White Paper on Industrialisation in Construction

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Contents

List of acronyms

AI	Artificial Intelligence
BACS	Building Automation and Control System
BIM	Building Information Modelling
CID	Clean Industrial Deal
DHC	District Heating and Cooling
EED	Energy Efficiency Directive
EPBD	Energy Performance of Buildings Directive
EPC	Energy Performance Certificate
ESCO	Energy Service COmpany
ETS	Emissions Trading System
EV	Electric Vehicles
GHG	Greenhouse Gases
GIS	Geographic Information System
IAQ	Indoor Air Quality
IWG	Implementation Working Group
LCA	Life Cycle Assessment
MFF	Multiannual Financial Framework
NECP	National Energy and Climate Plan
NBRP	National Building Renovation Plan
NZIA	Net Zero Industry Act
PV	Photovoltaics
RED	Renewable Energy Directive
SME	Small-Medium Enterprises
SRI	Smart Readiness Indicator
TRL	Technology Readiness Level

Executive summary

Decarbonising the built environment is not only an environmental imperative—it is a critical strategic opportunity to boost innovation, improve living standards, and strengthen Europe's energy security.

This white paper, prepared by Task Force 7 of the Implementation Working Group on Energy Efficiency in Buildings (IWG5), explores how industrialisation can accelerate the clean energy transition in buildings, focusing on six key thematic areas that are essential for unlocking widespread impact:

1. Digitalisation and Industrial Efficiency
2. Market Drivers and Financial Mechanisms
3. Social Acceptance and Workforce Readiness
4. Legislation, Standardisation, and Policy Alignment
5. Renovation and the Circular Economy
6. Systems Integration and Innovation

Major barriers are identified—including fragmented supply chains, low digital adoption, outdated regulations, and a shortage of skilled labour—and present actionable, targeted recommendations to overcome them. It proposes concrete strategies such as expanding digital construction hubs, integrating material tracking to improve circularity and enabling new financial models. It calls for policies supporting modular prefabricated housing concepts and the integration of advanced digital tools, such as Building Information Modelling (BIM) and Artificial Intelligence (AI) among others.

The paper highlights the need to better align policy instruments and funding mechanisms. It also stresses the importance of cross-sector collaboration—with energy, manufacturing, and digital industries—to unlock synergies and scale innovation. By enabling a more standardised, digitalised, and integrated approach to building renovation, the EU can reduce costs, cut emissions and stimulate sustainable economic growth.

The EU has at its disposal a range of policy and funding instruments that can accelerate the industrialisation of the built environment, such as under the next Multiannual Financial Framework and its recent Clean Industrial Deal Roadmap.

At the economic level, long-term, reliable funding mechanisms are vital for enabling widespread adoption of clean technologies and driving demand for industrialised renovation solutions. European public authorities, with procurement budgets exceeding €2 trillion annually, can play a major role in market transformation by adopting pre-commercial, encouraging ESCOs to deliver guaranteed performance outcomes and green procurement approaches.

The alignment of construction with energy, mobility, digital, and bioeconomy sectors offers opportunities to enhance supply chains, decarbonise heating and cooling systems, and ensure grid stability.

Lastly, the paper evaluates how industrialisation can reinforce the implementation of IWG5's innovation targets.

Introduction

Buildings are responsible for around 40% of the EU's energy use and 36% of its carbon emissions, taking into account construction, usage, renovation and demolition. To meet the challenges of decarbonising buildings and making them more resource efficient, the EU has set medium and long-term decarbonisation goals for 2030 and 2050 under its European Climate Law. The Fit for 55 Package increased the ambition of the EU's 2030 climate and energy objectives, including provisions for the decarbonisation of the construction sector in the revised directives for buildings (EPBD), renewables energy (RED) and energy efficiency (EED). Another key policy development (and a precursor to Fit for 55) was the 2020 publication of the Renovation Wave Strategy and its roadmap.

These political signals have given a new impetus to building renovation, including €81 billion in funding for energy efficiency in buildings from the Recovery and Resilience Facility, as well as the preparation of more detailed construction measures in national plans – both in the revised NECPs and the upcoming new NBRPs. These efforts have brought more attention to the building sector and increased the deployment of several key technologies, for example, the 'solar mandate' is expected to significantly impact on the development of rooftop solar. Nevertheless, Europe is at serious risk of falling behind and not meeting several of its energy targets, as BPIE highlights in its EU Buildings Climate Tracker. Missing the energy targets linked to buildings would have negative repercussions on the climate, people's indoor comfort, on Europe's energy prices and its energy security in the years ahead.

Two of the main hurdles for decarbonising buildings are the high economic costs – particularly for a significant amount of hours of on-site working time - and the complexity that are involved. This is particularly relevant for deep and energy efficient renovations, which are expected to represent the largest area of intervention. The industrialisation and standardisation of processes and products, along with the mainstreaming of digital technologies, has significant potential to reduce costs and building times. This paper aims to identify gaps and offer targeted recommendations to industrialise buildings' supply chains and the construction process itself. While industrialisation offers potential to overcome these economic and technical barriers, this paper also underscores the imperative for a Just Transition. This means ensuring that the benefits of energy-efficient renovations are accessible and equitably distributed across all societal groups.

