ✓ Biobased buildings designed with integrated disassembly and reuse frameworks. Circular design principles embedded in building codes and education ✓ Forest-based and agriculture-based value chains are fully integrated

Timeframe	>5 years (short-term)	5-10 years (mid-term)	10-15 years (long-term)
Buildings	▪ Commercial use of lignin- and tannin-based bioresins, adhesives & coatings and fire-retardants ▪ Market-ready wood protection chemicals & building materials from bark waste ▪ Increased market uptake of biobased and biofabricated acoustic/insulation panels & green roofs ▪ Market introduction of multifunctional biobased materials ▪ Pilot deployment of first-generation carbon-negative materials	▪ Optimised biobased adhesive and additives offering improved durability and weather resistance ▪ Biobased hybrid composites that are designed for circularity with embedded smart monitoring features ▪ Integration of adaptive and self-healing materials in commercial buildings ▪ Deployment of carbon-negative concrete in buildings ▪ improved separation and recycling of multi-material construction elements	▪ Full integration of high-performance biobased materials ▪ Biobased fire-protective materials ▪ Deployment of regenerative building envelopes that purify air and manage heat
Building system	▪ Prefabricated modules with hybrid systems ▪ Early-stage 3D printing with biocomposites for non-load bearing applications ▪ Biobased passive thermal systems	▪ Functionalised facades using temperature-regulating biobased composites ▪ Integration of prefabricated structural systems into net-zero housing ▪ System-level circularity adaption	▪ Modular and prefab systems using biobased materials dominate; plug-and play building blocks composed of biobased materials ▪ Advanced materials performance tracking via embedded sensers in biobased structures ▪ Standardised modular systems that use AI/ IoT for building adaptability and energy balance
Energy system	▪ Pilot-scale deployment of biobased composites in wind blade extensions and floating PV structure ▪ Biobased insulation materials in district heating and HVAC networks ▪ Lignin-based materials in energy storage prototypes	▪ Pre-commercial use of biobased Li-ion battery anodes and hard carbon ▪ Integration of green facades with solar and HVAC systems ▪ Localised microgrips with embedded biobased materials for passive regulation and CCS	▪ Full integration of biomaterials in buildings for energy capture, storage and environmental regulation ▪ Net-negative energy systems
Infrastructure	▪ Deployment of microbial bio-concretes in experimental bridges ▪ Biobased concrete piloting in marine environments ▪ Carbon capture cellulose-based materials tested and validated in marine environments	▪ Use of self-healing bioconcrete in municipal pavements ▪ Coastal defences built with carbon capture cellulose-based materials	▪ Full integration of smart infrastructure systems: repairable and circular biobased materials in use ▪ Embedded carbon storage features in infrastructure solutions

Technology/product innovations

Materials innovations

<u>Cross-cutting themes</u>

Policy & regulation: Align with EU green policies (e.g. CPD, taxonomy, SSbD) to enable biobased market access.
Biodiversity & local sourcing: Promote regenerative sourcing and ecosystem-positive materials from local, renewable biomass.
Societal acceptance & skills: Engage communities and support workforce upskilling for the bioeconomy transition.
Green Public Procurement (GPP): Use public demand to scale adoption of sustainable biobased construction.

5. Specific recommendations

- Promote **public-private R&I partnerships** to bridge the lab-to-market gap.
- Encourage **cross-sectoral collaboration** (construction, materials, digital) to accelerate adoption of multifunctional biobased materials.
- Provide a **Europe wide overview of biobased potential** coming from crops and biobased waste streams.
- Influence **regulation** to promote biobased future solutions uptake to the markets
- Create **3-yearly updates** of the Roadmap

6. Conclusions

The future of biobased materials in construction is bright, driven by advances in material science, technology, and supportive policies. With continued research, innovation and collaboration, the construction industry can lead the shift toward a more sustainable, resilient, and circular built environment.

This position paper presents a strategic roadmap that highlights key priorities: advancing research and innovation, fostering collaboration, supporting SMEs and aligning policy to accelerate the adoption of biobased construction materials.

