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D5.1 Skills for Industry 5.0 in the European Wood and Furniture Sector: Labour Market Trends and Enterprise-Level Recommendations

WP5/T5.1 – T5.2

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SUMMARY

Executive Summary

This report investigates the dual transformation of the European wood and furniture sector in the era of Industry 5.0, guided by two core questions:

- *What are the current and emerging green and digital skills required in the wood and furniture sector in Europe, and how do they align with Industry 5.0 needs? What mismatches exist between demand and supply?*
- *How can wood and furniture companies in Europe adopt Industry 5.0 principles by developing relevant skills, integrating available technologies, and applying EU tools for training and competence validation?*

The analysis demonstrates that the sector is undergoing a profound competence shift. On the green side, three clusters stand out: eco-materials, life-cycle thinking, and energy optimisation. On the digital side, four domains emerge: robotics and human–robot interaction, artificial intelligence, digital twins and simulation technologies, and data-driven decision-making. These technical competences are complemented by transversal skills—adaptability, digital collaboration, systems thinking, and co-design—that enable workers and firms to navigate complex, hybrid production ecosystems.

Despite this clear trajectory, significant mismatches persist. SMEs, which form the backbone of the sector, still rely heavily on informal, ad-hoc training. Digital adoption is uneven, green competences are insufficiently diffused, and training provision does not yet deliver the hybrid profiles required by Industry 5.0. This gap slows innovation, reduces resilience, and weakens competitiveness in both domestic and international markets.

To address these challenges, the report identifies five strategic priorities:

1. Shifting from reactive to proactive competence strategies, embedding skills development into business planning and technology investments;
2. Structuring upskilling and reskilling pathways, aligned with ESCO, the European Qualifications Framework (EQF), and microcredentials, to ensure modular, portable learning opportunities;
3. Implementing practical actions such as competence audits, alliances with training providers, integration of skills into technology roll-outs, and ecosystem-based governance involving clusters, social partners, and innovation centres;
4. Fostering workforce engagement by involving employees in co-design processes, peer-to-peer learning, and communities of practice, while leveraging facilitators and change agents to bridge internal needs with external ecosystems;
5. Leveraging EU programmes – including Erasmus+, Digital Europe, Horizon Europe, ESF+, LIFE, and the Single Market Programme – to access funding, networks, and cross-border innovation opportunities.

The implications are clear. For training providers, modular and targeted pathways must be designed to keep pace with emerging occupations. For policymakers, skills ecosystems and observatories are

needed to anticipate future mismatches and strengthen territorial clusters. For enterprises, competence development must become a strategic asset, directly linked to innovation, compliance, and resilience.

Ultimately, the central insight is that competences are not a supporting element but the linchpin of Industry 5.0 adoption. Closing the gap between emerging skill requirements and existing supply requires a dual strategy: equipping workers with hybrid green and digital capabilities, while embedding these competences into technology adoption, organisational models, and collaborative governance. By doing so, the European wood and furniture sector can align human-centric innovation, sustainability, and digitalisation, ensuring long-term competitiveness and resilience in the face of the twin transition.

§1 Introduction and Research Scope

The transformation of Europe's industrial landscape has recently led to a major conceptual turning point: **the shift from Industry 4.0, centred on automation and productivity, toward Industry 5.0, a vision that places greater emphasis on human-centred design, ecological responsibility, and systemic robustness**. Championed by the European Commission, this approach calls for reconfiguring industrial ecosystems to better support societal well-being and environmental goals, while simultaneously strengthening technological innovation and economic competitiveness[1].

This change does not emerge in isolation. It is embedded within a broader twin transition strategy that simultaneously advances digital transformation and ecological sustainability. The EU's overarching policy instruments - including the European Green Deal, the European Skills Agenda, and the Pact for Skills – position skills development as a critical lever for ensuring that these transitions are inclusive, adaptive, and economically viable[2]. Within this framework, particular emphasis is placed on green and digital competences, modular and flexible learning pathways, and the integration of European-level tools such as the European Skills, Competences, Qualifications and Occupations (ESCO) and the European Qualifications Framework (EQF).

The wood and furniture sector – comprising NACE[3] divisions C16 (wood manufacturing) and C31 (furniture production) – represents a highly relevant case for exploring the implications of Industry 5.0 in practice. Historically grounded in artisanal knowledge and aesthetic design, the sector is increasingly confronted with the **need to integrate advanced technologies** such as robotics, artificial intelligence, digital twins, IoT systems, and smart materials, while also responding to regulatory and market pressures related to **sustainability**, **traceability**, and **consumer transparency**. Instruments such as the forthcoming Digital Product Passport, introduced under the proposed Ecodesign for Sustainable Products Regulation, are indicative of this shift.

At the same time, the structure of the sector – predominantly composed of SMEs – creates a specific set of **challenges**: **limited investment capacity in training and digital infrastructure**, **difficulties in recruiting and retaining qualified staff**, and **fragmentation of knowledge transfer systems**. Prior EU-funded projects – such as DIGIT-FUR[4], SAWYER[5], and FurnCIRCLE[6] – have already

[1] Cf. Directorate-General for Research and Innovation (European Commission), Breque, M., De Nul, L., Petridis, A., (2021), *Industry 5.0. Towards a sustainable, human-centric and resilient European industry*, Policy brief, DOI: 10.2777/308407.

[2] Cf. COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, *European Skills Agenda for sustainable competitiveness, social fairness and resilience*, Brussels, 1.7.2020 COM(2020) 274 final; Council of the European Union (2022), *Council Recommendation of 16 June 2022 on a European approach to micro-credentials for lifelong learning and employability*, in Official Journal of the European Union C 243/10.

[3] The NACE classification (Nomenclature of Economic Activities) is the European Union's standard framework for classifying economic sectors, widely used for statistical reporting, labour market monitoring, and policy development across Member States. Cf. Eurostat (2008), *NACE Rev. 2 - Statistical classification of economic activities*, Office for Official Publications of the European Communities, Luxembourg.

[4] https://digit-fur.eu/

[5] https://circularfurniture-sawyer.eu/

[6] https://www.furncircle.eu/

documented both the opportunities and bottlenecks associated with upskilling and organisational innovation in this context.

This report, elaborated within the framework of the Furn5.0 project, addresses two interlinked research questions (RQs):

> *RQ1: What are the current and emerging green and digital skills required in the wood and furniture sector in Europe, and how do they align with Industry 5.0 needs? What mismatches exist between demand and supply?*

and

> *RQ2: How can wood and furniture companies in Europe adopt Industry 5.0 principles by developing relevant skills, integrating available technologies, and applying EU tools for training and competence validation?*

The following sections of this report are structured to provide complementary insights addressing both RQs. Each chapter contributes to clarifying the evolving skills landscape in the wood and furniture sector, while also identifying the practical and strategic levers available to companies seeking to adopt Industry 5.0 principles. Together, the analysis of occupations, emerging competences, labour market trends, and available EU tools offers an integrated perspective to support both workforce development and enterprise-level innovation in alignment with European policy objectives.

The research adopts a desk-based methodology. It triangulates:

1. The ESCO v1.2 taxonomy[7], which offers a harmonised vocabulary to describe job profiles and the associated knowledge, skills, and competences (KSC);
2. Labour demand data derived mostly from CEDEFOP's Skills Forecast by sector;
3. Sectoral policy documents and analytical outputs produced by the European Commission and relevant EU-level social partners.

In addition, this report integrates insights derived from a series of technology factsheets produced as part of Furn5.0, which document concrete applications of Industry 5.0 technologies in the wood and furniture value chain. By linking these technological trajectories to skill requirements, the report aims to build a comprehensive picture of how work is evolving in the sector – and how policy and training systems might respond effectively to this evolution.

§2 Key Occupations and Tasks in Industry 5.0

The transition toward Industry 5.0 in the wood and furniture sector is not only introducing new technologies but also reshaping traditional roles. While many occupations remain nominally the

[7] https://esco.ec.europa.eu/en/classification

same, their core tasks and competence requirements are evolving rapidly – especially in relation to the integration of robotics, AI, digital tools, and sustainability standards. This section presents a selection of key occupations drawn from the ESCO v1.2 classification, updated to reflect the skill shifts and task transformations driven by the technological enablers documented in the Furn5.0 project.