The first section on 'Scope and main objectives' identifies six key areas with objectives to drive industrialisation. The following section looks at gaps and barriers in these six thematic areas, followed by strategic insights with recommendations to overcome them. The next section builds on the previous two and focuses at the European level on 'EU Policy levers and funding instruments'. Lastly, there is a chapter on the 'Interlinks with other sectors and IWG5 targets' that explores synergies with the energy, materials and digital sectors; it also looks at how a drive to industrialise construction can speed up the implementation of IWG5 targets.

This white paper was prepared by the task force 7 on 'Industrialisation for the clean energy transition', a temporary group of building experts that was formed by the Implementation Working Group 5 on Energy Efficiency in Buildings (IWG5) , which brings together experts from national governments, trade associations, and research institutions. This paper feeds into the preparation of IWG5's Implementation Plan – the group's strategic document – that will be presented to the Steering Committee of the EU's Strategic Energy Technology (SET) Plan. This white paper focuses on the integration of innovative approaches and technologies

in the energy efficiency and renewable energy for the built environment. It supports the objectives of the EU's SET Plan to decarbonise Europe's energy system through innovation and cooperation between policymakers, industry and researchers. This publication on industrialisation is part of a series of thematic white papers that were published by IWG5.

1. Scope and main objectives

Achieving the EU's climate and energy goals demands a fundamental shift in how buildings are designed, renovated, and delivered. Central to this is the industrialisation of construction—replacing fragmented, on-site practices with streamlined, scalable, and tech-enabled approaches that deliver environmental, economic, and social benefits.

The six thematic areas that follow outline the key scopes and objectives driving this transformation via innovation—from digitalisation and market incentives to regulatory alignment, circularity, workforce readiness, and cross-sector innovation. Together, they provide a practical roadmap for scaling industrialised renovation in line with the EU Green Deal, the Renovation Wave, and the Clean Industrial Deal.

Digitalisation and Industrial Efficiency

Scope

Leverage advanced digital technologies—including Building Information Modelling (BIM), Internet of Things (IoT), Artificial Intelligence (AI), and scan-to-fabrication processes—to enhance productivity, precision, and energy performance across the construction and renovation lifecycle. These tools enable structured planning, real-time monitoring, dynamic energy management, and predictive control strategies. Digitalisation also supports circular supply chains through local material hubs and GIS-informed regional logistics, fostering closed-loop processes that reduce waste and embodied carbon. Collectively, digital tools support both standardised delivery and project-specific customisation, bridging automation with flexibility – for more detail, view the IWG5's white paper on 'Digitalisation of Buildings'.

Main Objective

Establish a digitalised construction ecosystem that streamlines planning, production, and operation by integrating BIM-based modelling, IoT-driven diagnostics, and AI-based forecasting. Implement the Smart Readiness Indicator (SRI) to track and support the mainstreaming of digital tools in construction. Enable real-time performance tracking and dynamic load management to optimise energy flexibility. Deploy scan-to-fab workflows, digital twins, and automated energy labelling systems to accelerate deployment, ensure regulatory compliance, and reinforce circular material flows at regional scale—laying the digital foundation for scalable and sustainable industrialised renovation.

Market Drivers and Financial Mechanisms

Scope

Activate market transformation through a coordinated mix of financial innovation, public procurement, and alignment with EU funding and policy initiatives—such as the Renovation Wave and the Energy Performance of Buildings Directive (EPBD). Speed up and mainstream

the implementation of Net-Zero Industry Act (NZIA) provisions on pre-commercial procurement, public procurement of innovative solutions and green public procurement to drive early demand for new products and services to improve a public building's energy performance, particularly in social housing projects.

Performance-based financing models, such as Energy Service Companies (ESCOs), align investor incentives with measurable energy outcomes and reduce financial risk. Leveraging EU regulatory frameworks and diversified public funding instruments - that include loans, guarantees and grants - ensures coherence and accelerates private-sector uptake of industrialised construction.

Main Objective

Establish robust market mechanisms that de-risk investment in sustainable construction by combining EU-aligned funding instruments with innovation-oriented public procurement and performance-based contracts. Promote lead markets for industrialised renovation through competitive tenders and climate-focused procurement. Encourage ESCOs and other intermediaries to guarantee long-term savings through energy performance contracts.

Reinforce the competitiveness of EU manufacturing by linking industrial policies with demand-side incentives that scale deployment and secure economic returns. Use existing funding instruments to leverage private finance with the aim of boosting Europe's manufacturing capacity of strategic products and components, such as new PV modules and heat pumps.

Social Acceptance and Workforce

Scope

Overcome social and industry resistance by fostering awareness, trust, and professional development tailored to the shift toward industrialised construction. Current barriers include a conservative construction culture, insufficient public understanding of industrialisation benefits, and a critical shortage of skilled labour. Addressing these requires communication strategies, co-design processes, and visible pilot projects that demonstrate performance, cost savings, and regulatory compliance. Additionally, new education and upskilling pathways are essential to ensure job quality, worker safety, and stable employment opportunities within an evolving sector – for more detail, view IWG5's white paper on 'Energy-efficient buildings as job-creation motor'.

