Strategic Energy Technology Plan

Implementation Working Group on Energy and Resource Efficiency in Buildings

Thematic Vision on Energy and Resource Efficiency in Buildings

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Content

Executive Summary 2

1. Introduction 4

    1.1. Scope and purpose of the Thematic Vision 4

    1.2. Progress and recent developments in the thematic area 4

    1.3. Alignment with SET Plan Task Force Recommendations 9

2. Vision and targets 10

    2.1. Short-term (2030) 10

    2.2. Medium-term (2040) 12

    2.3. Long-term (2050) 14

3. Conclusions and next steps 17

Abbreviations 18

References 20

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Executive Summary

Europe's building sector—responsible for around 35% of EU energy consumption, 40% of energy-related greenhouse gas emissions, and approximately 37% of total waste generation—sits at the heart of the green transition. Its transformation is not merely a technical challenge but an economic, social, and industrial programme of the first order. Despite substantial progress, the annual renovation rate remains around 1% of the building stock, well below the 2.5–3% required for climate neutrality by 2050, and deployment of key technologies such as heat pumping technologies remains below the trajectory required to meet EU 2030 targets.

This Thematic Vision draws on the IWG5 Implementation Plan 2025 and has been further informed by contributions from Member State mirror groups and national stakeholder processes. The four strategic themes introduced in this Vision reorganise, rather than replace, the innovation priorities of the IWG5 Implementation Plan, providing a long-term strategic framework that preserves continuity with the existing innovation targets and research activities while supporting the development of the SRIA and CIIPs. IWG5 enters this mandate period with a strong track record of delivery, including the 2025 update of the Implementation Plan, seven Task Force white papers, published recommendations on National Climate and Energy Plans (NECPs) and National Building and Renovation Plans (NBRPs), and a new online tool supporting evidence-based renovation planning. It is also aligned with the recommendations of the cross-cutting task forces of the SET Plan. The Vision is structured around four strategic themes that frame IWG5's priorities across the short, medium and long term: Supporting European Competitiveness; Enabling Circular, Resource-Efficient and Sustainable Construction; Delivering Affordable, Inclusive and People-Centred Renovation; and Delivering Climate-Neutral, Resilient and Energy-Integrated Buildings. Resilience is treated throughout as a fundamental and cross-cutting requirement — not a secondary consideration — embedded alongside efforts to reduce emissions and energy use.

Under Supporting European Competitiveness, the Vision identifies digitalisation, industrialisation of renovation and construction processes, and large-scale workforce upskilling as the three interconnected enablers of faster, higher-quality, and more cost-effective decarbonisation. Under Enabling Circular, Resource-Efficient and Sustainable Construction, circularity-by-design, embodied carbon reduction, and circular value chains are established as core objectives alongside operational energy performance.

Under Delivering Affordable, Inclusive and People-Centred Renovation, the Vision addresses sustainable and affordable renovation — with stable long-term financing identified as the single most impactful enabler — alongside user's health and well-being, condominium and multi-ownership governance, and heritage-compatible renovation as named priorities. Under Delivering Climate-Neutral, Resilient and Energy-Integrated Buildings, cooling is recognised as a growing challenge across Europe — not only in Southern and Mediterranean regions but increasingly in Middle and Western European countries — requiring differentiated solutions adapted to Europe's diverse climate zones. The Vision calls for a dedicated EU cooling strategy encompassing both passive approaches and district cooling solutions, alongside climate-zone-sensitive calibration of Minimum Energy Performance Standards.

By 2030, the focus is on cost-efficient zero-emission buildings, accelerating renovation rates, and ensuring the transition reaches vulnerable households before ETS2 carbon pricing takes effect. By 2040, a clear and irreversible decarbonisation trajectory should be visible, with industrialised renovation at scale, circular economy principles embedded across the sector, and resilient cooling mainstreamed across all European climate zones. By 2050, the building sector should achieve full

climate neutrality — and has the potential to become carbon-negative — with European industrial leadership in clean building technologies, buildings as active nodes in the energy system, and no category of building stock structurally excluded from the transition.

The IWG5 Thematic Vision (2026) preserves the technical foundations of the IWG5 Implementation Plan (2025) while broadening them to address industrial competitiveness, circularity, affordability, resilience, social inclusion and energy system integration. Together, the two documents provide a coherent pathway from current R&I priorities to the future Strategic Research and Innovation Agenda (SRIA) and the Common Implementation and Investment Plan (CIIP).

1. Introduction

1.1. Scope and purpose of the Thematic Vision

This Thematic Vision addresses energy and resource efficiency in buildings within Implementation Working Group 5 (IWG5) of the EU Strategic Energy Technology Plan (SET Plan). Since 2016, IWG5 has convened Member States, industry, research organisations, and technology platforms to advance clean energy solutions for the building sector.

Given the central role of buildings in Europe's climate, energy, and social objectives, decarbonising the building stock in a way that is both affordable and aligned with the principles of a Just Transition remains a key priority.

In line with the SET Plan Steering Group mandate (April 2026), the IWG5 Implementation Plan 2025, and relevant SET Plan recommendations, this Vision integrates perspectives from across the IWG5 membership, particularly on climate diversity, heritage buildings, cooling demand, and multi-owner governance. It pursues four interconnected objectives:

- Take stock of the current state of and progress in R&I for energy- and resource-efficient buildings in Europe;
- Identify the key barriers and cross-cutting challenges facing the sector(s);
- Establish ambitious and achievable short-, medium-, and long-term goals for the development, manufacturing, and market uptake of building energy technologies in Europe;
- Align R&I investment with key EU policy frameworks.

1.2. Progress and recent developments in the thematic area

The buildings sector faces a rapidly evolving regulatory landscape. The revised Energy Performance of Buildings Directive (EPBD) (2024) introduces zero-emission buildings and Minimum Energy Performance Standards (MEPS), while the Energy Efficiency Directive (EED), the Renewable Energy Directive (RED), the revised Construction Products Regulation (CPR), and REPowerEU strengthen the framework for building decarbonisation. The European Affordable Housing Plan, which aims to accelerate the renovation and construction of affordable, energy-efficient homes while improving access to financing and supporting sustainable urban development, further reinforces the link between decarbonisation and social affordability objectives. The forthcoming EU Heating and Cooling Strategy is also expected to provide an important additional policy anchor for the decarbonisation of heating and cooling in buildings, which remains central to IWG5's mandate.