In the area of quality and compliance, the introduction of the Digital Product Passport (DPP)[8] – a central instrument foreseen in the proposed Ecodesign for Sustainable Products Regulation (ESPR)[9]– is transforming how product-related data is structured, accessed, and shared across the value chain. Aimed at improving transparency, promoting circular practices, and ensuring regulatory adherence, the DPP facilitates both the monitoring of environmental performance and the empowerment of consumers to make informed choices, while also strengthening the enforcement of sustainability requirements[10]. As a result, this regulatory shift has led to the emergence of new professional roles focused on sustainability compliance and product traceability. These roles – often mapped in the ESCO v1.2 taxonomy to occupations such as quality engineering technician[11] or environmental scientists[12] – require a robust combination of technical and regulatory competences. Quality engineering technicians, traditionally tasked with monitoring production standards and supporting quality control systems, must now integrate structured data management and digital inspection tools into their workflows. Similarly, environmental scientists, whose responsibilities include assessing environmental risks and ensuring regulatory compliance, increasingly need to interpret traceability data, evaluate circularity metrics, and contribute to digital sustainability reporting. In both cases, a deep understanding of circular economy principles and familiarity with interoperable traceability systems based on digital platforms are becoming essential components of the role.

One of the most visibly affected roles is that of the furniture designer[13]. Traditionally focused on form, ergonomics, and material choices, this role now increasingly requires proficiency in immersive design environments, such as Extended Reality (XR), and the ability to co-design interactively with clients using AR-based tools. Tasks such as prototyping, once based on physical models, are now routinely conducted in virtual environments, supported by data overlays and real-time simulations.

[8] https://data.europa.eu/en/news-events/news/eus-digital-product-passport-advancing-transparency-and-sustainability
[9] European Parliament, Council of the European Union (2024), *Regulation (EU) 2024/1781 of the European Parliament and of the Council of 13 June 2024 establishing a framework for the setting of ecodesign requirements for sustainable products, amending Directive (EU) 2020/1828 and Regulation (EU) 2023/1542 and repealing Directive 2009/125/EC.* https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32024R1781&qid=1719580391746. https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/ecodesign-sustainable-products-regulation_en
[10] Cf. COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, *Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a framework for setting ecodesign requirements for sustainable products and repealing Directive 2009/125/EC*, Brussels, 30.3.2022, COM(2022) 142 final.
[11] ISCO code 3119.16.
[12] ISCO code 2133.7.
[13] ISCO code 2163.1.4.

This calls for a hybrid skillset combining creative design with digital modelling, human-machine interaction, and sustainability awareness.

Similarly, the occupation of wooden furniture machine operator[14] has undergone a notable transformation. While the foundational tasks of these operators – such as running production machinery, ensuring smooth operation, and performing basic maintenance – remain central to the role, the integration of autonomous systems and robotics with Human-Robot Interaction (HRI) interfaces is reshaping its practice. As these technologies become more responsive to human input and capable of real-time adaptation, workers must cultivate advanced digital skills, grasp the fundamentals of AI-enabled control systems, and learn to operate seamlessly alongside robotic platforms in collaborative environments.

The role of the process engineer[15] or production engineer[16] is evolving in response to the growing adoption of digital twin technologies, which allow for real-time simulation, monitoring, and optimisation of production systems. Traditionally responsible for improving the efficiency and reliability of manufacturing processes, these professionals must now integrate advanced capabilities in data-driven modelling, predictive analysis, and cross-functional systems thinking. Their expertise extends beyond process refinement to include the use of virtual environments that mirror live production flows and connect to IoT infrastructure and AI analytics platforms. This shift requires not only technical adaptation but also a more strategic role in managing complexity, variability, and continuous optimisation in Industry 5.0 ecosystems.

The sector also requires profiles not previously common in manufacturing environments, such as data analysts[17] working at the intersection of design, production, and marketing. These professionals play a crucial role in collecting, cleaning, and interpreting complex datasets to support faster and more informed decision-making across the value chain. In the context of Industry 5.0, their contribution extends to the use of AI-powered tools for trend analysis, customer profiling, and the visualisation of performance indicators through dashboards and interactive reports. When embedded within marketing functions, data analysts support the deployment of generative AI systems to personalise content, automate catalogue creation, and generate synthetic product media tailored to specific audiences and markets. This integration of data analysis and creative automation exemplifies the new hybrid competences required in an increasingly digitalised and customer-responsive furniture ecosystem.

Finally, vocational teachers[18] and corporate trainers[19] are taking on renewed importance as enablers of continuous learning and transformation. Beyond their traditional roles – centred on developing practical know-how in learners or enhancing workforce performance within companies – these professionals are now expected to operate within digitally augmented learning ecosystems. The

[14] ISCO code 7523.3.
[15] ISCO code 2141.10.
[16] ISCO code 2141.4.2.
[17] ISCO code 2511.3.
[18] ISCO code 2320.1.
[19] ISCO code 2424.2.

application of Extended Reality (XR) in training, as showcased by several Furn5.0 use cases, is expanding the scope of these roles to include the design of immersive learning paths, the use of simulation technologies, and the delivery of personalised reskilling programmes. Their activity now intersects **pedagogy**, **digital competence**, and **organisational change management**, reflecting a broader shift toward adaptive, experiential, and tech-integrated education models that align with the evolving needs of the European industrial landscape.

In all these cases, the transition to Industry 5.0 does not eliminate traditional occupations – rather, it redefines them. The integration of advanced technologies and sustainability standards is progressively reshaping job content, expanding required competences, and altering how tasks are performed. This evolution highlights the **need for a systematic update of occupational classifications and learning pathways**. Capturing these dynamics within tools such as the ESCO taxonomy is essential to support evidence-based upskilling strategies and ensure that workforce development reflects the operational realities of an emerging industrial paradigm. These occupational transformations call for proactive policy responses to close the gap between labour market needs and education and training systems. As the wood and furniture sector embraces the Industry 5.0 model, it is critical that public authorities, social partners, and training providers coordinate efforts to revise qualification frameworks, promote flexible and modular upskilling pathways, and integrate forward-looking skill demands into European tools such as ESCO and EQF. Only through such alignment can Europe equip its workforce for the hybrid, sustainability-oriented, and digitally enhanced roles that will underpin industrial competitiveness in the coming decade.

Against this background, a clearer articulation of the specific knowledge, skills, and competences required by Industry 5.0 becomes essential. In particular, the convergence of green and digital transformations reshapes not only the technological toolkit of the sector but also the broader competence frameworks needed across occupations. The following section provides a structured overview of these evolving skillsets, drawing on both the ESCO taxonomy and the technological scenarios outlined in the Furn5.0 technology factsheets, with a specific focus on how technical, transversal, and sustainability-related competences combine to define future-proof occupational profiles.

§3 Green, Digital and Soft Skills: An Overview

§3.1 Green Technical Skills

Green technical skills represent a core pillar of the competence transformation required in the wood and furniture sector as it aligns with the principles of Industry 5.0 and the broader objectives of the European Green Deal. These skills encompass distinct but interrelated knowledge domains and operational capabilities that enable companies and professionals to integrate environmental considerations into production, design, and compliance activities. Specifically, three key competence clusters can be identified:

I. Ecomaterials;
II. Life-cycle thinking;
III. Energy Optimisation.

The **eco-materials competence** cluster refers to the ability to select, apply, and evaluate materials based on their environmental performance throughout the lifecycle of furniture products. This includes a comprehensive understanding of sustainably sourced timber[20], recycled or bio-based materials, and emerging eco-innovations such as biodegradable composites or low-emission adhesives. Professionals are expected to evaluate materials in terms of durability, recyclability, environmental impact, and compliance with sustainability standards, such as those outlined by the EU Ecolabel. This competence directly contributes to reducing the environmental footprint of products and aligns with evolving market and regulatory expectations[21].

Life-cycle thinking entails a systemic perspective that extends beyond individual production stages to encompass the full spectrum of environmental impacts associated with a product's existence — from raw material extraction through production, distribution, consumption, and eventual end-of-life management, including disposal or recycling. This competence involves the capacity to assess products and processes through recognised methodologies such as Life Cycle Assessment (LCA), which offers a structured framework for quantifying environmental burdens across multiple dimensions. Such analysis requires a sound understanding of key impact categories, including carbon footprint, water consumption, and resource depletion, as well as familiarity with the standards and methodologies underpinning the transition to circular economy models.

By embedding life-cycle thinking into the design and development phases of products and processes, companies are better positioned to identify opportunities for improvement, reduce waste, and enhance resource efficiency throughout the value chain. This approach is particularly relevant in the current policy landscape, where regulatory instruments such as the Ecodesign for Sustainable Products Regulation (ESPR) and the forthcoming Digital Product Passport (DPP) aim to ensure that sustainability considerations are integrated from the earliest stages of production planning[22]. Through the adoption of life-cycle thinking, firms can thus align their operational strategies with European Union objectives on sustainability, transparency, and circularity, positioning themselves competitively in an evolving market context.