Main Objective

Build societal and industry support for industrialised renovation by launching inclusive, trust-building initiatives—such as pilot demonstrations, opinion-leader engagement, and education programs—that communicate benefits, ensure workforce readiness, and promote social equity. Mitigate labour shortages and performance gaps by embedding industrial construction methods into workforce training, reskilling programs, and quality assurance frameworks.

In parallel, develop transparent and accessible funding schemes that resonate with diverse communities and reinforce long-term confidence in sustainable construction practices. Deploy information campaigns – both for specific groups and the wider population – to disseminate practical user-level knowledge (and remove misconceptions) on the latest technologies in energy efficiency and renewable energy.

Legislation, Standardisation, and Policy Alignment

Scope

Create an enabling policy environment that supports the scalability of industrialised construction by harmonising definitions, simplifying permitting systems, and embedding prefabrication, modularity, and digital compliance into regulatory frameworks. Clear guidelines are needed to define industrialisation as a repeatable and scalable process guided by cost, quality, resource, and time efficiency. Alignment with overarching EU policies—such as the revised EPBD, the Net-Zero Industry Act (NZIA), and the Clean Industrial Deal—is essential to ensure that national renovation strategies are consistent, actionable, and integrated into broader sustainability goals.

Main Objective

Ensure regulatory coherence across all governance levels by embedding standardised industrialisation practices—such as modular design, off-site prefabrication, and digital permitting—into national and EU policy frameworks. Streamline administrative pathways through mechanisms like one-stop-shop permitting and digital renovation passports.

Strengthen legal clarity and enforcement by defining industrialisation within national and EU legislation, allowing scalable deployment and cross-border interoperability of solutions. National strategies should prioritise cost-effective industrialisation in the building and energy sector – this should be reviewed and updated regularly via the framework of National Energy and Climate Plans (NECPs) and National Building Renovation Plans (NBRPs). Moreover, the Governance Regulation - that sets out the NECP framework - should reinforce the role of industrialising buildings to improve competitiveness and reduce costs to consumers.

This regulatory alignment and the prioritisation of buildings will empower both public and private actors to implement industrialised renovation strategies confidently and efficiently.

Renovation and Circular Economy

Scope

Advance the renovation of Europe's building stock by deploying modular, prefabricated, and reusable systems that align with the goals of the Renovation Wave and the EPBD. Industrialised refurbishment must be grounded in standardised workflows, active plug-and-play systems (as proposed in the IWG5 white paper on active module), and circular material supply chains that reduce embodied carbon. These approaches support mass customisation, ensure consistent quality, and facilitate rapid, scalable implementation.

Circularity must be embedded at every stage—from local sourcing and reuse to design for disassembly and lifecycle-based material tracking.

Main Objective

Drive sustainable and scalable renovation by establishing industrialised approaches that integrate modular plug-and-play systems, standardised inspection protocols, and circular supply chains. Promote reuse, disassembly, and regional material hubs to reduce emissions and waste. Ensure consistency across projects through harmonised quality assurance systems and workflows. Apply digital tools—such as carbon-informed design platforms and GIS logistics—to close material loops and localise resource efficiency. This renovation strategy enables climate-neutral buildings while addressing cost, speed, and environmental performance.

Systems Integration and Innovation

Scope

Promote coordinated deployment of advanced building systems—including modular HVAC, active modules, and bio-based technologies—by integrating construction with sectors like energy, agriculture, and digital manufacturing. Scalable innovation must connect prefabricated systems with nature-based solutions (e.g., green façades and roofs), renewable energy systems, energy storage technologies and automated AI-supported factories. These integrations will enable the delivery of low-emission, high-performance buildings while creating synergies across sectors and regions. Local innovation ecosystems such as Living Labs and regional hubs are essential for demonstrating feasibility and accelerating market readiness.

Main Objective

Deliver next-generation, climate-resilient buildings by integrating smart HVAC systems, cross-sectoral innovations, and nature-based solutions into industrialised construction workflows. Support AI-driven digital factories and energy-aware prefabrication aligned with sustainability goals, cost-efficiency and customisation (when tailor-made products are needed). Establish city- and region-scale innovation platforms—such as Living Labs and digital manufacturing hubs—to empower SMEs, test new business and operational models,, and scale up cross-sector collaboration. Pop-up factories can help to avoid the risks of heavy and rigid prefabrication techniques, moving towards a more flexible, reusable and tailor-made version of industrialisation. This systems-based approach enables holistic performance optimisation and reinforces the EU's leadership in clean-tech construction.

2. Gaps, barriers and recommendations to overcome them

The shift toward industrialised renovation in Europe is essential to achieving climate neutrality, but several systemic barriers continue to slow progress. Challenges span across digital adoption, fragmented supply chains, outdated regulations, workforce shortages, misaligned financing, and limited integration of circular practices.