At the same time, ETS2 will extend carbon pricing to fossil-fuel heating systems. To help ensure a fair transition, the Social Climate Fund — financed by ETS2 revenues — and the European Affordable Housing Plan are designed to support vulnerable and low-income households. The European Affordable Housing Plan in particular represents a significant policy commitment to ensuring that energy renovation benefits reach all income groups, and its objectives should be explicitly reflected in IWG5's R&I priorities — particularly in the design of renovation solutions, financing instruments, and social inclusion targets. The upcoming Circular Economy Act (expected 2026), which aims to double the EU's circular material use rate to 24% by 2030 and create a single market for secondary

raw materials, is also expected to be highly relevant for the sustainable materials and circularity objectives of IWG5's R&I agenda.

Against this backdrop, the period to 2032 represents a critical window for ensuring that the clean energy transition in buildings is both effective and socially equitable. Research, innovation, and deployment efforts should therefore focus on delivering affordable renovation solutions, accessible financing mechanisms, and targeted technical assistance at scale.

In this context, IWG5 supports the transition by promoting good practices, fostering dialogue among Member States and stakeholders, and bridging European and national perspectives. Through knowledge exchange and collaboration, the group helps accelerate the uptake of effective solutions and pathways for transforming Europe's building stock. This role has been further strengthened and structured through successive updates of its Implementation Plan.

IWG5's Implementation Plan was first adopted in November 2018, substantially updated in September 2024 (adding solar thermal/PVT and technology integration activities), and further revised in July 2025 to incorporate societal and just-transition perspectives. The update was informed by seven dedicated Task Forces whose white papers have been published. National Energy and Climate Plans (NECPs) from several Member States were also analysed, a recommendation on National Building and Renovation Plans (NBRPs) was published, and a new online tool was developed to support evidence-based renovation planning across European climate zones.

IWG5's work is underpinned by the updated 2025 Implementation Plan, which outlines 11 strategic innovation targets and 9 R&I activities across two subgroups: 'Sustainable materials and technologies for energy efficiency solutions for buildings' (5.1) and 'Cross-cutting heating and cooling technologies for buildings' (5.2). The 2025 revision expanded the scope beyond technical R&I to include societal dimensions and just-transition elements. IWG5 also renamed the working group to 'Energy and Resource Efficiency in Buildings' to reflect the growing relevance of circularity and embodied carbon.

Despite substantial progress, deployment remains below the pace required to achieve the EU's climate objectives. The annual renovation rate remains around 1% of the building stock, while rates of 2.5–3% are generally considered necessary to achieve climate neutrality by 2050. Heat pump deployment has expanded rapidly, with more than 25 million units installed across Europe. Following a 21% decline in sales in 2024 to around 2.2 million units, the market recovered in 2025 with sales increasing by approximately 10%, though deployment remains below the trajectory required to meet the EU's 2030 targets. District heating and cooling currently supplies approximately 13% of Europe's heat demand, while the deployment of solar thermal technologies for heating and cooling in buildings remains uneven across Member States.

Building-related greenhouse gas emissions have declined significantly compared with 1990 levels, but further acceleration is required to align with the EU's 2040 and 2050 climate objectives. At the same time, EU construction output declined by 2.0% in early 2026 compared with the same period in 2025, construction producer prices for new residential buildings have risen by 56% since 2010, and 75% of construction firms report low levels of innovation — compared with 67% across other industries — underscoring the structural barriers to renovation at scale.

A key challenge also remains the transition from fragmented pilot projects to standardised, replicable and bankable solutions at scale. Drawing on lessons from technology-specific initiatives, greater emphasis is needed on broader-scale demonstration, validation under real operating conditions, and the development of standardised system designs and performance databases. This transition is essential to enable standardisation, reduce costs, de-risk investment, and enable rapid replication across Member States and European climate zones. The activities of IWG5 contribute directly to all

five dimensions of the Energy Union. **Energy security** is strengthened through reduced energy demand—particularly for natural gas imports, which remain the main energy source for space heating—and increased deployment of renewable heating and cooling technologies. Energy security is further reinforced through diversified renewable heating and cooling technologies, thermal energy storage, demand-side flexibility, circular material value chains and reduced dependence on critical raw materials. **The internal energy market** benefits from smart buildings, smart integrated energy systems, demand-side flexibility, and enhanced integration between buildings, distributed renewable electricity generation, electric vehicle charging and energy networks – an increasingly important role for buildings as electrification of transport and heating advances. Particular emphasis is placed on smart integrated energy systems, where sector integration maximises the use of renewable energy, decreases energy losses, and enhances system flexibility. **Energy efficiency** is advanced through renovation strategies, zero-emission building solutions, and resource-efficient construction. **Decarbonisation** is accelerated through heat pumping technologies, renewable heating and cooling, district energy systems, and circular construction approaches. **Research, innovation, and competitiveness** are reinforced through IWG5's innovation targets, flagship projects, and support for European industrial leadership in clean building technologies.

Four strategic themes frame the priorities of this Thematic Vision:

— **Supporting European Competitiveness**

Digitalisation: Despite the potential of BIM, digital twins, and AI-driven analytics, adoption remains limited — especially among SMEs — due to digital literacy gaps, fragmented data standards, and weak knowledge transfer from research to practice. Smart integrated systems that facilitate sector integration — connecting buildings with energy networks, electric mobility, and renewable sources — remain underdeployed, limiting the potential to maximise renewable energy use and minimise energy losses. The widespread availability of frequent smart meter readings across parts of Europe provides a foundation for data-driven, evidence-based methods for building energetic characterisation and renovation targeting — including applications in energy labelling, optimised renovation programmes, and sensor-based control of indoor climate and comfort, and as a data-driven complement to the Smart Readiness Indicator. Without harmonised data infrastructure and interoperable smart systems, digitalisation cannot deliver its full decarbonisation potential. Common data models, interoperable European data spaces, secure data sharing and open digital standards are needed to enable seamless interaction between buildings, products, energy systems and Digital Product Passports.