Energy optimisation competences refer to the ability to design, implement, and continuously monitor energy-efficient solutions within manufacturing contexts. This expertise encompasses a

[20] Through relevant certifications' bodies, such as the Forest Stewardship Council (FSC) and the Programme for the Endorsement of Forest Certification (PEFC).
[21] Cf. CEDEFOP (2021), *The green employment and skills transformation: insights from a European Green Deal skills forecast scenario*, Publications Office. Luxembourg http://data.europa.eu/doi/10.2801/112540; European Commission (Shane Donatello, Hans Moons and Oliver Wolf) (2017), *Revision of the EU Ecolabel Criteria for Furniture Product. Final technical report*, Publications Office of the European Union, Luxembourg.
[22] Cf. COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, *Proposal for a REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a framework for setting ecodesign requirements for sustainable products and repealing Directive 2009/125/EC*, Brussels, 30.3.2022, COM(2022) 142 final

thorough understanding of technologies aimed at reducing energy consumption, such as smart lighting systems, high-efficiency motors, and energy recovery mechanisms. It also requires the analytical skills necessary to assess energy flows within industrial processes, identify inefficiencies, and propose corrective measures, typically through the application of tools such as energy audits or digital platforms for real-time energy monitoring.

Moreover, energy optimization increasingly involves the integration of renewable energy sources into production environments, including photovoltaic systems, biomass heating solutions, and other forms of low-carbon energy. This competence not only contributes to cost efficiency and regulatory compliance but also aligns with broader decarbonisation objectives set out in EU strategies for climate neutrality and industrial sustainability. In the context of Industry 5.0, these skills are essential for embedding energy intelligence across the value chain, fostering a proactive approach to resource management and environmental stewardship.

It is critical to recognise that the three identified competence clusters — ecomaterials, life-cycle thinking, and energy optimisation — cannot be conceptualised as separate or self-contained domains. Rather, they represent interdependent and mutually reinforcing dimensions of knowledge, skills, and competences (KSC), coherently articulated within the European ESCO taxonomy. This integrated architecture reflects the inherent complexity of green competences, whose cross-disciplinary nature aligns with the systemic shifts underpinning Industry 5.0 and the ambitions of the European Green Deal.

In the dimension of knowledge, **these competence clusters build upon established and emerging bodies of expertise in materials science, energy systems, and environmental regulation**. Such knowledge provides the necessary epistemological foundation for firms to advance sustainable innovation while remaining compliant with an increasingly demanding regulatory landscape.

At the level of skills, **these clusters translate into the operational capacity to employ specific methodologies and technological tools — notably, life-cycle assessment (LCA) software, digital energy monitoring systems, and advanced analytics platforms**. These instruments enable companies to transform abstract sustainability objectives into concrete, measurable actions within both production and organisational frameworks.

The competence dimension concerns the higher-order ability to make informed, ethically grounded, and forward-looking decisions. It entails critically evaluating environmental trade-offs, anticipating long-term impacts, and embedding sustainability considerations into the very core of business strategies and value creation processes. Such competences are not merely technical adjuncts but are increasingly integral to maintaining competitiveness, reputational capital, and regulatory alignment in a rapidly evolving market environment.

§3.2 Digital Technical Skills

Digital technical skills constitute a fundamental pillar in the evolving competence framework of the European wood and furniture sector, aligning with the human-centric, resilient, and sustainable paradigm of Industry 5.0. These skills enable companies and professionals not merely to adopt new technologies, but to integrate them strategically within business processes, thereby fostering adaptability, innovation, and competitiveness in increasingly complex industrial ecosystems. Specifically, four interrelated competence clusters emerge as central to the sector's digital transition:

I. robotics and human-robot interaction (HRI);
II. artificial intelligence (AI);
III. digital twins and simulation technologies;
IV. data-driven decision-making.

The competence cluster associated with **robotics and HRI** relates to the capacity to configure, operate, and optimise collaborative robotic systems within manufacturing environments. This extends beyond traditional automation towards intelligent, responsive systems capable of adapting to human input and supporting enhanced production processes. Professionals in this area are expected to understand the technical, ergonomic, and safety implications of robotics integration, aligning operational procedures with both productivity objectives and worker well-being.

Artificial intelligence (AI) competences encompass the application of AI-based systems across design, production, and organisational management. This includes skills related to generative AI for design iteration, AI-supported predictive maintenance, and the deployment of AI-driven knowledge management tools. Mastery of these technologies requires not only operational proficiency but also an awareness of their ethical implications, in line with emerging European regulatory frameworks on trustworthy AI.

Digital twins and simulation technologies represent a further domain of strategic competence. These tools enable the creation of virtual replicas of products, processes, or systems, facilitating real-time monitoring, performance optimisation, and scenario analysis. Professionals are expected to develop and manage digital twin environments, integrating data flows from IoT infrastructures and applying simulation outputs to improve production efficiency, resource utilisation, and sustainability performance.

Finally, the cluster concerning **data-driven decision-making** encompasses competences in data collection, analysis, interpretation, and visualisation. This includes familiarity with advanced analytics tools, dashboards, and business intelligence platforms, enabling evidence-based management across functions such as supply chain, production planning, and market strategy. Competences in this area extend to ensuring data quality, security, and compliance with regulations such as GDPR, further embedding data literacy as a transversal requirement across occupational profiles.

At the level of knowledge, **these clusters draw upon foundational and emerging fields, including automation engineering, computer science, data management, and systems theory**. Such knowledge underpins the sector's capacity to engage with technological innovation in a manner aligned with sustainability, efficiency, and competitiveness.

In terms of skills, **these competences translate into the practical ability to operate specialised technologies and methodologies — from robotics programming interfaces to AI platforms, simulation software, and data analytics systems**. These operational capabilities enable companies to convert digital potential into concrete business value, supporting continuous improvement and innovation across the value chain.

The competence dimension addresses the higher-order ability to leverage digital tools in making informed, strategic decisions that balance technological opportunities with organisational objectives and societal expectations. This entails the capacity to critically assess risks, anticipate technological impacts, and embed digital transformation within long-term business models and governance structures.

Taken together, these integrated KSC domains — encompassing both green and digital competences — serve as essential drivers of occupational evolution within the European wood and furniture sector. They underpin the alignment of business processes, organisational models, and product innovation with the sustainability and technological imperatives set by Industry 5.0 and the European Green Deal. By embedding these competences into core operations, firms are better positioned to navigate the dual challenges of technological disruption and ecological transition, ensuring long-term competitiveness and resilience. In this regard, the development, validation, and formal recognition of green and digital competences emerge as strategic priorities for aligning workforce capabilities with evolving regulatory frameworks, market demands, and the technological frontiers shaping the future of European industry.

§3.3 Soft Skills

In parallel with the acquisition of advanced technical expertise, the wood and furniture sector's transition toward Industry 5.0 increasingly demands a **robust set of transversal competences**. These competences enable individuals and organisations not only to operate effectively within digitally and ecologically transformed environments but also to engage proactively with the systemic complexities that characterise modern industrial ecosystems. Their relevance extends across occupations and hierarchical levels, reflecting the broader organisational and cultural shifts required by the twin transition.

Adaptability emerges as a foundational competence in this regard. It reflects the capacity of individuals to adjust rapidly and effectively to evolving technologies, changing production processes, and increasingly stringent regulatory contexts. In a sector where the pace of technological innovation is accelerating, and where sustainability imperatives continuously reshape operational requirements,

adaptability underpins workforce resilience and organisational agility. This competence also intersects with lifelong learning attitudes, fostering openness to continuous upskilling and professional reinvention.

Digital collaboration represents another critical dimension. Beyond mere familiarity with digital communication tools, this competence encompasses the ability to engage in collaborative processes mediated by digital platforms, including project management software, virtual design environments, and collaborative production systems. It facilitates seamless coordination across dispersed teams and international supply chains, enabling co-design, problem-solving, and innovation within hybrid physical-digital workspaces. In the furniture sector, where cross-functional collaboration between design, production, and marketing is paramount, digital collaboration enhances both efficiency and creativity.

Systems thinking[23] is equally indispensable, particularly in contexts where environmental, technological, and organisational factors intersect in complex ways. This competence involves recognising and understanding the interdependencies within production ecosystems — from raw material sourcing to product lifecycle impacts — and identifying leverage points for optimisation and innovation. Systems thinking supports holistic approaches to problem-solving, enabling professionals to anticipate unintended consequences, align decisions with sustainability objectives, and contribute to organisational resilience in the face of volatility.