In conclusion, integrating biobased materials into construction will not only help mitigate climate change and improve resource efficiency, but also open new business opportunities and enhance the sustainability of our built environment. Achieving this vision will require a collective effort—bringing together stakeholders across the sector through shared commitment and innovation.

Timeframe	>5 years (short-term) **Pilot deployment**	5-10 years (mid-term) **Commercial integration**	10-15 years (long-term) **Widespread adoption**
Key trends	✓ Pilot testing, fast-tracked regulation, and GPP integration accelerate biobased market readiness. ✓ Digital tools, workforce training, and verified biomass sourcing support scalable deployment.	✓ Shared pilot facilities and harmonised standards streamline adoption across Europe. ✓ Public procurement and diversified feedstocks drive sustainable, resilient supply chains.	✓ Biobased materials become mainstream through circular design and digital transparency. ✓ Fully integrated forest and agriculture-based value chains enable closed-loop construction systems.
Buildings	▪ Market introduction of advanced biobased building materials.	▪ Deployment of circular, smart, and carbon-negative biobased materials in commercial construction.	▪ Full integration of high-performance, fire-safe, and regenerative biobased building systems.
Building system	▪ Hybrid prefab, 3D-printed, and passive biobased systems.	▪ Integration of circular, net-zero structural systems with smart biobased façades.	▪ Widespread adoption of modular, sensor-enabled biobased systems with AI-driven adaptability.
Energy system	▪ Biobased materials in renewable energy infrastructure and storage.	▪ Pre-commercial integration of biobased energy systems in buildings and local grids.	▪ Full integration of biobased materials for net-negative, self-regulating energy systems.
Infrastructure	▪ Introduction of carbon-storing biobased concretes in infrastructure and marine environments.	▪ Application of self-healing and carbon-capturing materials in urban and coastal infrastructure	▪ Full integration of circular, smart biobased materials with embedded carbon storage in infrastructure.

Technology/product innovations

Materials innovations

Cross-cutting themes

Policy & regulation: Align with EU green policies (e.g. CPD, taxonomy, SSbD) to enable biobased market access.
Biodiversity & local sourcing: Promote regenerative sourcing and ecosystem-positive materials from local, renewable biomass.
Societal acceptance & skills: Engage communities and support workforce upskilling for the bioeconomy transition.
Green Public Procurement (GPP): Use public demand to scale adoption of sustainable biobased construction.

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8. Annexes

ANNEX 1. OVERVIEW OF RECENT AND ONGOING NATIONAL AND EUROPEAN RESEARCH PROJECTS WITH A FOCUS ON BIOMATERIALS IN THE CONSTRUCTION SECTOR.