Industrialisation: Renovation and construction remain largely fragmented and reliant on small-scale, project-by-project delivery, which limits standardisation and can slow delivery timelines. Greater industrialisation of processes, alongside continued support for skilled craftsmanship, could help scale up delivery, though further evidence is needed on the impact on costs and quality across different building types. Beyond its contribution to climate neutrality, the buildings sector is a strategic pillar of European competitiveness. European companies hold strong positions in heat pumping technologies, solar thermal technologies, advanced construction materials, district heating and cooling solutions, and digital building technologies. Accelerating innovation, manufacturing, and deployment in these areas can strengthen European value chains, create high-skilled jobs, reduce dependence on imported fossil fuels, and enhance Europe's leadership in global clean technology markets. Industrialisation is also essential for accelerating the large-scale deployment and market uptake of SET Plan technologies, with the aim of enabling more energy-efficient, affordable, and consistent-quality renovation and construction across Europe as this evidence base develops.

Skills: Europe faces an acute shortage of skilled workers trained in energy-efficient renovation, circular construction, and digital building management. This skills gap is a major barrier to scaling up the renovation wave, as ambitious targets cannot be achieved without a qualified workforce. Addressing this challenge requires equal access to interdisciplinary training opportunities that combine engineering, digital, and sustainability competences, harmonised competence frameworks, mutual recognition of qualifications, and continuous professional development across Europe.

In addition to the three analysed parameters, several cross-cutting enablers will shape Europe's long-term competitiveness, including stronger innovation ecosystems, more effective technology transfer, and greater participation of SMEs throughout the innovation value chain, helping to translate research results into market-ready solutions and accelerate their deployment.

— **Enabling Circular, Resource-Efficient and Sustainable Construction**

Circularity and waste reduction: Construction and demolition waste accounts for nearly 37% of all EU waste. The limited uptake of life-cycle assessment (LCA), eco-design principles, and harmonised whole-life-cycle carbon accounting constrains both policy development and investment decisions. Furthermore, direct reuse and remanufacturing are still insufficiently prioritised, despite being higher-value circular strategies than recycling. Achieving a truly circular built environment will require a systemic shift in the organisation of building activities, including the wider adoption of product-as-a-service models that support life-cycle responsibility from design and supply through operation, maintenance, and end-of-life recovery. Embedding circularity across the entire building life cycle is essential to reducing Whole-Life Global Warming Potential (WLGWP), as operational emissions reductions alone are no longer sufficient to meet Europe's climate objectives. Priority should be given to higher-value circular strategies including durability, repair, refurbishment, reuse and remanufacturing before recycling, consistent with European circular economy principles.

— **Delivering Affordable, Inclusive and People-Centred Renovation**

Sustainable and affordable renovation: Despite the Renovation Wave target of renovating approximately 35 million buildings by 2030, renovation rates remain far below what is needed. High upfront costs, long payback periods, complex permitting procedures, and limited accessibility for vulnerable households continue to constrain investment. The challenge is compounded by significant regional disparities in renovation rates, household incomes, access to finance, and construction-sector capacity, requiring place-based approaches. Stakeholder evidence consistently identifies unstable and unpredictable financial incentive schemes as the principal barrier to renovation, highlighting the need for long-term, coordinated financing frameworks. Renovation should also improve people's health and well-being by integrating Indoor Environmental Quality (IEQ), affordability, efficient energy use, climate resilience, accessibility, and adaptability into building design and lifespan. Vulnerable households require particular attention, as poorly managed renovations can lead to renoviction and displacement. User-centred delivery models—including One-Stop Shops, energy coaching, Renewable Energy Communities, and Building Renovation Passports—should be scaled up and aligned with the European Affordable Housing Plan to ensure renovation benefits reach all income groups. Research and innovation should support business models that combine technical innovation with long-term financial sustainability, enabling renovation at scale while reducing investment risks for households and investors.

Condominium and Multi-Ownership Governance: Multi-ownership residential buildings (condominiums) dominate the urban building stock across many Member States, yet their governance and financing arrangements are structurally more complex than those of single-owner properties. Decision-making processes require supermajority thresholds, investment timelines are difficult to

coordinate, and access to renovation finance is constrained for individual co-owners. Multi-ownership governance should be formally recognised as a named renovation barrier in the IWG5 framework, supported by dedicated instruments including pooled technical assistance, simplified collective decision-making procedures, and financial products designed for shared-ownership contexts. Addressing this barrier is a precondition for unlocking renovation at the scale required by the Renovation Wave.

Historic and Heritage-Protected Building Stock: A significant share of the European built environment is subject to heritage conservation constraints — historic city centres, listed buildings, and small historic villages — which are incompatible with standard deep-renovation and energy-related regulation approaches. A dedicated renovation track is needed that recognises conservation-compatible technologies (reversible interventions, sympathetic envelope solutions, building-integrated solar (PV and/or thermal) for heritage contexts, including solar thermal and PVT (hybrid PV+thermal) panels as options) where compatible with heritage conservation requirements, visual integrity and reversibility principles and provides tailored regulatory flexibility for protected buildings.

— **Delivering Climate-Neutral, Resilient and Energy-Integrated Buildings**

Cooling and Climate-Adaptive Envelopes: Rising temperatures, more frequent, intense and longer heat waves, and the urban heat-island effect are making cooling a growing energy challenge across Europe. Climate change, urbanisation, and an ageing population are driving rapid growth in cooling demand, particularly in Southern and Mediterranean regions but increasingly across the EU, making cooling a strategic priority for the energy transition. Meeting this challenge requires greater deployment of passive and active cooling solutions, including climate-adaptive building envelopes, solar shading, natural, hybrid or mechanical ventilation, cool surfaces, urban greening, district cooling, and integrated cooling systems, building on knowledge generated through initiatives such as IEA EBC Annex 80. District cooling deserves explicit recognition as a collective high-efficiency solution that can reduce peak electricity demand, enable thermal energy storage, improve grid flexibility, and mitigate urban heat-island effects. Research should also address overheating risk assessment methodologies and adaptive comfort approaches appropriate for different European climate zones. In line with Article 25 of the Energy Efficiency Directive, research and innovation should support municipalities in planning sustainable cooling, prioritising passive and high-efficiency solutions, while accelerating demonstrators across Europe and contributing to the development of a dedicated EU Cooling Strategy.