Finally, **co-design** skills are increasingly valued as companies adopt more participatory approaches to innovation. Co-design entails the ability to facilitate structured dialogue and iterative collaboration between technical teams, clients, and end-users, integrating diverse perspectives into the development of products, services, and processes. In the context of Industry 5.0, this competence supports user-centric innovation, enhances the relevance and acceptance of new solutions, and strengthens the alignment between technological development and market needs.

Taken together, these transversal competences complement technical skillsets, enabling individuals and organisations within the wood and furniture sector to navigate complexity, foster innovation, and contribute meaningfully to the human-centric, sustainable, and resilient industrial paradigm promoted by European policy frameworks. Their development should be prioritised within training strategies, alongside technical upskilling, to ensure a workforce capable of thriving within the evolving contours of Industry 5.0.

The evolution of professional profiles within the wood and furniture sector clearly illustrates how Industry 5.0 is reshaping both the technical and transversal competence frameworks required across the value chain. From traditional roles such as machine operators and quality technicians, now increasingly embedded in digitally augmented environments, to emerging profiles like data analysts, sustainability specialists, and digital designers, the sector demands a workforce equipped with hybrid skillsets that bridge technical expertise, digital literacy, and sustainability awareness. These shifts are

[23] Cf. Cabrera, D., Cabrera, L. (2023), *What Is Systems Thinking?*, in Spector, J.M., Lockee, B.B., Childress, M.D. (eds), *Learning, Design, and Technology*, Springer, Cham. https://doi.org/10.1007/978-3-319-17461-7_100

not merely technological but reflect deeper transformations in organisational models, production processes, and market expectations. As will be discussed in the following section, such transformations have significant implications for the structure of labour demand across Europe. Understanding these evolving skillsets is therefore critical to anticipate future workforce needs, identify potential mismatches between demand and supply, and support the development of targeted upskilling strategies aligned with the long-term competitiveness and resilience of the sector.

§4 Labour Market Demand and Mismatch Analysis

§4.1 European Green Deal scenario and implications for manufacturing

A relevant state of the art on the topic is offered by the publication *The Green Employment and Skills Transformation*[24], which presents a valuable macro-level overview of green trends. The report adopts an aggregated, cross-sectoral analytical framework, which prompted the use of CEDEFOP's dedicated forecasting interface for a more granular, sector-specific investigation. Using 2020 as its baseline year, it develops a scenario-based projection to 2030, combining macroeconomic modelling with skills anticipation methodologies. Its overarching aim is to estimate the effects of decarbonisation policies and the deployment of green technologies on employment structures, occupational demand, and the evolution of competence requirements.

The analysis unfolds across three interconnected dimensions:

1. an assessment of the macroeconomic and sectoral impacts of the European Green Deal (EGD), with a focus on projected employment changes across broad economic sectors;
2. an exploration of occupational and skills implications, including the emergence of green tasks, the increasing importance of transversal competences, and shifts in qualification needs;
3. a review of policy considerations, highlighting the role of education, training, and labour market measures in enabling a just and effective green transition. While this perspective provides essential context for understanding the overarching dynamics of the green transformation, its high level of aggregation limits its applicability to industries such as wood and furniture, where distinctive production structures, technological adoption patterns, and competence profiles require more targeted analysis.

Achieving the objectives of the EGD will alter both the levels and structure of employment, with sectoral changes accompanied by shifts in occupational demand and competence requirements. The success of the green transition will depend on the capacity to deliver large-scale upskilling and reskilling, shaped by four main trends: requalification for workers in declining sectors, training to

[24] Cf. CEDEFOP (2021), *The green employment and skills transformation: insights from a European Green Deal skills forecast scenario*, Publications Office. Luxembourg http://data.europa.eu/doi/10.2801/112540

meet rising demand for established 'green' occupations, targeted upskilling where tasks remain largely unchanged, and the creation of new profiles linked to innovative products and processes [25].

In manufacturing, the EGD scenario projects the strongest employment effects in sectors directly targeted by decarbonisation and circular economy measures, such as basic metals, electronics, and electrical equipment, where recycling and clean technologies are expected to preserve or create jobs. In most other manufacturing industries, including motor vehicles, changes will stem less from net job growth and more from intra-sectoral mobility and up- or reskilling, driven by the need to cut emissions, reduce waste, and adopt circular design principles[26].

The wood and wood products sector are subject to similar pressures. Its dependence on natural raw materials, tightening sustainability regulations, and the shift towards energy-efficient and circular production make it a clear candidate for targeted skills development.

§4.2 Labour demand projections for the wood and wood products sector (2025–2035)

To assess the evolution of labour demand in the wood and furniture sector across Europe, this section draws on projections from CEDEFOP's Skills Forecast by sector tool. The analysis applies filters to include all occupations within the "Wood and wood products" sector, across 32 European countries, over the period 2025–2035.

Two key indicators are used to capture projected labour market trends in the "Wood and wood products" sector. The average annual employment growth rate measures the percentage change in total employment per year over the forecast period, offering insight into the sector's underlying growth dynamics. The absolute change in employment quantifies the net number of jobs expected to be created or lost between 2025 and 2035, providing a direct measure of the scale of labour demand shifts across individual countries.

These projections offer a forward-looking representation of labour dynamics in the sector, helping to contextualise emerging skill needs and identify areas of potential labour market imbalance.

At EU-27 level, the sector is projected to grow at an average annual rate of +0.3%, corresponding to a modest net employment increase. However, this aggregate conceals a high degree of heterogeneity. Countries such as Poland (+20,977 jobs), Spain (+7,427), Finland (+2,787), Estonia (+1,727), and Italy (+1,570) exhibit both positive absolute change and above-average annual growth, possibly reflecting investments in value-added production, export competitiveness, or incremental adoption of Industry 5.0 technologies.

In contrast, Germany (-5,698; -0.4%), Czechia (-1,333; -0.3%), Slovenia (-970; -1.0%), and Türkiye (-7,968; -0.8%) are expected to experience sustained contraction. These figures may signal ongoing

[25] Ibid., pp. 17-18.
[26] Ibid., pp. 29-30.

restructuring, automation-induced substitution, or relocation of production capacity. A limited group of countries – including Malta (+3.2%), North Macedonia (+3.7%), and Cyprus (+2.3%) – display high relative growth despite modest absolute figures, possibly due to niche development strategies or recent industrial expansion.

Overall, the data outline a sector with low overall growth but diverging national trajectories, reflecting broader structural transformations across the EU. While some labour markets appear poised to consolidate or expand their wood-related manufacturing base, others are likely to undergo adjustment or shrinkage. This uneven evolution calls for differentiated responses at policy level, particularly concerning skills anticipation, requalification programmes, and the facilitation of labour mobility within the EU.

Table 1: Employment growth (% annual rate) by country. Country (32): All | Sector (1): Wood and wood products | Occupation (41): All | From year: 2025 | To year: 2035

Countries	Employment growth (% annual rate) 2025-2035
EU-27	0.3%
Austria	-0.2%
Belgium	0.2%
Bulgaria	0.1%
Croatia	N/A
Cyprus	2.3%
Czechia	-0.3%
Denmark	0.4%
Estonia	0.9%
Finland	1.2%
France	N/A
Germany	-0.4%
Greece	N/A
Hungary	-0.1%
Iceland	1.7%
Ireland	1.5%
Italy	0.2%
Latvia	N/A

Lithuania	-0.3%
Luxembourg	N/A
Malta	3.2%
Netherlands	0.7%
North Macedonia	3.7%
Norway	N/A
Poland	1.1%
Portugal	0.2%
Romania	0.1%
Slovakia	0.7%
Slovenia	-1.0%
Spain	1.2%
Sweden	-0.2%
Switzerland	0.5%
Turkiye	-0.8%

Table 2: Employment change (absolute numbers) by country. Country (32): All | Sector (1): Wood and wood products | Occupation (41): All | From year: 2025 | To year: 2035.