Name	Short description	Focus	TRL (end)	Years	Funding
NABB	Nationale Agenda Biobased Bouwen www.buildingbalance.eu/nationale-aanpak-biobased-bouwen	Supply chain "short cyclic" Biobased materials ("from land to building")	3-7	23-28	National (NL)
TBL	Toekomstbestendige Leefomgeving www.toekomstbestendigeleefomgeving.nl	Focus on application in industrially produced buildings using biobased materials (up to TRL 8) . Also, TRL 3-5 activities on straw and hemp towards application	5-8	23-28	National (NL)
UNRAVEL	Development and scale-up of biomass valorisation processes www.cbe.europa.eu/projects/unravel	Xylonic acid (TRL5), Acetone (TRL5), PU foams (TRL5), bitumen additive (TRL5)	5	18-22	BBI-JU
Hypelig num	Use of biogenic and sustainable materials, wood and wood derivatives, in electronics www.hypelignum.eu	Conductive inks, dielectric inks, fire retardants, cellulose-based PCB, coatings, resins	5	22-26	Horizon 2020
EB-Phase2	Emissieloos Bouwen- Phase 2 www.tki-bouwentechniek.nl/programmas	Several projects working towards emission-free construction. Focus on industrial, biobased construction	5 - 7	23-25	National (NL)
BIOMAT	Open Innovation Test Bed Nano-Enabled Biobased PUR Foams and Composites. www.biomat-testbed.eu	Develop and scale up 12 processes to TRL7 for producing nano-enabled biob. composite materials and low-cost cellular, nano-reinforced foams.	4-7	20-24	Horizon 2020
R-LIGHT BIOCOM	New biobased raw materials www.r-lightbiocom.eu	New biobased and sustainable raw materials enabling circular value chains of high-performance lightweight	5	22-26	Horizon 2020
VIBES	Recyclability of thermoset composite materials through a greners recycling www.vibesproject.eu	The VIBES project aims to develop 100% biobased bonding materials (BBM) for thermoset composites with tailored debonding functionality	5	21-25	BBI-JU
ECOFUN C	Eco-Friendly Circular and Functional Building Materials for Sustainable Construction. www.ecofunco.eu	The use of carbon-negative polyhydroxyalkanoates (PHAs), produced by microorganisms using CO2 as feedstock, thereby reducing the sector's environmental footprint	7	25-29	Horizon 2020
BIOMAC	European Sustainable Biobased nanoMAterials Community www.biomac-oitb.eu	Open access to facilities (17 Pilot Lines) and complementary services required for development, testing and upscaling of materials and products with nano-enabled biobased materials	7	21-25	Horizon 2020
Subbimat t	Sustainable, Biobased and Bio-Inspired Materials www.protoqsar.com/en/portfolio	Develop sustainable, biobased, and bioinspired smart technical textile materials to address energy needs.		24-27	Horizon
Metabuil ding lab.	EU-wide network of Testing facilities www.metabuilding-labs.eu	EU Construction Open Innovation Testbed & Innovation services for new building envelope technologies and products		21-26	Horizon
RELIANCE	Innovative self-disinfectant antimicrobial nanocoating www.reliance-he.eu	Contact killing and leachable antibacterial actions ascribed to the additive, with the non-sticking action due to the coatings' formulation		22-26	Horizon
STT	Smart Technical Textiles	Material development (several), taking climate considerations into account	7	21-25	Horizon 2020
BEST	Biobased materials for a greener construction industry, www.cordis.europa/project/id/101086440	BEST it will research the use and implementation of biobased composites that will allow for improved structural and energy efficiency	4-7	23-27	Horizon 2020 MSCA