Climate-Zone Diversity and Climate-Responsive Renovation Strategies: The EU building stock spans diverse climate zones, from the Mediterranean south to the Scandinavian and Alpine north. While the EPBD provides a common framework for Minimum Energy Performance Standards (MEPS), implementation is carried out at national level, reflecting the characteristics of each country's building stock. IWG5 should support R&I that strengthens the evidence base for climate-responsive renovation strategies by developing climate-zone-specific performance benchmarks, assessing technology effectiveness under different climatic conditions, and identifying cost-optimal renovation pathways, including the changing heating/cooling demand throughout the building lifetime for future climate scenarios. This would help Member States implement ambitious and effective renovation strategies while ensuring that solutions are adapted to local climatic conditions and building characteristics. Data-driven methods should also be developed to evidence MEPS calibration and to characterise and activate demand-side flexibility, ensuring buildings can be integrated with energy grids through demand-response technologies.

1.3. Alignment with SET Plan Task Force Recommendations

IWG5 has contributed substantively to four of the five SET Plan cross-cutting Task Forces — Circularity and Material Substitution, Skills, Digitalisation, and Societal Needs — ensuring that this Thematic Vision reflects the shared priorities emerging across the SET Plan community. The July 2025 Implementation Plan already shows strong alignment with these recommendations: sustainable materials activities advance life-cycle assessment, Digital Product Passports, circular design and long-term circularity; digitalisation actions strengthen open BIM standards, data spaces, AI-enabled analytics and digital twins; and the IWG5 Skills Framework incorporates guidance on updated curricula, skills passports, qualification recognition and workforce upskilling. Societal readiness and affordability have also been integrated into key innovation targets.

The Circularity and Material Substitution Task Force focused primarily on materials and products for energy technologies, including batteries, photovoltaics, wind energy and hydrogen systems, with particular emphasis on critical raw materials. While buildings are considered through the Level(s) framework, the recommendations give comparatively limited attention to buildings as long-lived infrastructure assets, material stocks and energy assets. The IWG5 Thematic Vision complements this perspective by explicitly promoting building-level circularity strategies, including renovation-first approaches, adaptive reuse, preservation of embodied carbon, design for adaptability and disassembly, service-life extension, and recognising buildings as reservoirs of both materials and energy.

The Digitalisation Task Force (March 2026) recommends that IWGs support interoperable smart-metering approaches across Europe. These enable real-time energy information, participation in demand-response and flexibility markets, and consumer-centric digital energy services. Combined with the Data Act and EPBD Article 16 on data exchange, they allow Big-Data-driven optimisation of building design, material choices, HVAC systems and operational protocols.

The Access to Market Task Force identifies regulatory, financial and infrastructural barriers to the uptake of SET Plan technologies, recommending regulatory sandboxes, innovation hubs, de-risking finance instruments and stronger investor engagement. These reinforce the Vision's emphasis on stable, long-term financing as a critical enabler of renovation and support the industrialisation and market-scaling priorities under Supporting European Competitiveness.

The Societal Needs Task Force calls for embedding societal readiness, affordability and just-transition principles into SRIAs and Thematic Visions, alongside improved citizen engagement and stronger synergies between energy systems and land use. These recommendations align closely with the Vision's Delivering Affordable, Inclusive and People-Centred Renovation theme and its focus on resilience, heritage buildings and multi-ownership governance.

2. Vision and targets

The overarching vision of IWG5 is a climate-neutral, climate-resilient, resource-efficient, socially inclusive, and digitally enabled European building stock by 2050. This requires a fundamental transformation spanning building design, sustainable materials, heating and cooling systems, digitalisation, renovation practices, and workforce skills.

Realising this vision requires the system-level integration of four interconnected pillars: sustainable and affordable renovation, industrialisation of the building sector, circular and resource-efficient construction, and climate-resilient and energy-integrated buildings, ensuring that research and innovation deliver interoperable solutions that simultaneously optimise operational performance, whole-life environmental impacts, affordability, and resilience across the entire building life cycle.

Resilience is a foundational and cross-cutting requirement — not a secondary or purely technical consideration — embedded across all pillars and essential to buildings' capacity to withstand climate extremes, system disruptions, and long-term socio-economic change. Resilience encompasses climate resilience (and resilience to natural and anthropogenic hazards), energy system resilience, resource security, digital resilience and social resilience, ensuring that buildings remain safe, healthy, affordable and operational under changing technological, environmental, economic and societal conditions.

The transition must be just and equitable — actively reducing energy poverty and vulnerability risk, and guaranteeing access to safe, affordable, healthy, and climate-resilient buildings for all European citizens, regardless of income or region. As IWG5 adopts a cascade approach, the identified gaps have been prioritised and phased over time. Consequently, not all gaps are addressed through the short-term goals, with some reserved for later stages of implementation that take into account input from IWG5's SRIA and CIIP.