This section identifies six critical thematic gaps—each paired with a targeted strategic insight. Addressing these barriers is key to unlocking scalable, high-performance renovation. Through coordinated action on digitalisation, market mechanisms, social readiness, policy alignment, circularity, and system integration, the EU can enable the transformation of its building sector at speed and scale.

Digitalisation and Industrial Efficiency

Barrier:
Despite the widespread availability of advanced digital technologies—including Building Information Modelling (BIM), 3D modelling, and scan-to-fabrication systems—their adoption across the construction sector remains limited, particularly among small and medium-sized enterprises (SMEs). This is largely due to insufficient digital literacy, lack of technical infrastructure, low trust in data-driven coordination, and inadequate knowledge transfer mechanisms between research and industry. Moreover, promising models and methods developed in academia often remain confined to theoretical frameworks, failing to translate into scalable industry-ready tools and software. This dual gap—of adoption and applied innovation—significantly hinders digital industrialisation.

Strategic Insight:

To unlock the potential of digitalisation, a comprehensive strategy is needed that both builds market trust and bridges the research-to-practice divide. The EU should invest in SME-focused capacity building, including hands-on training programs, digital literacy support, and the creation of regional digital construction hubs. These hubs can offer shared infrastructure and access to open 3D component libraries to lower entry barriers. Simultaneously, EU programs like Horizon Europe and the Innovation Fund should fund cross-sector platforms that include industry actors in research projects and demonstrators, from early Technology Readiness Levels (TRLs) all the way up to the market deployment of new products and services. This will help generate interoperable, practice-ready digital tools and strengthen the application of BIM, AI, and automation in real-world renovation workflows.

Market Drivers and Financial Mechanisms

Barrier:
Europe lacks a fully developed and coordinated industrial ecosystem for modular and industrialised construction. This is characterised by insufficient regional infrastructure,

fragmented supply chains, and the absence of integrator firms that can manage digitalised value chains across design, manufacturing, and assembly. At the same time, the sector faces high upfront costs for renovation and renewable energy integration, with funding streams and subsidies that are poorly aligned with performance-based or prefabricated approaches. In addition, traditional fee structures based on time spent rather than results delivered create disincentives for collaboration and innovation.

Strategic Insight:

A multi-pronged strategy is needed to activate market uptake and unlock investment. The EU should mobilise regional development funds to establish industrialisation hubs and foster ecosystem-building efforts that link manufacturers, logistics providers, and digital enablers. Examples are: the upcoming TECNALIA Basque Hub in Spain for industrialised construction, under the umbrella of the regional policies for housing; the Italian Hub DIHCUBE for Construction and Built Environment.

Financial support instruments should be reformed into performance-based, multi-stage schemes that reward outcomes like emissions reduction and energy savings. Research programmes and funding tools for technology roll out should better link to each other, taking a project pipeline approach that enables strategic clean technologies and products in buildings to move up from the development phase to deployment.

One-Stop Shops must be expanded and integrated with Renovation Passports and green financial products such as low-interest loans and climate-adjusted mortgages. Finally, public procurement rules should promote outcome-based fee structures and Integrated Project Delivery (IPD) models to de-risk early adoption and encourage private-sector participation.

Social Acceptance and Workforce

Barrier:
The construction sector is simultaneously facing a critical shortage of skilled labour and a trust deficit among consumers and developers regarding the reliability and quality of industrialised solutions. The aging workforce, unattractive working conditions, and outdated vocational education have contributed to the sector's inability to scale digital and sustainable practices. Meanwhile, industrialised and modular methods are often perceived by end-users as low quality, inadequate or risky. Developers may also lack the technical knowledge or confidence to adopt these methods effectively, further slowing their market uptake.

Strategic Insight:

To build the foundation for workforce readiness and societal acceptance, the EU and its member states must launch coordinated education campaigns in line with the recommendations of the IWG5 white paper on skills. It's essential to modernise vocational training and promote future-ready skills in industrialised construction, LCA, and digital platforms like BIM and automation. The EU's Erasmus+ programme should build on its success by increasing its budget and prioritising the development of competences in the

construction sector. Training centres linked to digital innovation hubs and Living Labs can provide hands-on experience.

In parallel, targeted public awareness campaigns and high-visibility pilot projects should be implemented to build trust among consumers. Co-design processes and developer training programs will help shift perceptions and foster confidence in the performance and reliability of industrialised renovation methods. Municipalities and regions can offer subsidised visits from energy advisors to give recommendations to households and businesses considering renovating their buildings – this independent advice can also reduce knowledge gaps and remove misconceptions.

Legislation, Standardisation, and Policy Alignment

Barrier:
Existing legal and regulatory frameworks across the EU are not well adapted to the requirements of modern, industrialised construction. Many mortgage, insurance, and planning laws are still rooted in conventional on-site construction practices, leading to administrative friction and delayed approvals—especially for prefabricated or cross-border modular systems. Additionally, the lack of harmonised performance standards, testing protocols, and certification procedures across member states creates regulatory fragmentation. This is compounded by siloed governance structures that divide responsibility for energy, housing, and construction across different ministries, further undermining coordinated implementation of industrialised renovation.