Calimero	Improving biobased industries' life cycle sustainability www.calimeroproject.eu	Analyses case studies across five biobased sectors to find solutions and improve overall environm., economic and social performance of industries	4-7	22-25	Horizon 2020
INGUMA	Reducing the footprint of consumer products through public dialoGUe and innovative biobased Material www.inguma-biobased.eu	Development biobased materials and their acceptance by the public. 3 main values: sustainability, inclusion, and aesthetics. Demo house, incl. structural mycelia-fibres insulation panels & resin free wood fiber boards	5-6	24-27	Horizon 2020
INBUILT	Innovative bio/geo-sourced, re-used and recycled products www.inbuilt-project.eu	Amongst others large-sized rammed earth blocks, recycled bricks, straw-clay boards and smart windows, coupled with a BIM-based digital platform for low carbon construction, circular economy, energy and resource efficiency	4 - 7	23 -27	Horizon 2020
GREEN-LOOP	Sustainable manufacturing systems towards novel biobased materials www.greenloop-project.eu	Multifunctional panels, rubber panels with fire resistance and vibrational applications	4-7	22-25	Horizon 2020
BIO-UPTAKE	BIOcomposites in smart plastic transformation processes to pave the way for the large-scale UPTAKE of sustainable biobased products www.centexbel.be/nl/innovatie/onderzoek/bio-uptake	Ensure a sustainable uptake (increase the use by 39%) of bioplastic composites through boosting a twin green and digital transformation in the European manufacturing industry	4-7	22-26	Horizon 2020
MULTICLIMACT	A multi-faceted replicable approach for intervening on several climatic and natural hazards www.multiclimact.eu	A hemp-based thermal insulation panel will be adopted as support for a new sustainable, patented plaster mix for indoor applications.	7	23-27	Horizon 2020
TEAPOTS	agriculTurE wAste PyrOlysis and Thermocomposting for renewable energy in Sustainable agri-food sector www.teapots-project.eu	Efficient biochar production from various biomass sources		24-27	Horizon
BIO4EEB	BIO insulation materials for Enhancing the Energy performance of Buildings www.bio4eeb.eu	-hazardous biobased materials such as the seagrass Posidonia oceanica and various biobased foams to develop smart components		23-26	Horizon
BIOBUILD	Innovative biobased building materials with thermal energy storage function www.bio-build.eu/about-biobuild	Biobased wallboards and parquet, Bio-composites with energy storage functionalities (PCM), Materials bound by plant oil resins		24-27	Horizon
Caleche	Coherent Acceptable Low Emission Cultural Heritage Efficient Renovation www.calecheproject.eu	Energy retrofit of historic buildings, focus on developing a multi-benefit decision support system (DSS). Insulating lime-based plaster with biobased aggregates. Interior bio-insulation with high hygrometric performance	4 -5	23-26	Horizon
FuturHist	to develop replicable retrofit solutions for historic buildings of the future www.futurhist.eu	Natural materials like clay, natural lime, and biochar for internal and external insulation system variants	5	24-27	Horizon
BASA JAUN	Sustainable building with wood www.basajaun-horizon.eu	Demonstrate how wood construction chains can be optimized to foster both rural development and urban transformation whilst being connected with sustainable forest. Thermal insulation material as the core layer of Structural Insulation Panels (SIP) and applications of similar conventional materials (e.g., glass wool). Full-scale demo projects	6-7	19-23	Horizon
HIPer	High-performance cellulose-based composites www.hiperproject.com	Target of HiPer project is to generate a completely new product portfolio based on lightweight, sustainable composite materials.	5	22-24	National (FIN)
Fold2	create novel folding technology for light-weight design structures and protective packaging www.fold-project.com/category/fold2	Create a new, industrial-scale technology and a new portfolio of industrially foldable sustainable products that increase the export volume and open new business opportunities for Finnish companies	5	24-26	National (FIN)
LigniOx	Valorisation of lignin www.cbe.europa.eu/projects/ligniox	demonstrate the techno-economic viability of the unique alkali-O2 oxidation technology (LigniOx) for the conversion of several lignin-rich side-streams into versatile dispersants, and especially high-performance concrete and mortar plasticizers.	7-8	17-22	EU CBE JU