2.1. Short-term (2030)

By 2030, the following innovation targets[1] are set under Action 5.1 (Sustainable Materials and Technologies) and Action 5.2 (Cross-Cutting Heating and Cooling Technologies):

Sub-group	Target	Title	Description	Priorities
5.1	**5.1-T1**	**Energy use reduction**	Reduce the energy use of buildings by 16% compared to 2020, prioritising passive renovation measures while promoting targeted financial support for the most vulnerable households.	Delivering Affordable, Inclusive and People-Centred Renovation

[1] *Note: The targets below originate from IWG5's 2025 Implementation Plan. As the SRIA is developed, these targets are expected to evolve to better align with the Mid-term and Long-term goals set out in this Thematic Vision. Suggestions for updating the targets have already emerged during the preparation of this Vision; these will be carried forward and addressed as part of the SRIA development process.*

Sub-group	Target	Title	Description	Priorities
5.1	**5.1-T2**	**Zero-emission buildings**	Develop and demonstrate cost-efficient solutions for a wide range of zero-emission building types by 2030, promoted and incentivised to build social trust, acceptance, and uptake for a fair and inclusive energy transition.	Delivering Affordable, Inclusive and People-Centred Renovation
5.1	**5.1-T3**	**Construction speed**	Develop and demonstrate market-ready solutions reducing the average duration of energy-related construction works by more than 40% for both renovation and new buildings, compared to current national standard practices.	Supporting European Competitiveness
5.1	**5.1-T4**	**Energy performance gap**	Develop solutions reducing the gap between predicted and measured energy performance to a maximum of 15% after commissioning, with an ambition to reach 10%.	Supporting European Competitiveness
5.1	**5.1-T5**	**Building flexibility**	Develop interoperable, data-driven applications enabling at least 20% flexibility capacity in a minimum of 20% of all buildings at district level, without unacceptable impairments for users.	Delivering Climate-Neutral, Resilient and Energy-Integrated Buildings
5.1	**5.1-T6**	**Materials circularity**	Develop data-driven solutions maximising the reusability and high-value recyclability of building materials and elements at end-of-life, achieving 50% upcycling by 2030.	Enabling Circular, Resource-Efficient and Sustainable Construction
5.2	**5.2-T1**	**Heat pump systems**	Develop plug-and-play hybrid/multi-source heat pump systems and integrated modular heat pump plants; demonstrate heat-upgrade technologies for district heating networks at 90–160°C supply temperatures; increase the number of heat pumps across Europe by an additional 10 million by 2030.	Delivering Climate-Neutral, Resilient and Energy-Integrated Buildings
5.2	**5.2-T2**	**District heating and cooling**	Increase district heating's share of EU heat demand to 20% by 2030, preferably from low-temperature waste heat and renewable sources; integrate 8 million households into district heating/cooling networks across Europe; accelerate the deployment of district cooling where appropriate.	Delivering Climate-Neutral, Resilient and Energy-Integrated Buildings

Sub-group	Target	Title	Description	Priorities
5.2	**5.2-T3**	**Combined (Cooling) Heat and Power**	Integrate highly flexible C(C)HP systems with heat storage, heat pumps and renewable heat sources to reduce annual fuel consumption; develop C(C)HP technologies running on renewable gases (hydrogen, ammonia, methanol, synthetic gas) with performance comparable to natural gas; develop post-combustion solutions reducing emissions by more than 50% while maintaining operational flexibility.	Delivering Climate-Neutral, Resilient and Energy-Integrated Buildings
5.2	**5.2-T4**	**Thermal energy storage**	Commission 100 new large-scale thermal energy storage systems in district heating and cooling networks by 2030; demonstrate 10 sensible thermal-storage systems using renewable/waste heat for more than 60% of annual heat demand; demonstrate 20 compact thermal-storage systems at TRL 6/7 with a storage density of 120 kWh/m^3.	Delivering Climate-Neutral, Resilient and Energy-Integrated Buildings
5.2	**5.2-T5**	**Solar thermal systems and PVT**	Reduce the cost of solar thermal combi-systems with a minimum 60% solar fraction to 12–16 €ct/kWh; develop standardised solutions for easier integration of solar thermal in building renovation, particularly in active prefabricated elements; reduce PVT panel costs by a factor of 1.5–2 from the 2020 reference of €1,000/m^2.	Delivering Climate-Neutral, Resilient and Energy-Integrated Buildings

2.2. Medium-term (2040)

By 2040, the buildings sector will be on a clear and irreversible trajectory towards full decarbonisation, consistent with the EU's 2040 climate target of a 90% reduction in net greenhouse gas emissions. Key medium-term orientations are set out below.

A parallel objective is strengthening European manufacturing capacity across heat pumping technologies, solar thermal, thermal storage, advanced insulation, advanced renovation systems, prefabricated and circular construction products, and digital construction technologies — reducing strategic dependencies and increasing European market share through sustained R&I investment.

By 2040, annual renovation rates are expected to reach at least 2.5–3% of the building stock, placing Europe on a credible pathway towards full decarbonisation by 2050. Heat pumping technologies should provide the dominant share of heating in renovated and new buildings. As their widespread deployment will significantly increase electricity demand, complementary renewable heating solutions—such as solar thermal combined with thermal energy storage—will need to be scaled up to reduce peak electricity demand, enhance system flexibility, and support the expansion of district

heating/cooling. District heating, supported by thermal energy storage, should continue to expand as a key enabler of sector integration and flexibility in an increasingly electrified Europe. A comprehensive cooling strategy should likewise drive the deployment of district cooling alongside passive and other resilient cooling solutions across all climate zones.

The majority of new buildings should operate as zero-emission buildings, and a substantial share of the existing stock should have undergone deep renovation. Resilience will be embedded as a core design principle alongside energy efficiency and decarbonisation, ensuring that buildings are adaptable, climate-resilient, and capable of withstanding disruptions while actively contributing — through EV charging infrastructure, local renewable generation, and thermal flexibility — to a robust, flexible, and integrated energy system. Occupant health and well-being, adaptation, and resilience to changing climatic and socio-economic conditions should be integral to both new construction and renovation.

Broad market uptake of zero-emission building technologies — heat pumping technologies, solar thermal, PVT, district heating and cooling, and other low-carbon heating solutions (noting that solid biomass, while not a priority for expansion under IWG5's R&I agenda, continues to play a significant role in the existing heating mix in Nordic and rural areas and is expected to remain part of the transition landscape in those contexts) — supported by mature policy frameworks including ETS2 and EPBD MEPS.

— **Supporting European Competitiveness**

Digitalisation: Digitalisation fully integrated into building life-cycle management: digital twins, AI-supported renovation planning, and real-time grid interaction as standard practice for a significant share of the building stock. Data-driven methods enable grid-friendly buildings through automated activation of energy flexibility.