Strategic Insight:

A broad legislative and institutional alignment is needed to remove these structural barriers. Member states should update national legal and planning frameworks to formally recognise off-site, modular, and digitised construction methods. Streamlined permitting procedures (e.g., one-stop shops) and digital compliance platforms should be adopted to accelerate project approvals. At the EU level, regulatory harmonisation should be advanced by fast-tracking modular system standards through CEN/CENELEC and EOTA, and by embedding industrialisation into EU Taxonomy technical screening criteria. National “renovation task forces” should be established to coordinate cross-ministerial action, eliminate regulatory overlap, and align national strategies with broader EU goals.

Renovation and Circular Economy

Barrier:
Lifecycle Assessment (LCA) frameworks are increasingly important for evaluating the environmental performance of buildings, yet they often fail to include the full impact of building services—particularly HVAC systems and control technologies. These components are frequently oversimplified or excluded, despite their substantial influence on both operational and embodied carbon, especially in industrialised and modular design contexts.

As a result, many LCA-driven decisions do not fully account for system-level dynamics, leading to suboptimal design and financing choices.

Strategic Insight:

Primary data for LCA need to be developed with the national scale, to include solid data to assess the complete energy and environmental impact of HVAC systems and other building services, especially in modular and prefabricated solutions. These revisions should be reflected in the EU Taxonomy, Renovation Passports, and green financing frameworks to ensure consistency and transparency in climate impact evaluations. Member states and EU institutions should promote carbon-informed design tools that enable accurate lifecycle modelling of technical systems, facilitating better decision-making for sustainable renovation.

Systems Integration and Innovation

Barrier:
Unlike more advanced industrial sectors such as automotive or aerospace, the construction industry lacks integrator firms that oversee the full lifecycle of industrialised renovation—from digital design and component manufacturing to logistics and on-site assembly. This absence results in fragmented delivery models, inconsistent quality assurance, and poor system-level coordination. Without integrators, efforts to link digital tools, smart systems, and modular solutions into a cohesive process remain disjointed and inefficient.

Strategic Insight:

The EU should support the emergence of integrator firms or multi-stakeholder alliances that are capable of managing end-to-end digital value chains. One strong example is Cadwork Informatik AG, a Swiss company that provides an end-to-end digital workflow for timber construction. These entities must combine design, manufacturing, and on-site implementation capabilities using shared digital platforms such as BIM, IoT, and AI-based logistics coordination. Innovation funding, public-private partnerships, and preferential treatment in public procurement can accelerate the formation of such integrators. By fostering systems-level coordination, these actors will enable high-performance, low-emission buildings that are delivered efficiently at scale.

Table 1: Summary of six thematic areas with linked barriers and recommendations

Thematic Area	Barrier	Strategic Insight / Recommendation
1. Digitalisation and Industrial Efficiency	Limited adoption - particularly by SMEs - of digital tools (e.g., BIM, 3D modelling) due to low digital literacy, lack of infrastructure,	Invest in SME-focused training, digital literacy, and regional digital hubs. Fund cross-sector platforms through EU programs to develop interoperable, practice-ready tools and integrate industry actors from early R&D to market deployment.

	and weak research-to-industry transfer.	
2. Market Drivers and Financial Mechanisms	Fragmented industrial ecosystem, high upfront costs, misaligned funding, and fee structures that disincentivise innovation.	Establish industrialisation hubs and ecosystems (e.g., TECNALIA, DIHCUBE). Reform financial instruments to be performance-based, and integrate social conditionalities to ensure a Just Transition. Expand One-Stop Shops and integrate with green finance. Promote outcome-based procurement and Integrated Project Delivery (IPD) models.
3. Social Acceptance and Workforce	Labour shortages, outdated training, and low trust in industrialised methods among consumers and developers.	Modernise vocational education and promote future-ready skills. Expand Erasmus+ for construction skills. Launch public awareness campaigns and pilot projects. Provide energy advisor visits to households and businesses to build trust and reduce knowledge gaps.
4. Legislation, Standardisation, and Policy Alignment	Outdated laws and fragmented regulations hinder modular and cross-border construction. Siloed governance structures slow coordinated action.	Update national laws to recognise modular methods. Streamline permitting and adopt digital compliance tools. Harmonise EU standards via CEN/CENELEC and EOTA. Integrate industrialisation into EU Taxonomy criteria, and ensure these criteria contribute to social equity objectives. Create national renovation task forces to align cross-ministerial strategies with EU goals.
5. Renovation, Sustainability Assessment and Circular Economy	Need for better lifecycle assessment tools that don't leave out important elements and for the deployment of country-specific databases with a focus on technological innovation	Revise LCA methodologies to include HVAC and building services. Align with EU Taxonomy and green finance. Promote national activities and projects to develop LCA primary data for application in the built environment regarding materials and systems used within buildings.
6. Systems Integration and Innovation	The construction sector lacks integrator firms that oversee the full lifecycle of	The EU should support the creation of integrator firms or multi-stakeholder alliances capable of managing end-to-end digital value chains, combining

	industrialised renovation, resulting in fragmented delivery models, inconsistent quality assurance, and poor coordination.	design, manufacturing, and on-site implementation capabilities using shared digital platforms. Innovation funding, such as public procurement, can boost integrators.