DWoC	Design Driven Value Chains in the World of Cellulose www.chemarts.aalto.fi/index.php/dwoc	Combining design thinking and design-driven proto-typing with a strong competence in technology development. To utilize cellulose in highly refined products like textiles, fashion, interior decoration, health products, architecture and construction.	5-6	13-18	National (FIN)
FCCBE	FireCellCoat/BioEconomy in the North www.firecellcoat.wordpress.com	develops bio-inspired, fire-resistant wood coatings based on high-consistency microfibrillated cellulose (MFC) that protects wood-based building products in interior and exterior applications.	5	00-22	Regional National (FIN)
ReWoBioRef	recycled waste wood that has reached the EC end-of-waste criteria www.firecellcoat.wordpress.com	To explores the techno-economic feasibility, scientific requirements, and material specifications to utilize recycled waste wood in lignocellulosic (LC) biorefinery processes	5	14-17	ERA-NET & National (FIN)
ABiCo	Demonstrating biocomposites in industrial processing techniques	Develop innovative biobased biocomposite solutions to replace fossil-based primary raw materials and increase the use of recycled polymers and biobased raw materials	6-7	25-28	National (FIN)
Circular Drifter	Design ready, demo house will be built 2025 (funding negotiations with companies ongoing) www.vttresearch.com/en/news-and-ideas/pop-cafe-transforms-mini-office	Design a building that will be built and dismantled at least twice. The experiment aims to investigate building materials and products in real disassembly and reassembly situations.	-	25-xx	National (FIN)
EU SuperBark	Adhesives and coatings for wood panels www.superbark.eu	Create safe and sustainable adhesives and coatings sourced from pine and spruce bark, which are major industrial side streams of the forest industry	4-5	23-27	CBE JU
EU-BioPhenom	Tannin-based flame retardants and wood preservatives www.biophenomproject.eu	Produce biophenols from industrial biomass sidestreams using advanced technologies and processes such as fast pyrolysis and liquid extraction. Biophenols for biobased intumescent flame retardants (bio-IFRs) and to replace SVHC in wood products, bio-CF thermoset composites, and PLA-based thermoplastic composites.	5	24-28	Horizon
Perfect Wood	Make the most out wood by exploring the possibilities to improve its characteristics and requirements set by wood construction in urban area www.expandfibre.com/news/item/perfectwood-co-research-project-joins-the-expandfibre-ecosystem	Investigate the chemical modification of construction wood by improve fire retardancy, dimensional instability and decay resistance.	6-7	24-27	National (FIN)
HISER	Holistic Innovative Solutions for an Efficient Recycling and Recovery of Valuable Raw Materials from Complex Construction and Demolition Waste www.hiserproject.eu	Development of optimized building products (low embodied energy cements, green concretes, bricks, plasterboards and gypsum plasters, and extruded composites) through the partial replacement of virgin materials by secondary high-purity raw materials from complex C&DW	6-7	15-19	Horizon
ICEBERG	Innovative circular economy-based solutions for the building industry. Innovative tools and technologies to advance the industry's uptake of the circular economy. www.iceberg-project.eu	Develop innovative technologies and strategies for the production of high-purity secondary raw materials from construction, renovation, and demolition waste (CDW). Key objectives include: developing technologies for sorting, processing, and purifying various types of waste materials such as wood, concrete, plasterboard, glass, and polymeric insulating foams, implementing circular design solutions to enhance the circularity of building materials and produce innovative building products with high recycled content & creating smart solutions for reverse logistics, including upgraded BIM-aided smart demolition tools, digital traceability platforms, and identification systems using Radio Frequency and QR codes.	7	20-24	Horizon