Industrialisation and competitiveness: Industrialised renovation at scale: standardised, prefabricated building envelope and system solutions widely available with cross-border interoperability, substantially reducing renovation time and cost. Cross-sector collaboration between buildings, renewable energy technologies, advanced materials, and manufacturing industries has become standard practice, promoting integrated innovation ecosystems and accelerating market deployment of circular and low-carbon building solutions.

Skills: A skilled and digitally literate construction workforce: recognised cross-border competence frameworks in place, skills gaps substantially closed, and regional disparities in workforce capacity measurably reduced.

— **Enabling Circular, Resource-Efficient and Sustainable Construction**

Embodied carbon reduction: The objective is to support a significant reduction in the embodied carbon of the EU building sector, in line with the EPBD WLGWP reporting framework and the EU Taxonomy criteria.

Circular economy integration: Circular economy principles embedded across all building renovation and construction: digital product passports, material cadastres, and harmonised LCA approaches and databases in wide operational use; direct reuse and reuse after remanufacturing established as standard practice, underpinned by product-as-a-service models that span the full building life cycle from supply and operation through to end-of-life. Circularity has progressively moved beyond waste management towards circularity-by-design, promoting life extension, adaptability, design for disassembly, and high-value reuse and remanufacturing, while reducing

dependence on critical raw materials through sustainable material substitution, ensuring a safe second-life.

Progress should increasingly be measured through harmonised indicators covering embodied carbon, circular material use, reuse rates, Digital Product Passport implementation and Whole-Life Global Warming Potential.

— **Delivering Affordable, Inclusive and People-Centred Renovation**

Condominium and multi-ownership governance: Multi-ownership governance barriers should be substantially reduced: dedicated instruments — pooled technical assistance, simplified collective decision-making, and shared-ownership financial products — should be widely available across Member States, enabling condominium buildings to participate in the Renovation Wave on comparable terms to single-owner properties.

Historic and heritage-protected building stock: Reconversion of abandoned stock and heritage-compatible renovation should be mainstreamed: demographic decline across Southern, Eastern, and rural regions is creating a growing stock of abandoned buildings requiring adaptive reconversion combining energy upgrading with functional repurposing. In parallel, conservation-compatible technologies for heritage-protected buildings — reversible interventions, sympathetic envelope solutions, building-integrated renewables such as building-integrated solar (PV and/or thermal) and PVT (hybrid PV+thermal) panels — should be proven at scale, with heritage stock no longer structurally excluded from the Renovation Wave.

Renovation, Innovation and District-Scale Integration: User-centred renovation is embedded across the sector, ensuring that innovation, after building and urban renovation, not only improves energy performance but also enhances indoor environmental quality, affordability, climate resilience, adaptability, and overall occupant health and well-being. Positive Energy Districts (PEDs), Renewable Energy Communities, and building-to-grid integration further provide scalable district-level solutions, supported by harmonised assessment methodologies and replicable deployment frameworks.

— **Delivering Climate-Neutral, Resilient and Energy-Integrated Buildings**

Resilient cooling and climate-adaptive buildings: Passive and active cooling solutions—including climate-adaptive building envelopes, natural, hybrid or mechanical ventilation, solar shading, cool surfaces, urban greening, and district cooling—are increasingly integrated into renovation and new construction, particularly in regions most exposed to rising temperatures.

In parallel, Member States implement the **EPBD through climate-zone-specific Minimum Energy Performance Standards (MEPS)** and technology pathways, supported by robust performance benchmarks, cost-optimality assessments, and evidence on the effectiveness of different solutions across European climate zones. This enables climate-responsive renovation strategies that improve resilience, reduce cooling demand, enhance grid flexibility, and ensure cost-effective deployment of innovative cooling technologies.

2.3. Long-term (2050)

By 2050, Europe's building sector should achieve full climate neutrality in line with the European Climate Law — and has the potential to become net carbon-negative, with biogenic carbon storage in timber, bio-based insulation, and other innovative materials making the sector a net sink. Long-term goals include:

— **Supporting European Competitiveness**

European industrial leadership: European manufacturers of heat pumping technologies, solar energy technologies for buildings (including solar thermal, solar photovoltaic (PV), and hybrid PV-T systems), advanced building materials, and digital building technologies are global leaders, underpinned by sustained R&I investments and supported by the Net-Zero Industry Act and the Clean Industrial Deal.

Digitalisation fully embedded across the building life cycle: digital twins, AI-supported design and renovation planning, harmonised data spaces, and real-time grid interaction are universal practice across the European building stock; open, interoperable digital infrastructure underpins building performance monitoring, circular material traceability, and seamless integration with energy networks; and the digital divide between large and small construction actors has been substantially closed.

Industrialised construction and renovation at full scale: Renovation and new construction are delivered through standardised, industrialised, and digitally integrated processes as the norm; fragmentation and craft-based delivery have been substantially overcome across all Member States and building typologies.

A skilled, future-ready construction workforce: Europe's construction sector is supported by a fully upskilled, digitally literate, and cross-border-recognised workforce; skills gaps have been eliminated; and the sector attracts the talent needed to deliver renovation at the pace required for climate neutrality. Future-proof the workforce by embedding digital literacy, Artificial Intelligence (AI) and machine learning, data analysis, and system-level knowledge into every training pathway across VET, higher education, schools, and lifelong learning.

— **Enabling Circular, Resource-Efficient and Sustainable Construction**

Full circularity: Construction and demolition waste minimised; materials circulating at high value within the European economy; reuse, refurbishment, and recycling of building components routine practice underpinned by digital traceability and harmonised standards. Buildings operate within circular value chains where materials, components, and products remain traceable throughout multiple life cycles, supported by harmonised digital information systems, circular business models, and mature European secondary material markets.

— **Delivering Affordable, Inclusive and People-Centred Renovation**

Social equity and inclusive renovation: Energy poverty and vulnerability risk have been significantly reduced; all European citizens have access to comfortable, healthy, energy-efficient, affordable, and climate-resilient homes; and regional and social disparities in building quality have been substantially reduced. Renovation policies systematically promote indoor environmental quality, accessibility, adaptability, and occupant well-being, while the objectives of the European Affordable Housing Plan are fully embedded across the renovation ecosystem.