3. EU Policy levers and funding instruments

As the European institutions started the new term recently, it is pivotal that new policy initiatives and funding streams under the post-2027 budget are going in the right direction. Continuation of the key measures adopted under the European Green Deal, as well as creation of new proposals that will speed up industrialisation in the built environment, will be instrumental in delivering benefits on the ground to all stakeholders involved in the transition.

3.1 The European Green Deal and new policies

Looking back at the previous policy cycle, measures secured under the EPBD and its implementation can support the political commitments at the national level via NBRPs and NECPs on a timely scale. As the EU is an importer of components and technology to reach climate neutrality by 2050, the NZIA identified several key technologies to boost industries and internal manufacturing capacities, thereby seeking to reduce dependencies and increase resilience. NZIA measures are expected to facilitate permitting, attract investments, enhance skills and help to develop innovation. Many of these technologies will play a key role in decarbonising buildings, such as heat pumps and geothermal in space heating and cooling.

In the 2024-2029 priorities outlined by the European Commission, the role of industry, innovation and competitiveness is emphasised, together with strengthening the EU position in the world, while decreasing energy prices and decarbonising our economy. The Clean Industrial Deal is a major legislative roadmap that can foster industrialisation: the creation of a lead market (referring to a market where demand for low-carbon/innovative/circular products is created and scaled up through a set of policies/incentives), and its Industrial Decarbonisation Accelerator Act in 2026 can be beneficial in boosting the industrialisation and transposition of RED to streamline permitting rules for renewable projects.

Additionally, the Affordable Energy Action Plan can also contribute to the boost of industrialisation in the built environment, with its final goal to lower energy prices for everyone. The Plan's Action 6 has a promising proposal to set contracts between the public sector, energy producers and end users to create conditions for a favourable investment environment while increasing competitiveness.

Within the next MFF, the Competitiveness Fund also emphasises the need to support innovation. Over 99% of the construction sectors rely on craft trades, SMEs and micro companies. The EU's Start-up and Scale-up Strategy is a great opportunity to further strengthen and scale-up SMEs in the construction sector, with a key focus on lifting barriers to access the EU Single Market, investments in innovative industries as well as simplify access to EU funding with One-Stop-Shops. SME can further expand with distributed manufacturing processes, thanks to online 3D hubs and the digitalisation of the value chain.

Yet lacking in European initiatives are the further support for the creation of new industrial construction companies, alliances across the EU and aggregators to create a strong supply chain for industrialised solutions. Alongside, large scale deployment of innovative results from EU projects must take pace, particularly in identified successful business cases at large.

3.2 The economic aspects of industrialisation

Long-lasting and predictable funding instruments are one of the most important elements that bring transformation. They support R&I development, enable deployment on clean technologies and also help to increase people's acceptance and willingness to join the energy transition. One popular example that had significant impact in building decarbonisation in Italy - the Italian Superbonus - can be an experience to reflect on, analysing the pros and cons of its design. An interesting example of a funding programme that supports industrialisation is in place in Austria that could be replicated in other EU countries.

Public authorities annually spend over 2T€ per year on services, works and supplies. Public procurement for construction materials, particularly for climate-friendly steel and cement, can reduce GHG emissions significantly. Moreover, a 1% energy efficiency gain across public buildings in the EU can save around 20B€ per year. Using green and pre-commercial public procurement in public buildings – including social housing - can accelerate the deployment of new sustainable products to market and support innovative industrialised approaches in both new constructions and renovations.

Actions can be taken at the regional and local levels as well. City-scale initiatives, such as the EU Mission Cities, put together technology, market and social aspects towards concrete application of technical actions on the building stock, calling the boost for industrialisation not only of technologies but also for processes. Another international initiative worth mentioning is the Urban Transitions Mission that was launched at the COP26 and facilitates exchanges of best practice. At the industrial level, to fight fragmentation, it is advantageous to foster the creation and operation of local/regional hubs for - among other things - material recovery, waste processing and shared machinery.

3.3 Innovation and streamlining constructions

Innovation is key. The implementation of digital tools (such as parametric design, automated permit checks and BIM) can accelerate and optimise construction processes, including innovative approaches to assess and improve sustainability in building services, particularly for:

- Measurement-based verification of indoor climate performance.
- Integration of advanced sensors and data-driven diagnostics to reduce energy and material waste.

- Smart control strategies for IAQ and thermal comfort that align with circular economy goals.

These abovementioned measures are currently overlooked in the EU policies and spurring their rollout can effectively increase efficiency and shorten lead times, e.g. the development of standardised prefabricated housing concepts suitable for industrial construction methods. Additionally, finding other policies to complete the shift to 3D manufacturing of construction projects is key to foster industrialisation.

Finally, developing modular and prefabricated housing solutions will help accelerate delivery and reduce construction waste. To ensure their widespread uptake, clear performance-based incentives should be introduced to promote the use of low-carbon and energy-efficient technologies in construction projects.