Countries	**Employment change (absolute numbers)**
Austria	-775
Belgium	250
Bulgaria	131
Croatia	62
Cyprus	674
Czechia	-1333
Denmark	395
Estonia	1727
Finland	2787
France	243

Germany	-5698
Greece	n/A
Hungary	-227
Iceland	20
Ireland	542
Italy	1570
Latvia	-18
Lithuania	-570
Luxembourg	-2
Malta	51
Netherlands	1356
North Macedonia	1232
Norway	30
Poland	20977
Portugal	547
Romania	611
Slovakia	2198
Slovenia	-970
Spain	7427
Sweden	-656
Switzerland	1856
Turkiye	-7968

From a strategic perspective, even in countries where employment in the wood and furniture sector is projected to remain stable or contract, the qualitative transformation of work driven by Industry 5.0 will be unavoidable. The combined effects of digitisation, circular economy practices, and the integration of advanced manufacturing technologies are expected to reshape task content, creating demand for new occupational profiles and hybrid digital–green competences. Anticipating these shifts and aligning workforce development systems with evolving sectoral trajectories will be critical to preserving competitiveness, fostering innovation capacity, and ensuring resilience in an increasingly sustainability-driven industrial landscape.

§4.3 Emerging Skill Needs and Potential Mismatches

The projected occupational trends in the wood and furniture sector, as outlined in §4.2, underscore a moderate aggregate employment growth at EU-27 level, coupled with significant divergence across national labour markets. This uneven evolution suggests that, beyond quantitative employment shifts, qualitative transformations in work organisation, production methods, and market positioning will be decisive in shaping skill demand. The principles of Industry 5.0 – embedding digitalisation, sustainability, and human-centric innovation – are set to accelerate these transformations, placing increasing emphasis on the integrated green and digital competences analysed in §3.1–3.3.

Green competences, particularly in eco-materials, life-cycle thinking, and energy optimisation (§3.1), are expected to become central to compliance with tightening EU environmental regulations and to the realisation of circular economy strategies. Yet, in many labour markets, the current prevalence of these competences remains limited, often confined to niche segments or early adopters. Countries projected to experience sectoral contraction may face additional challenges, as restructuring processes tend to prioritise cost reduction over proactive upskilling, potentially widening the gap between regulatory requirements and the capabilities of the existing workforce.

On the digital side (§3.2), the transition towards digitally enabled design, production, and supply chain management is progressing unevenly. In regions where technology adoption is incremental rather than systemic, the demand for advanced digital competences – such as data-driven process optimisation, CAD–CAM integration, and digital twin applications – may exceed the supply, creating a structural skills mismatch. This is particularly relevant in SMEs, which constitute the backbone of the sector and often lack the resources or organisational structures to implement comprehensive digital transformation strategies.

Transversal competences (§3.3) – including adaptability, systems thinking, digital collaboration, and co-design – will be critical enablers for managing the complexity of hybrid work environments that combine physical craftsmanship with digitally augmented processes. However, these competences are rarely embedded in formal training pathways for the sector, leaving a gap between the collaborative and problem-solving abilities required by Industry 5.0 workplaces and those currently fostered by education and training systems.

The interplay between slow or uneven technological adoption and rising skill requirements is likely to produce specific bottlenecks. For example, the integration of energy-efficient manufacturing systems demands both technical know-how and cross-functional coordination, yet current training provision often treats these dimensions separately. Similarly, the demand for designers capable of applying life-cycle assessment tools in product development will outpace supply in markets where environmental competences are not yet a mainstream component of vocational education and training (VET).

If left unaddressed, these mismatches could constrain the sector's capacity to capture the competitive advantages of Industry 5.0, particularly in high-value-added market segments where sustainability, digital innovation, and design excellence converge. A forward-looking approach will require the alignment of VET curricula, work-based learning schemes, and lifelong learning opportunities with the integrated green–digital skill profiles emerging from the sector's transformation, ensuring that workforce capabilities evolve in step with technological and regulatory trajectories.

§4.4 Policy Implications for Workforce Adaptation

The projected labour market dynamics and emerging skill gaps outlined in §§4.2–4.3 underscore the **urgency of designing targeted policy responses to align workforce development with the twin transition**. Although overall employment in the European wood and furniture sector is expected to remain relatively stable, the qualitative transformation of work – driven by digitalisation, sustainability imperatives, and Industry 5.0 principles – requires a systemic rethinking of skills strategies and training provision.

At European level, this calls for strengthening sectoral skills intelligence mechanisms that combine CEDEFOP's forecasting tools with national and regional labour market observatories[27]. Such intelligence should feed into qualification frameworks and curricula updates, ensuring that training systems capture the evolution of digital-green hybrid competences and transversal capabilities.

At national and regional level, policies should prioritise flexible, modular learning pathways, including microcredentials and recognition of prior learning, to facilitate rapid re- and upskilling in response to evolving occupational needs. Given the predominance of SMEs in the sector, special attention must be paid to supporting their capacity to invest in training and innovation, through financial incentives, advisory services, and cluster-based cooperation.

Furthermore, the heterogeneity of sectoral trajectories across Member States requires differentiated approaches. **In countries experiencing growth, the focus should be on scaling up VET provision and fostering collaboration between firms and training institutions. In contracting markets, active labour market policies, mobility schemes, and transition support measures will be essential to prevent structural unemployment** and enable workers to redeploy their competences in adjacent industries.

Ultimately, embedding green and digital skill development into broader industrial policy frameworks – such as circular economy strategies, regional innovation agendas, and EU sustainability regulations – will be decisive. As already mentioned, skills policies cannot be conceived in isolation: they must

[27] Examples of national and regional labour market observatories include: Excelsior Unioncamere (Italy), DARES and France Stratégie (France), IAB and BIBB (Germany), SEPE – Observatorio de las Ocupaciones (Spain), ROA – Research Centre for Education and the Labour Market (Netherlands), Le Forem and VDAB (Belgium), Arbetsförmedlingen (Sweden), Ministry of Economic Affairs and Employment / VATT (Finland), and SOLAS – Skills and Labour Market Research Unit (Ireland). These institutions provide complementary intelligence to CEDEFOP forecasts by monitoring occupational trends, skill shortages, and training needs at national or regional level.

be fully integrated into industrial and sustainability strategies to ensure competitiveness, resilience, and social fairness in the twin transition.

In this perspective, the notion of skills governance becomes central[28]. Effective governance implies not only producing reliable skills intelligence but also ensuring that it is co-constructed and utilised through dialogue among diverse stakeholders – public authorities, enterprises, training providers, and social partners – at European, national, regional, and sectoral levels. Strong governance mechanisms make it possible to balance skill supply and demand, align education and training with labour market transformations, and provide a stable basis for targeted investment in competences. In the context of the green and digital transition, such multi-level and participatory governance can be a game changer, helping to steer sectoral trajectories and ensuring that the workforce remains employable throughout its life cycle.

Good practice examples illustrate how skills governance operates in practice. For instance, in Austria, apprenticeship programmes are regularly modernised through structured collaboration between social partners, chambers, ministries, and external experts, ensuring that occupational profiles and curricula evolve in step with green transition demands. Similarly, **Denmark's** Job-VEU model mobilises companies, job centres, social partners, and training providers in co-designing short VET programmes for both employed and unemployed workers, with particular attention to disadvantaged groups. These cases show how shared ownership of skills policies, grounded in stakeholder negotiation and evidence-based monitoring, can accelerate the alignment of training systems with green and digital transformation[29].

Further evidence of this governance approach comes from national strategies explicitly linking the green transition to VET reform. In **Austria**, the Just Transition Action Plan on training and reskilling (2023) sets out a multi-horizon roadmap that integrates climate-relevant content into apprenticeship curricula, develops new occupational profiles, and upgrades vocational schools' infrastructure. Portugal's Green Skills & Jobs programme aligns with the 2030 Energy and Climate Plan, offering modular training for unemployed and at-risk workers, particularly in fossil fuel industries, with attention to women and underqualified groups. Spain's *Just Transition Strategy 2020–30* embeds skills development within a broader socio-economic framework, mobilising unions, employers, NGOs, municipalities, and regional governments through Just Transition Covenants to finance training, promote green entrepreneurship, and support vulnerable territories [30].

Concerning the ways in which regional strategies operationalise skills governance, several territorial development frameworks embed training and reskilling into broader economic and social transformation agendas. In **Germany**, the *Unna district's Regional Development Concept 2020* integrated education, climate protection, and labour market measures, combining basic digital

[28] Cf. CEDEFOP (2025), *Meeting skill needs for the green transition – Skills anticipation and VET for a greener future*, Publications Office, Luxembourg https://data.europa.eu/doi/10.2801/6833866, p. 29.
[29] The examples of Austria and Denmark are drawn from *Box 12. Good practice examples of stakeholder collaboration in developing VET programmes* in CEDEFOP (2025), *Meeting skill needs for the green transition – Skills anticipation and VET for a greener future*, p. 33.
[30] Ibid., Box 21, pp. 44-45.

upskilling for the long-term unemployed with sustainability training for youth and reskilling pathways in zero-emission mobility and climate-friendly construction. The *Lusatia 2050 strategy* similarly fostered multi-stakeholder networks linking companies, research centres, trade unions, and education providers to secure high-quality employment and talent pipelines in regions undergoing structural change.