CRESTIMB/Forest Value2	Increased Service Life of Innovative Timber Buildings Systems www.forestvalue.org/project/crestimb	Ground-breaking timber building system for multi-storey structures with open spaces. The system will feature glue-laminated timber frames made from softwood or hardwood, combined with innovative beam-to-column connections and dowel cross-laminated timber floor panels	5-6	23-27	Horizon
WATERin WOOD	Image-based Modelling of Water Transport In Wood including material biodegradation www.cris.vtt.fi/en/projects/image-based-modelling-of-water-transport-in-wood-including-materi	Develop a comprehensive multi-phase model for transient moisture transport in wood and modified wood,	5	22-25	National (FIN)
5G timber	5G-TIMBER aims to support the rapid uptake of 5G technologies, considering real industrial practices and constraints in the EU timber industry over the wood value chain. www.5g-timber.eu	Support the rapid uptake of 5G technologies, considering real industrial practices and constraints in the EU timber industry over the whole value chain, focusing on small-volume manufacturing industries. 5G-Timber aims to increase wood-based recycling by 50%, productivity by 15%, reach 99% of the work done in the factory (vs. 85% today), reduce on-site work by 10% & product nonconform-mities by 10%, and increase workers' safety in wooden houses production and onsite assembling.		22-25	Horizon
BIOTRANSFORM	Circular BIOeconomy TRANSFORMation for regions by enabling resource and governance networks www.biotransform-project.eu	Provide European policymakers with an adequate assessment and policy development framework, knowledge base and expert support ecosystem to accelerate the transition from linear fossil-based to circular biobased systems. It is operating at the interface between the circular economy and the bioeconomy transitions.		22-25	Horizon
CIRCBUILT	Circular Biobased Products for the Built Environment www.circbuilt.eu	Validation of 4 different kind of construction products made from 100% secondary biobased materials: thermal insulation panels, construction panels, indoor acoustic panels and adaptive passive cooling smart windows.	5	25-28	Horizon (MISS, NEB)
BIO-UP	Towards Biobased concretes with controlled properties	Development of new additives for concrete and assessment of their properties	3 - 6	21-25	National (FIN, ANR)
BIOMETA	Biobased, flame-retardant materials optimized for thermal and acoustic applications www.biometa.fi	Identify and use biobased flame retardants compatible with plant wools; optimize the material's performance at reduced thickness to compete with conventional materials; develop a method for joint global optimization of acoustic and thermal performance	3 - 6	24-28	National (FIN, ANR)
Cluster of Excellence IntCDC	Integrative Computational Design and Construction for Architecture www.itke.uni-stuttgart.de/research/current-research-projects/cluster-of-excellence-integrative-computational-design-and-construction-for-architecture	Establish an overarching methodology of Co-Design between the development of computational design and construction methods, robotic manufacturing and construction processes, and next-generation material and construction systems. Wood, structural fibre (e.g., flax), etc. Fundamental research, but several real buildings and bridges built	1 - 3	19-25 & 2nd phase 26-32	National (DE)
ValBio	Valorisation of Bioresources www.valbio.uni-stuttgart.de	Establishing sustainable development through intensive application of bioeconomy. Wide range of biobased materials, including construction materials (e.g., Bio-concrete, etc.)	1 - 3	21-24	National
EASI ZERo	Low impact envelope system for efficient renovation and zero energy buildings www.easizero.eu	Develop and validate an innovative building envelope component package for efficient building renovation with a low carbon footprint. Material sources are wood, used wood pieces, grown mycelium, or recycled construction waste	7 - 8	22-26	Horizon

Exploit4InnoMat	Establish a sustainable Open Innovation Test Bed (OITB) across Europe. www.exploit4innomat.eu	Platform to support the design, upscaling, and validation of new advanced and nano-enabled materials for building envelopes. Functional graded concrete with recycling material, bio-concrete, 3D-printed semi-inorganic façade elements, Cement-free materials and components	7 - 8	23-26	Horizon
SNUG	Development of sustainable insulation solutions www.snugproject.eu	Biobased panels, aerogel solutions from CDW and aerogel waste, bio-PU, etc.	7 - 8	23-27	Horizon
Wood Stock	Climate-smart, circular, and zero-waste use of underutilized wood resources in the construction sector. www.woodstockproject.eu	Key objectives 1)Developing climate-smart solutions for increasing the use of underutilized wood resources, 2) Advancing circular economy practices in wood construction, 3) Promoting zero-waste innovation through the use of reclaimed timber, 4) Quantifying and mapping wood resources using advanced methodologies like dynamic Material Flow Analysis and Life Cycle Assessment.	5	24-28	Horizon (NEB)
iclimabuilt	Functional and advanced insulating and energy harvesting/storage materials across climate-adaptive building envelopes www.iclimabuilt.eu	The project aims to greatly improve buildings' energy efficiency by developing the necessary materials (biobased and artificial) and taking climate considerations into account to deliver Europe's sustainable buildings of the future.	6-8	21-25	Horizon 2020
Circular Tech	Industrial Cluster for the development of innovative products and services that respond to the specific challenges of the transition to a Circular Economy www.circulartech.pt	Contribute to solving a problem that humanity has faced since the Industrial Revolution: waste. The Agenda aims to change the paradigm and make it a resource to be valued. To this end, it aims to put intelligence into the management of the waste value chain, from the logistics of local and/or regional storage, through the optimization of its transport, and culminating in the transformation of this waste into a resource to be reintroduced into the chain as raw material.	1-4	23-25	PRR - Recovery and Resilience Plan by the European Union

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