4. Interlinks with other sectors and with IWG5 innovation targets

4.1 Interlinks with other sectors

Industry and the built environment are interlinked with various angles of our economy and society, as it can include people's wellbeing at home, international raw material trade, green supply chains, as well as bioeconomy and digitalisation. Accelerating the industrialisation and competitiveness in the built environment is expected to bring a wide range of benefits to individuals, society and the economy.

Manufacturing and raw materials

Raw materials, the manufacturing supply chain and logistics are pivotal in speeding up the deployment of renewable energy technologies and accelerating the renovation rate in the built environment. The collaboration with the manufacturing sectors, particularly with the transformation of some sectors experiencing downturns, could focus on industrialisation of construction components.

An opportunity arises with the integration of bio-based materials from the forestry and agricultural sector to enhance sustainability and circularity in construction creating new materials for construction. Bio-based materials - particularly those derived from wood - have significant potential to develop resilient European supply chains, while also storing considerable amounts of biogenic carbon. Lastly, more integration with the waste management and agro-industry sectors should be encouraged to develop bio-based products from waste and byproducts.

Energy sector

The connections with the power supply sector and electricity market are essential to ensure the buildings are fed by renewables without problems for the grid; its integration with the electricity grid and mobility can offer an important opportunity not only to spur industrialisation for energy efficient buildings, but also to offer energy storage services and flexibility. Furthermore, the large-scale adoption of electric vehicles has significant potential to balance grids at distribution level, allowing to store and self-consume local-produced renewable electricity (rooftop solar in particular), as well as to sell it when prices are high (mainly via aggregators). Industrialisation of buildings, with integrated smart energy management systems, can facilitate the vehicle-to-home (V2H) and vehicle-to-grid (V2G) capability. To unlock the storage potential of electric mobility, Europe must develop standards for bi-directional charging and require automakers to make their cars compatible with vehicle-to-home and vehicle-to-grid standardised protocols.

Moreover, positive energy buildings and districts have the potential to provide energy to nearby consumers, thereby reducing grid congestion and the need for additional infrastructure. Prosumers in buildings can take advantage of using aggregators and even joining energy communities, thereby reducing costs and mutualising benefits.

Digitalisation

As also explained in the IWG5 White paper on Digitalisation, the technology development of digital and automation tools, BIM and GIS, among others, can be further implemented in the construction sector, supporting the design, planning, procurement and construction stages, and the off-site production of custom components. BIM-based procurement, where suppliers have to submit 3D BIM models before installation, has a large untaped potential. Pushing the idea of "build before it's built" in the digital models needs to be encouraged to make the shift toward digitalisation faster.

Digital technology developers and main manufacturing industrial companies incorporate modern methods and provide a holistic approach. Introducing AI in the construction sector is key by populating models and/or evaluating the components of construction structures in terms of component data, recognition and management. Additionally, controlling indoor climate is essential to the sustainable building renovation frameworks, particularly how to embed climate KPIs in renovation decision-making tools and synergies between thermal comfort and energy performance.

4.2 IWG5 innovation targets

The revised IWG5 2024 Implementation Plan sets a number of European targets to boost innovation in the building sector (see annex I). These IWG5 targets building upon and complement the EU's 2030 targets under the Fit for 55 package, seeking to deploy key innovative technologies to boost building decarbonisation. By industrialising the manufacturing and construction processes, it is expected that it will also help to meet the IWG5 targets.

For 5.1 IWG5 energy efficiency targets, industrialisation can make very significant advances in the following areas:

- Integrating modular and digital technologies can significantly decrease construction times in line with Target 5.1-T3 calling for 'market ready solutions to reduce the average duration of energy-related construction works by more than 40% for renovation and for new buildings'
- Increase overall connectivity of devices and improve a building's SRI in line with target Target 5.1-T5 asking for 'interoperable and data-driven applications with the ability to maximise the use of the flexibility-potential of buildings'

- Use digital technologies to improve the traceability of materials and increase buildings' circularity, as stated by target Target 5.1-T6 calling for 'data-driven solutions to maximise the reusability and high-value recyclability of materials and building elements'

For 5.2 IWG5 heating and cooling targets, industrialisation can also make very significant advances. A strong industrial policy that focuses on boosting manufacturing competitive and easy to install H&C products, coupled with balanced financial incentives for individuals and companies, can contribute to all 5.2 technology-deployment targets, including heat pumps, DHC and solar thermal. With the ETS carbon tax covering fossil fuel boilers from 2027, it is essential that clean heating and cooling technologies become more affordable and easier to install.

IWG5 targets are relevant and reinforce the need for a more industrialised, standardised and data-driven construction sector. Policymakers should consider these innovation targets while drafting industrial policies and countries' National Building Renovation Plans.

5. Conclusions

The industrialisation of Europe's building sector is no longer a vision - it is an urgent necessity for achieving the EU's climate neutrality goals and enhancing energy security, affordability, and resilience. This white paper highlights the critical importance of moving beyond incremental improvements and embracing a systemic transformation in how buildings are renovated, constructed, and operated.