In **Slovakia**, the *Upper Nitra Action Plan* and the *Banská Bystrica Programme 2022–30* show how regional authorities are adapting curricula, expanding dual VET, and building supra-company training centres to requalify workers from coal-dependent industries while supporting employer-driven training initiatives. Likewise, **Poland's** *Lower Silesian Development Strategy 2020–30* emphasises environmental education, innovative pedagogies, and closer cooperation between enterprises and VET providers to strengthen human capital for sustainable growth.

These examples highlight that the regional level is a decisive arena for skills governance in the twin transition. By embedding upskilling and reskilling measures into territorial development plans, regions can tailor responses to sectoral, demographic, and social challenges, ensuring that the benefits of green and digital transformations are more evenly distributed across local communities[31].

Taken together, these European, national, and regional initiatives demonstrate that workforce adaptation in the wood and furniture sector cannot be addressed through training provision alone, but requires coherent governance frameworks that connect skills intelligence, stakeholder collaboration, and industrial strategies. Embedding skills governance into the design and implementation of policies ensures that competences are not only anticipated but also effectively mobilised to support innovation, resilience, and just transition objectives. In this sense, the capacity of institutions and stakeholders to negotiate, co-design, and continuously update training systems will determine whether the sector can seize the opportunities of Industry 5.0 while mitigating risks of exclusion, polarisation, and territorial disparity.

§5 Competence Validation and Certification

The ability to validate, certify and make competences visible is a fundamental condition for aligning workforce development with the demands of the green and digital transitions. At European level, three instruments provide the main architecture for this process: ESCO[32], the European Qualifications Framework (EQF)[33], and microcredentials[34]. ESCO offers a multilingual classification system that describes skills, competences, qualifications and occupations in a transparent and comparable way. By creating a shared reference language, it helps connect education and training systems with labour market needs, making mobility and matching more effective across countries. The EQF complements

[31] Ibid., Box 22, pp. 47-48.
[32] https://esco.ec.europa.eu/en/classification
[33] https://europass.europa.eu/en/europass-digital-tools/european-qualifications-framework
[34] https://education.ec.europa.eu/education-levels/higher-education/micro-credentials

this role by connecting national qualifications frameworks through eight reference levels, each of which describes what individuals are expected to know, understand and be able to do.

Together, ESCO and the EQF form the backbone of competence validation in Europe. They make it possible to translate sector-specific learning outcomes – such as those emerging from green and digital transitions – into qualifications and competences that can be understood and recognised across industries and countries. Microcredentials strengthen this system by adding a more flexible and modular dimension. Built around short, targeted learning experiences, they provide learners with the opportunity to acquire and certify new skills quickly, in response to evolving labour market needs[35]. They can stand alone or be combined into larger qualifications, and their portability allows them to follow individuals across jobs, sectors and countries. In this integrated framework, ESCO, the EQF and microcredentials create both the common language and the practical tools needed to anticipate emerging skills needs, reduce mismatches, and support workforce transitions. By making competences visible and transferable, they provide the conditions for labour markets and education systems to adapt more effectively to the challenges of Industry 5.0 and the twin transition.

While ESCO and EQF ensure standardisation and comparability, microcredentials add the necessary flexibility and responsiveness. A microcredential is a learner-owned, portable record of specific learning outcomes assessed against transparent standards, typically acquired through short, targeted learning experiences. They can stand alone or be stacked to contribute to larger qualifications, thereby complementing traditional education and training rather than replacing it. Their main strength lies in their speed and modularity: they allow individuals to upskill or reskill quickly in response to emerging labour market needs, particularly those associated with the green and digital transitions. Designed with a strong labour market orientation, microcredentials can address skills mismatches and bottlenecks, enhance employability, and provide more adaptive lifelong learning pathways.

The strategic relevance of microcredentials becomes especially evident in the context of the European Green Deal. The rapid diffusion of clean technologies, sustainability standards and circular economy practices requires continuous upskilling that conventional qualification pathways often cannot guarantee. **Microcredentials can play a "sprint role" by quickly equipping workers with new competences, facilitating transitions into greener occupations, or responding to regulatory requirements in specific jobs**. Their design can focus on transversal competences, such as eco-awareness, waste reduction, and compliance with environmental regulations, as well as on occupation-specific skills, such as eco-design, safe installation of renewable technologies, or the application of circular production methods. This dual approach reflects the hybrid nature of skill needs in the green transition, where technical expertise must be combined with transversal sustainability competences.

Recent initiatives illustrate the transformative potential of microcredentials in supporting the twin transition. Among them, the MASTERY project[36] stands out as a European collaborative effort

[35] Cf. Council of the European Union (2022), *Council Recommendation of 16 June 2022 on a European approach to micro-credentials for lifelong learning and employability*, in Official Journal of the European Union C 243/10. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.C_.2022.243.01.0010.01.ENG#d1e32-21-1.
[36] https://amueblacooperacion.es/en/proyecto-mastery-el-impulso-de-las-microcredenciales-para-sectores-sostenibles/

involving training providers, business representatives and sectoral organisations, all aiming to make the green transition a driver of sustainable growth for industries and communities. Its central achievement is the creation of a collection of twelve Green Skills Microcredentials, designed specifically for strategic sectors such as agri-food, construction, manufacturing, and wood/furniture. These microcredentials are conceived as short, flexible and targeted learning units, directly aligned with the skills needs generated by decarbonisation, circular economy and digitalisation processes. Their modular structure allows workers and companies to adopt them quickly and adapt them to evolving sectoral contexts, while their focus on practical competences ensures immediate labour market relevance.

Beyond content design, the MASTERY project emphasises the importance of digital issuance and integration into National Qualifications Frameworks, which ensures portability, comparability and transparency across Member States. This facilitates their recognition by employers, increases their legitimacy within training ecosystems, and fosters their uptake across diverse industrial and regional contexts. By combining the standardisation provided by ESCO, the comparability guaranteed by the EQF, and the flexibility offered by microcredentials, sectors such as wood and furniture can build a robust validation and certification ecosystem. Such an ecosystem can not only address short-term mismatches between labour supply and demand but also enhance long-term adaptability, competitiveness and resilience in a rapidly changing industrial environment.

§6 How to adopt Industry 5.0 principles through skills strategies and technology integration? Recommendations for Companies.

The effective implementation of Industry 5.0 principles in the wood and furniture sector requires not only the integration of advanced technologies but also the parallel development of workforce competences. While European policy instruments provide the framework for validation and recognition, it is at company level – particularly within SMEs – that strategic choices about upskilling, reskilling, and technological adoption determine the pace and direction of transformation. In this respect, the contribution of European Social Partners is particularly relevant. The 2023 EFIC report, published in the context of the European Year of Skills, underlines that persistent labour shortages in woodworking and furniture are often linked to mismatches between company needs and the competences offered by VET systems[37]. To address this gap, the report calls for strengthening skills intelligence to anticipate shortages, fostering international mobility through Erasmus+ to enhance attractiveness, embedding long-term training plans into workforce development cycles, and creating networks among companies, schools and training providers to share resources and drive innovation[38]. These recommendations, rooted in structured social dialogue, reinforce the need for coordinated governance and collaboration to ensure that SMEs can align competence strategies with the twin transition and secure their competitiveness.

§6.1 Strategic priorities for SMEs: from ad-hoc solutions to structured competence development

The evidence collected in §§3–5 has shown that the wood and furniture sector requires a hybrid set of green and digital competences, ranging from eco-design and lifecycle assessment to robotics, data-driven decision-making, adaptability, and systems thinking. However, the current supply of skills remains fragmented. Rather than using formal, consistent programs, many European firms—especially SMEs that form the core of the sector—still default to informal, on-the-job training. This approach, while useful in addressing urgent operational needs, does not provide the critical mass of competences required to support structural transformation. The result is a lag in digital adoption, a limited diffusion of green competences, and a mismatch between emerging technological trajectories and workforce capabilities.

For SMEs, the challenge lies in moving from reactive training measures to proactive competence strategies. This requires embedding skills development within broader business planning, ensuring that every technological investment—whether in digital twins, automated production, or eco-materials—is supported by corresponding upskilling or reskilling actions. Training should no longer

[37] Cf. EFIC, CEI-Bois, EFBWW (2023), *European Year of Skills. EU Social Partners reccomendations* https://www.efic.eu/_files/ugd/a1d93b_cdc13039afda425997bc18661d4b13e0.pdf
[38] Ibid.

be seen as an optional cost but as an integral investment in competitiveness, directly linked to innovation capacity, market positioning, and compliance with sustainability standards[39].