Multi-ownership buildings fully integrated into the decarbonised building stock: Governance and financing barriers for condominium and multi-owner buildings have been resolved across all Member States, and the renovation rate for multi-ownership residential stock matches that of single-owner buildings, ensuring urban housing is not structurally excluded from climate neutrality.

Heritage buildings fully integrated into the decarbonised building stock: Conservation-compatible renovation technologies are mature and widely deployed — including building-integrated solar (PV

and/or thermal) and PVT (hybrid PV+thermal) panels for heritage contexts; heritage-protected buildings achieve deep energy performance improvements without compromising their architectural or cultural value; and no category of building stock is structurally excluded from climate neutrality.

— **Delivering Climate-Neutral, Resilient and Energy-Integrated Buildings**

Climate-Adaptive, Net-Zero and Energy-Integrated Buildings: Europe's building stock is fully adapted to changing climatic conditions through the widespread deployment of passive and resilient cooling strategies, including climate-adaptive envelopes, natural, hybrid and mechanical ventilation, solar shading, evaporative cooling, nature-based urban cooling, and high-efficiency district and integrated cooling systems.

Climate-zone-responsive Minimum Energy Performance Standards (MEPS) and technology pathways are fully embedded across the EU, supported by climate-specific performance benchmarks, robust cost-optimality evidence, and renovation pathways tailored to different building stocks and climatic conditions. All new buildings, together with a substantial share of the renovated stock, operate with net-zero greenhouse gas emissions, while biogenic and other innovative construction materials contribute to carbon removals and make the buildings sector a net contributor to Europe's climate objectives. Buildings also function as active, intelligent nodes within the European energy system, integrating renewable energy generation, providing flexibility services through smart controls, sector coupling and thermal/electrical storage, and supporting a resilient, decarbonised electricity grid. In this context, hybrid renewable heating and cooling generation and storage systems become a standard solution across the building stock, reducing grid electricity demand compared to a single-system electrification scenario and improving overall system resilience through multi-source optimisation.

Buildings are fully integrated into neighbourhood- and district-level energy systems, with shared thermal networks, local energy communities, and coordinated flexibility management optimising performance beyond the scale of the individual building.

Progress towards this Thematic Vision could be supported by a harmonised monitoring framework building on the methodological work developed within the SET-IWG5 project, particularly under WP3. Quantitative KPIs should focus on energy use, carbon emissions, indoor environmental quality, and building resilience, considering both operational and life-cycle performance, as well as the dynamics of a changing climatic scenario. While IWG5 currently monitors progress through its flagship projects and implementation activities, the methodologies and indicators developed within SET-IWG5 could provide a more systematic framework for tracking progress towards the EU’s 2030, 2040, and 2050 objectives.

3. Conclusions and next steps

Achieving Europe's climate objectives requires an equitable transformation of the building sector, with the challenge increasingly requiring a shift from technology development towards effective deployment at scale, alongside continued innovation in areas such as digitalisation, industrialisation, and circularity. Building on the IWG5 Implementation Plan 2025 and aligned with the SET Plan, this Vision calls for coordinated R&I, stable policy frameworks, stronger governance, and closer alignment between EU and national actions. It also highlights the importance of renovation, climate adaptation, resilient cooling, circularity, skills, industrialisation, digitalisation, stable long-term financing and affordability, social equity, and coherence with broader EU initiatives.

The four strategic themes presented in this Vision provide the strategic bridge between the operational priorities of the IWG5 Implementation Plan and the future Strategic Research and Innovation Agenda, ensuring continuity across all stages of the SET Plan implementation process.

The completion of this Thematic Vision marks the first step towards the development of the SET Plan Common Implementation and Investment Plans (CIIPs). As the next phase, IWG5 will prepare a Strategic Research and Innovation Agenda (SRIA) in close collaboration with industry and research stakeholders. The SRIA will build on the existing strategic agendas of ECTP and RHC-ETIP and will be developed in close cooperation with other SET Plan Implementation Working Groups, including Positive Energy Districts, Geothermal Energy, Solar Thermal Technologies, Solar PV, and Integrated Energy Systems, to ensure coherence and identify cross-cutting research and innovation priorities. To support this process, IWG5 will organise a joint workshop with the Implementation Working Group on Positive Energy Districts (IWG PED) and RHC-ETIP to strengthen collaboration, align priorities, and identify opportunities for joint actions.

Abbreviations

Abbreviation	Full Term
AI	Artificial Intelligence
BIM	Building Information Modelling
CIIP	Common Implementation & Investment Plan
CPR	Construction Products Regulation
Data Act	Regulation (EU) 2023/2854 on harmonised rules on fair access to and use of data
DHC	District Heating and Cooling
DPP	Digital Product Passport
ECTP	European Construction and sustainable built environment Technology Platform
EED	Energy Efficiency Directive
EPBD	Energy Performance of Buildings Directive
ETS2	Emissions Trading System for Buildings and Transport
EV	Electric Vehicle
GHG	Greenhouse Gas
HVAC	Heating, Ventilation and Air Conditioning
IEA EBC Annex 80	International Energy Agency – Energy in Buildings and Communities Programme, Annex 80 (Resilient Cooling)
IEQ	Indoor Environmental Quality
IWG5	Implementation Working Group 5 (Energy & Resource Efficiency in Buildings)
LCA	Life-Cycle Assessment
Level(s)	EU Framework for Sustainability Performance of Buildings
MEPS	Minimum Energy Performance Standards
NBRPs	National Building and Renovation Plans

Abbreviation	Full Term
NECPs	National Energy and Climate Plans
One Stop Shop	Integrated Renovation Support Service
PV	Photovoltaic
PVT	Photovoltaic Thermal Hybrid System
REC	Renewable Energy Community
RED / RED III	Renewable Energy Directive
REPowerEU	EU Plan for Rapid Renewable Deployment & Reduced Fossil Dependence
RHC-ETIP	European Technology and Innovation Platform on Renewable Heating and Cooling
SET Plan	Strategic Energy Technology Plan
SRIA	Strategic Research & Innovation Agenda
Task Forces	SET Plan Cross Cutting Task Forces (Circularity, Skills, Digitalisation, Societal Needs, Access to Market)
TES	Thermal Energy Storage
TRL	Technology Readiness Level
WLGWP	Whole Life Global Warming Potential

References

EU policy and legislative documents

European Parliament and Council (2024). Directive (EU) 2024/1275 on the energy performance of buildings (recast EPBD). Official Journal of the European Union.