Through comprehensive analysis of six key thematic areas—digitalisation, market drivers, workforce readiness, legislative alignment, circular renovation, and systems integration—this document not only exposes obstacles currently hindering progress, but also identifies strategic levers capable of unlocking scalable, high-impact solutions. The findings point to a clear path forward: enabling innovation through coordinated policy, aligning funding with performance, and investing in the workforce and public trust.

Decarbonising buildings at the required pace and scale demands more than just better technologies—it requires an ecosystem shift with industrial hubs, trusted value chains and strong policy coherence. Industrialisation has the potential to transform the construction sector for the benefit of consumers and entrepreneurs, by reducing fragmentation in the sector, simplifying and speeding up the construction process, increasing the quality of energy renovations, as well as enabling more material recovery and recycling. Key enablers in shift are digital tools, AI and data-driven coordination. Importantly, this transformation must embody a 'Just Transition', ensuring reduced energy poverty, improved living conditions, and equitable access to green jobs and healthier homes for all European citizens

This white paper contributes directly to the IWG5 Implementation Plan and supports the wider SET Plan objectives. It calls on policymakers, industry leaders, and research institutions to align their efforts and rapidly scale industrialised renovation across Europe. By doing so, Europe can not only meet its climate targets but also build a more inclusive, competitive, and future-ready construction sector.

Annex I: IWG5 innovation targets

3. Innovation Targets

3.1. Innovation targets 5.1

Action 5.1	Sustainable materials and technologies for energy-efficient solutions for buildings
Target 5.1-T1	Reduce the energy use of buildings by 16% in 2030 with respect to 2020
Target 5.1-T2	Develop and demonstrate solutions for zero-emission buildings by 2030 while retaining cost-efficiency
Target 5.1-T3	Develop and demonstrate market ready solutions to reduce the average duration of energy-related construction works by more than 40% for renovation and for new buildings compared to current national standard practices
Target 5.1-T4	Develop and demonstrate market ready solutions to reduce the difference between the predicted and the measured energy performance to maximum 15% after the commissioning period with the ambition to reach 10%
Target 5.1-T5	Develop and demonstrate interoperable and data-driven applications with the ability to maximise the use of the flexibility-potential of buildings (minimum of 20% flexibility capacity, without unacceptable impairments for users, of a minimum of 20% of all buildings on district level)
Target 5.1-T6	Develop and demonstrate data-driven solutions to maximise the reusability and high-value recyclability of materials and building elements at end-of-life (50% upcycling in 2030)

3.2. Innovation targets 5.2

Action 5.2	Cross-cutting heating and cooling technologies
Target 5.2-T1	Heat Pump Systems • Development of prefabricated, fully-integrated 'plug in and play' hybrid/multisource heat pump systems and integrated compact heating/cooling plants based on modular heat pump • Full-scale demonstration of heat upgrade technologies for district heating networks with supply temperatures in the range 90 - 160°C • Increase the number of heat pumps across Europe to 10 million by 2030
Target 5.2-T2	District heating and cooling: • Increase the share of district heating in the EU's heat demand to 20% by 2030 preferably using low temperature waste heat and renewable sources • Integration of 8 million households into the district heating/cooling networks across Europe
Target 5.2-T3	Micro CHP/CCHP • Integration of highly flexible CCHP systems with heat storage, heat pumps and renewable heat sources with the aim of reducing annual fuel consumption • Development of CCHP technologies running on renewable gases (hydrogen, ammonia, methanol, synthetic gas, etc.) with comparable performances as running on natural gas • Development of CCHP solutions with post combustion treatments to reduce emissions by >50% and keeping operational flexibility
Target 5.2-T4	Thermal Energy Storage
	• 100 new large thermal energy storages in district heating and cooling networks in progress in 2030 • 10 new demo systems with sensible thermal energy storage with a usage of RES and waste heat to more than 60% of the yearly heat demand • 20 systems for compact thermal energy storage demonstrated at TRL 6/7 with a storage density at system level increased to 120 kWh/m3
Target 5.2-T5	Solar Thermal Systems and PVT • Cost reduction for solar thermal combi-systems with high solar fraction (min. 60%), towards a range of 12-16 €ct/kWh • Development of standardised solutions for easier integration of solar thermal in building renovation, in particular in active prefabricated building elements • Cost reduction of PVT panels by a factor of 1.5 to 2 from the 2020 reference value of €1000/m², also by ensuring easier installation

Annex II: Further reading on industrialisation

Construction innovation hubs :

- The Basque region's Hub
- DIHCUBE – Digital Italian Hub for Construction and Built Environment

Position papers and studies:

- EU Buildings Climate Tracker 3rd edition by Buildings Performance Institute Europe
- Approaching Industrialization of Buildings and Integrated Construction Using Building Information Modelling - ScienceDirect
- The growing significance of off-site construction and challenges in its widespread adoption | BUILD UP
- Position paper on management innovation for industrialisation
- ARD Documentary on cost of building standards

Projects:

- NetZeroCities: Accelerating Europe's Urban Climate Ambition
- Industrial construction for a faster, affordable, and sustainable building sector - TNO