A structured approach to competence development can follow three strategic priorities:

1. **Anticipation rather than adaptation**: instead of reacting to skill shortages as they arise, companies need to map future competence requirements in line with sustainability regulations (e.g. EU Green Deal targets), new consumer demands for sustainable products, and technological integration;
2. **Integration across functions**: competences should not be confined to technical staff. Marketing, logistics, design, and management roles also require digital and green literacy to ensure coherence across the value chain;
3. **Embedding Industry 5.0 principles**: beyond efficiency and automation, the emphasis must be on human-centric and resilient production models. This means valuing creativity, sustainability, and adaptability as strategic assets, not just as secondary competences.

In practice, this shift entails moving from isolated training courses to systematic competence frameworks, aligned with European tools such as ESCO, EQF and microcredentials (analysed in §5). By aligning competence development with business strategies, SMEs can transform fragmented training into long-term workforce development plans. This approach strengthens the ability of firms to anticipate regulatory changes, exploit new technologies effectively, and position themselves competitively in both domestic and international markets.

Ultimately, SMEs that evolve from ad-hoc solutions to structured competence development will be better equipped to face the twin transition, ensuring that the adoption of Industry 5.0 principles is not only a technological upgrade but also a strategic transformation of organisational and human capital.

§6.2 Upskilling and reskilling paths

For wood and furniture companies, upskilling and reskilling cannot be conceived as occasional interventions, but as strategic levers for competitiveness. In an Industry 5.0 framework, where green and digital transformations evolve rapidly, firms need to populate existing and emerging job roles with a workforce that is both qualified and adaptable. This requires not only the recruitment of new talent but also systematic investment in the requalification of existing staff, enhancing their polyvalence and employability.

Such investment positions human capital as a driver of resilience: by equipping workers with hybrid competences, firms can ensure smoother transitions when introducing new technologies, complying

[39] Regarding the relevance of education and training as a strategic asset for competitiveness: Draghi, M., *The Future of European Competitiveness - In-depth Analysis and Recommendations*, European Commission, 2024. For a reasoned synthesis on the topic: Pace, C., *Competenze e competitività: il ruolo della formazione all'interno del Rapporto di Mario Draghi sulla competitività in Europa*, Bollettino ADAPT, 16 settembre 2024, n. 32.

with sustainability regulations, or diversifying into new markets[40]. From an HR perspective, this means **embedding competence development into workforce planning, performance appraisal, and career progression systems**. Moreover, the collective dimension is equally relevant: **upskilling and reskilling initiatives should be framed within social dialogue and collective bargaining**, enabling agreements on lifelong learning rights, training hours, and the co-financing of learning programmes. In this sense, workforce development becomes not just an operational necessity but a field of negotiation and shared responsibility between employers, employees, and social partners.

Concrete skill demands illustrate how these strategies translate into practice. Starting from §2:

- Furniture designers increasingly require digital and eco-design competences, supported by immersive environments and AR/VR tools.
- Wooden furniture machine operators need reskilling to interact with robotics and AI-assisted systems, moving beyond manual operation towards digital troubleshooting and HRI-based workflows.
- Process engineers must acquire capabilities in digital twins, predictive analytics, and IoT integration to optimize production in real time.
- Quality technicians and environmental specialists are called to integrate sustainability compliance and traceability tools, especially in relation to instruments such as the Digital Product Passport.
- Data analysts, a role not traditionally embedded in manufacturing, are now essential for turning big data and AI outputs into actionable insights across design, production, and marketing.
- Finally, vocational teachers and corporate trainers need to update their methods through XR-based pedagogies and immersive simulations, becoming key enablers of continuous learning within firms.

In all these cases, structured upskilling and reskilling pathways – aligned with ESCO, EQF and supported by microcredentials – provide a way to close skill mismatches while building long-term adaptability. For SMEs in particular, linking competence strategies with HR planning and collective bargaining ensures that investments in people are recognised as part of the company's competitive model, not as ancillary costs. In doing so, the sector can transform skills into a shared strategic asset, enabling wood and furniture firms to move from reactive adaptation to proactive innovation in the era of Industry 5.0.

§6.3 Practical actions for Industry 5.0 adoption

To make the transition from strategy to implementation, companies in the wood and furniture sector need a set of concrete and actionable measures. Five priority actions emerge from the analysis.

[40] Cf. OECD (2025), *Empowering the Workforce in the Context of a Skills-First Approach*, OECD Skills Studies, OECD Publishing, Paris, https://doi.org/10.1787/345b6528-en.

First, firms should **invest in mapping internal competences and skills gaps**. Competence audits, when framed through the ESCO taxonomy, help enterprises classify roles, identify gaps in green and digital skills, and target their training resources where they matter most. This systematic mapping creates the foundation for anticipating future needs and aligning workforce planning with business strategies.

Second, companies should **establish strong alliances with training providers**. Partnerships with VET centres, universities, and sectoral academies enable the co-design of curricula that are responsive to evolving technological and regulatory demands. At the same time, cluster-level initiatives can ensure that even SMEs have access to cutting-edge training resources, reducing fragmentation and strengthening collective capacity.

Third, firms can **leverage European tools such as ESCO, the EQF, and microcredentials** to structure learning pathways. ESCO provides a common language for defining job profiles, while the EQF ensures that qualifications and skills acquired across Europe are comparable and portable, reducing barriers to cross-border recruitment and workforce mobility. Microcredentials add the flexibility of short, modular training, which can be quickly deployed to address specific competence gaps while remaining stackable into broader qualifications.

Fourth, **skills development should be closely linked to technology adoption**. Training plans must accompany every investment in robotics, AI, or sustainability-oriented technologies, ensuring that employees are prepared to use new tools effectively. Innovative learning methods such as digital twins and immersive XR environments can facilitate this integration. By embedding training into the roll-out of new technologies, firms reduce resistance to change, shorten learning curves, and maximise the return on investment in digital and green technologies[41].

Fifth, **companies should mobilise territorial and institutional ecosystems** to support their efforts. Competence centres, chambers of commerce, regional innovation clusters, and social partners all provide resources to share costs, risks, and expertise. Embedding upskilling within social dialogue can also lead to agreements on training rights and co-financed lifelong learning programmes, reinforcing the collective responsibility for workforce development.

Taken together, these actions translate strategic intentions into operational pathways. By combining internal audits, external alliances, European frameworks, technology-linked learning, and ecosystem mobilisation, wood and furniture firms can build a coherent roadmap for adopting Industry 5.0 principles in practice, ensuring that skills development becomes both a driver of competitiveness and a guarantee of resilience.

[41] Regarding the relevance of immersive learning processes through the use of headsets, it is possible to consult https://allview.eu/downloads/, the section of the Allview project where the reports on the subject are published. Several papers address the relationship between new educational devices and methodologies and training in the European wood and furniture industry. These reports stem from the need to better integrate the strategic pillars of process automation and sustainability into training programs and organizational structures.

Table 3: Priority actions for adopting Industry 5.0 in the European wood and furniture sector: practical measures, rationales, and expected impacts.

Action	Description	Rationale	Expected Impact
1. Mapping internal competences and skills gaps	Conduct competence audits using ESCO taxonomy to classify roles, identify gaps, and anticipate needs.	Provides an evidence-based foundation for targeted training and workforce planning.	Clear overview of skills; better alignment between workforce and business strategies.
2. Alliances with training providers	Partner with VET centres, universities, academies, and clusters to co-design responsive curricula.	Ensures access to cutting-edge training resources and reduces SME fragmentation.	Curricula aligned with technology and regulation; stronger collective capacity.
3. Leveraging EU tools (ESCO, EQF, microcredentials)	Use ESCO as a skills language, EQF for comparability and portability, and microcredentials for modular training.	Creates structured, flexible, and portable learning pathways across Europe.	Reduced barriers to mobility; rapid upskilling and reskilling; qualifications recognised EU-wide.
4. Linking skills development to technology adoption	Integrate training plans with investments in robotics, AI, sustainability technologies, and XR-based learning.	Embeds competence development into innovation cycles, reducing resistance.	Faster adoption of technologies; shorter learning curves; higher ROI on digital/green investments.

5. Mobilising territorial and institutional ecosystems	Engage competence centres, chambers of commerce, clusters, and social partners; embed upskilling in social dialogue.	Shares costs and risks; creates a collective responsibility for workforce development.	Broader access to resources; co-financed lifelong learning; stronger resilience and competitiveness.