European Parliament and Council (2023). Directive (EU) 2023/1791 on energy efficiency (recast EED). Official Journal of the European Union.

European Parliament and Council (2023). Directive (EU) 2023/2413 amending the Renewable Energy Directive (recast RED III). Official Journal of the European Union.

European Parliament and Council (2024). Regulation (EU) 2024/3110 on construction products (recast CPR). Official Journal of the European Union.

European Parliament and Council (2023). Directive (EU) 2023/959 amending the EU Emissions Trading System Directive — establishing the new ETS2 for buildings, road transport, and additional sectors. Official Journal of the European Union.

European Parliament and Council (2023). Regulation (EU) 2023/955 establishing the Social Climate Fund. Official Journal of the European Union.

European Commission (2022). REPowerEU Plan. COM(2022) 230 final.

European Commission (2020). A Renovation Wave for Europe — greening our buildings, creating jobs, improving lives. COM(2020) 662 final.

European Commission (2025). European Affordable Housing Plan. COM(2025) 1025 final.

European Parliament and Council (2024). Regulation (EU) 2024/1991 on nature restoration (Nature Restoration Law). Official Journal of the European Union.

European Parliament and Council (2021). Regulation (EU) 2021/1119 establishing the framework for achieving climate neutrality (European Climate Law). Official Journal of the European Union.

European Parliament and Council (2024). Net-Zero Industry Act. Regulation (EU) 2024/1735. Official Journal of the European Union.

European Commission (2025). Clean Industrial Deal. COM(2025) 85 final.

European Commission (2020). A new Circular Economy Action Plan — For a cleaner and more competitive Europe. COM(2020) 98 final. [Source for 2030 circularity targets including the 24% recycling rate benchmark.]

European Parliament and Council (2023). Regulation (EU) 2023/2854 on harmonised rules on fair access to and use of data (Data Act). Official Journal of the European Union.

European Commission (2020). Level(s) — European framework for assessing the sustainability performance of buildings. Available at: https://green-forum.ec.europa.eu/green-business/levels_en

IWG5 documents

IWG5 (2025). Implementation Plan Update. Available at: https://www.iwg5-buildings.eu/wp-content/uploads/2025/07/IWG5_IP_Update_Final_20250728.pdf

IWG5 (2023). NECP Report on Innovation in Buildings. Available at: https://www.iwg5-buildings.eu/wp-content/uploads/2023/12/IWG5_Deliverable-1.4_NECP-report-on-innovation-in-buildings_07-Dec-2023.pdf

IWG5 (2025). Recommendations on National Building and Renovation Plans. Available at: https://www.iwg5-buildings.eu/wp-content/uploads/2025/06/IWG5_Deliverable-1.10_Recommendations-on-how-to-prepare-upcoming-National-Building-Renovation-Plans-with-a-focus-on-Zero-Energy-Buildings.pdf

IWG5 Task Force White Papers (2023–2025). Available at: https://www.iwg5-buildings.eu/media/policy-briefings/

IWG5 (2024). IWG5 Online Tool for evidence-based renovation planning across European climate zones. Available at: https://www.iwg5-buildings.eu/resources/iwg5-online-tool/

SET-IWG5 Consortium (2023–2026). SET-IWG5 Horizon Europe project — Supporting the Implementation of the SET Plan IWG5 on Energy and Resource Efficiency in Buildings, including WP3 on monitoring frameworks and KPIs. Available at: https://www.iwg5-buildings.eu

IWG5 Italian Mirror Group (2026). Thematic Vision – Italy Mirror Group. Available at: https://www.iwg5-buildings.eu/wp-content/uploads/2026/06/Thematic-Vision-Italy-mirror-group-June026-Clean.pdf

Market data and statistics

European Commission (2024). In-depth analysis in support of the Commission's assessment of the integrated national energy and climate plans. SWD(2024) 63 final. [Source for 35% energy consumption, 40% GHG emissions figures.]

Eurostat (2024). Generation of waste by waste category, hazardousness and NACE Rev. 2 activity. [Source for 37% of all EU waste from construction and demolition.]

Eurostat (2026). Construction production index. [Source for 2.0% decline in EU construction output, January 2026 vs January 2025.]

Eurostat (2025). Construction producer prices for new residential buildings index. [Source for 56% price increase since 2010.]

European Commission / Eurostat (2024). Community Innovation Survey. [Source for 75% of construction firms reporting low innovation, vs 67% across other industries.]

European Heat Pump Association (EHPA) (2025). European Heat Pump Market and Statistics Report 2025. [Source for heat pump sales figures: 21% decline in 2024 to 2.2 million units; ~10% recovery in 2025; 25 million units installed across Europe.]

Euroheat & Power (2024). District Heating and Cooling: Country by Country Survey. [Source for district heating and cooling supplying approximately 13% of Europe's heat demand.]

Sgaravatti, G., Tagliapietra, S., Trasi, C. and Zachmann, G. (2023). National policies to shield consumers from rising energy prices. Bruegel Dataset. [Source for €150 billion/year investment gap to meet EPBD requirements.]

Research and technical references

IEA Energy in Buildings and Communities Programme (EBC) Annex 80 (2023). Resilient Cooling of Buildings. [Source for resilient cooling strategies framework referenced in the Cooling and Climate-Adaptive Envelopes section.]

RHC-ETIP (2022). Strategic Research and Innovation Agenda for Renewable Heating and Cooling. European Technology and Innovation Platform on Renewable Heating and Cooling.

ECTP (2023). Strategic Research and Innovation Agenda 2024–2030. European Construction and sustainable built environment Technology Platform.

European Commission (2023). Progress Report on the Energy Performance of Buildings Directive implementation and renovation rates across Member States. SWD(2023) 165 final. [Source for approximately 1% annual renovation rate figure.]