§6.4 Fostering workforce engagement

Industry 5.0 emphasises human-centricity, which implies that the workforce must be engaged not merely as recipients of training, but as active participants in the design, implementation, and governance of competence strategies. In the wood and furniture sector, this engagement is a precondition for ensuring that transitions to greener and more digital practices are effectively embedded in day-to-day operations.

A first step is to involve employees in the co-design of training pathways, so that upskilling and reskilling reflect real production challenges and are closely aligned with the evolving tasks and roles described in §2. This participatory approach strengthens ownership, improves the relevance of training, and reduces resistance to change, ensuring that competence-building efforts are not experienced as top-down impositions but as jointly defined priorities.

Linking engagement to occupational roles highlights where and how targeted measures can be applied along the production process.

Furniture designers can be involved in co-design processes that integrate immersive tools such as XR-based prototyping with sustainability requirements, ensuring training reflects both creative and regulatory challenges.

Wooden furniture machine operators, increasingly collaborating with autonomous systems, benefit from peer-to-peer models and collaborative learning that accelerate the adoption of human–robot interaction practices.

Quality engineering technicians and environmental scientists, central to compliance and traceability, can be supported through modular training solutions embedded in multi-stakeholder governance frameworks, ensuring constant updates on regulatory and data-management requirements.

Process engineers, managing digital twin integration, require targeted support from internal facilitators and external clusters to align technological advances with continuous improvement strategies. **Data analysts**, operating across design, production, and marketing, are best engaged through communities of practice that connect departments and encourage co-creation of analytics-

based solutions. Finally, **vocational teachers and corporate trainers** represent the linchpin for engagement itself: by being equipped through EU projects and networking initiatives, they can deliver adaptive and experiential training that bridges firm-level and sectoral needs.

At the same time, engagement cannot be confined within the boundaries of individual firms. The dynamics of competence development in Industry 5.0 unfold within skills ecosystems that extend across clusters, sectors, and regions. Here**, multi-stakeholder governance plays a critical role**: by bringing together enterprises, training providers, research institutions, social partners, and public authorities, it creates the conditions to systematically map skill gaps, anticipate future needs, and design shared responses. For SMEs, participation in these networks multiplies their capacity to access resources, identify emerging competences, and benchmark strategies against broader industrial and territorial transitions.

Within companies, this broader logic can be operationalised through facilitators or change agents - employees or teams entrusted with connecting technological adoption, training initiatives, and organisational practices. Unlike isolated "ambassador" roles, these figures act in constant dialogue with external stakeholders, ensuring that internal transformations resonate with sector-wide trajectories and that external inputs are effectively translated into company-level action.

Finally, the **diffusion of collaborative learning models - peer-to-peer exchanges**, **project-based learning**, and **communities of practice - reinforces workforce engagement** by enabling knowledge circulation and the integration of tacit know-how with digital and sustainability competences. Coupled with multi-stakeholder governance, such participatory practices allow enterprises not only to strengthen their internal resilience but also to become active nodes within the broader networks that shape skill formation and validation at national and EU levels. In this sense, fostering workforce engagement addresses a crucial point emerging from the two research questions: companies can only align with Industry 5.0 principles if they combine internal investment in R&D and competence development with external strategies of clustering and networking, leveraging both local ecosystems and European frameworks to transform fragmented skill acquisition into systemic industrial transformation.

Table 4: Workforce Engagement in Industry 5.0 – Occupations, Measures, and Governance Levers.

Occupation	**Targeted Engagement Measures**	**Governance / Ecosystem Levers**
Furniture Designers	Co-design of training pathways integrating XR tools and sustainability requirements; participatory prototyping with clients	Collaboration with design schools, sustainability agencies, and EU eco-design initiatives

Wooden Furniture Machine Operators	Peer-to-peer exchanges on human–robot interaction; collaborative learning sessions to adapt to autonomous systems	Sectoral training consortia; cluster-level labs for robotics adoption
Quality Engineering Technicians	Modular training on compliance and digital traceability; integration of regulatory updates into learning	Multi-stakeholder governance platforms embedding ESPR/DPP requirements
Environmental Scientists	Engagement in data-driven monitoring; collaborative modules on circularity metrics and sustainability reporting	Cross-sector partnerships with regulatory bodies and environmental agencies
Process Engineers	Support from internal change agents to translate digital twin integration into workflows; continuous improvement communities	Regional clusters facilitating access to IoT and AI demonstrators
Data Analysts	Communities of practice across design, production, and marketing; co-creation of analytics-based solutions with cross-functional teams	Partnerships with tech providers, EU programmes (Digital Europe, Horizon) for AI-driven innovation
Vocational Teachers & Corporate Trainers	Networking initiatives and EU-funded projects to develop adaptive, experiential learning models; role as facilitators of workforce engagement	Integration into regional skills ecosystems; Erasmus+ partnerships for VET innovation

§6.5 Leveraging EU programmes for training and innovation

For wood and furniture companies, embracing Industry 5.0 is not only a matter of internal investment but also of making full use of the resources available at European level. EU programmes provide both

funding and networks that help firms strengthen their training strategies, adopt new technologies, and align with broader industrial and sustainability objectives.

Several initiatives stand out. **Erasmus+** supports innovative approaches to vocational education and training (VET), promoting mobility and the design of modular pathways such as microcredentials. The **Digital Europe Programme** helps firms access key enablers of Industry 5.0 - AI, high-performance computing, cybersecurity - thus linking digital adoption with workforce upskilling. **Horizon Europe** complements this by funding R&D projects on sustainable materials, circular economy solutions, and digital twins, creating opportunities to combine technological innovation with competence development.

On the social and economic side, the **European Social Fund+** (ESF+) remains the main EU instrument for co-financing reskilling and lifelong learning, with a strong focus on workers affected by the twin transition. The **Single Market Programme** and its **COSME component** encourage SME competitiveness and cluster cooperation, while the **LIFE Programme** specifically fosters green innovation and climate-friendly practices. Together, these initiatives enable companies to co-develop training, pilot advanced solutions, and position themselves within Europe-wide partnerships.

The added value for firms lies not only in financial support but also in their integration into European innovation ecosystems. Participation in EU projects allows companies to anticipate regulatory trends, benchmark their strategies, and learn from cross-border cooperation. For SMEs in particular, this external anchoring multiplies the impact of limited internal resources and strengthens the resilience of the clusters they belong to.

In light of the two research questions guiding this study, EU programmes play a dual role. They provide structured responses to emerging skill mismatches by enabling targeted training, and they act as catalysts that link competence development with technological transformation. Companies that strategically engage with these instruments enhance their competitiveness and at the same time contribute to Europe's wider agenda for a sustainable, human-centred industrial future.

§7 Conclusions and Key Insights

In this report, we addressed two fundamental questions: which green and digital skills are currently emerging in the European wood and furniture sector—particularly those aligned with Industry 5.0—and where do they face mismatches in demand and supply? And, how can companies in the sector effectively adopt Industry 5.0 principles by cultivating relevant skills, leveraging new technologies, and embracing European competence validation tools?

Our analysis revealed a profound transformation underway. Technical skills related to eco-design, lifecycle assessment, robotics, digital twins, and data analytics must now be complemented by transversal competences such as adaptability, systems thinking, digital collaboration, and sustainability awareness. However, supply still lags behind—digitization remains uneven among

SMEs, green competencies are under-diffused, and training systems have yet to fully integrate the hybrid profiles demanded by Industry 5.0.

This mismatch has clear implications for various stakeholders: training providers need to deliver modular, flexible learning paths—microcredentials aligned with ESCO and EQF—tailored to emerging roles. Policymakers and public authorities should bolster skills ecosystems through multi-stakeholder governance, cluster-based strategies, and sectoral observatories capable of tracking skill evolution and anticipating future gaps. Enterprises themselves must shift from reactive, ad-hoc solutions toward embedding competence development directly within strategic and technological planning.

Sustained monitoring and forward-looking intelligence are essential. Skills observatories, supported by tools like Foresight Platforms and Skills Radars, will enable Europe to anticipate emerging skill needs before they become systemic constraints, ensuring both workforce adaptability and industrial competitiveness.

In sum, the central insight is that competences are the linchpin of Industry 5.0 in the wood and furniture sector. Closing the gap between emerging skill requirements and existing supply demands a dual strategy: equipping workers with hybrid green and digital capabilities while embedding these in technology adoption, business models, and collaborative networks. Competence development is not a supporting activity—it must become the driving force aligning human-centric innovation, sustainability, and digitalization with Europe's long-term industrial resilience.

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