Industrial Innovation Report

2026

eit Manufacturing

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Executive summary

A manufacturing sector at a critical juncture

The European manufacturing industry is navigating a "polycrisis" environment, shaped by geopolitical uncertainty, cost pressures, rapid technological change, skills shortages and climate crisis. These combined forces are testing the resilience and long-term competitiveness of Europe's industrial base. While Europe retains strong research and technological capabilities, it faces increasing pressure from global competitors, fragile supply chains, structural cost disadvantages and a persistent gap between innovation and large-scale market deployment.

Against this backdrop, the report identifies ten interconnected strategic priorities that will shape the future of European manufacturing. These priorities span the entire industrial system, including connected and digitalised factories, intelligent and agile automation, zero-defect and predictable quality, decarbonised and circular production models, resilient and transparent supply networks, workforce availability and continuous upskilling, secure data infrastructures and safe, human-centric work environments.

Across the five industrial sectors analysed — aerospace & defence, automotive, cleantech, electronics & semiconductors, and energy-intensive industries — common structural challenges threaten Europe's competitiveness. These include high dependence on non-European suppliers for critical inputs, persistent cost disadvantages, widening skills gaps driven by digital and green transitions and Europe's limited ability to consistently translate technological excellence into scalable commercial solutions.

Despite sector-specific differences, the technological responses required are highly convergent. The analysis highlights six cross-sector technology solution clusters as key levers for transformation: advanced materials, circular economy and decarbonisation enablers, advanced manufacturing and automation, artificial intelligence (AI) and data, connectivity and cybersecurity, and human-machine collaboration. In particular, AI- and data-driven solutions and advanced automation emerge as foundational capabilities, underpinning progress across most strategic priorities and industrial contexts.

Overall, the report calls for coordinated, cross-sector action to reinforce Europe's manufacturing competitiveness — accelerating market uptake of innovation, strengthening industrial sovereignty and ensuring that people remain at the centre of the industrial transformation.

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Introduction & methodology

Purpose of the report

The Industrial Innovation Report is EIT Manufacturing's annual publication designed to support informed decision-making across the European manufacturing innovation ecosystem. Its primary purpose is to identify and articulate the most relevant strategic challenges, transformation priorities and innovation needs shaping European manufacturing in the near-term. It provides guidance to stakeholders and prospective applicants engaging with EIT Manufacturing's programmes, clarifying prioritised domains, challenges and solution areas.

The report does not forecast technologies or prescribe policy choices; it focuses on manufacturing-relevant implications of ongoing transitions where urgent innovation is needed to strengthen Europe's industrial resilience, competitiveness and sustainability.

Scope

This report addresses manufacturing challenges and solution pathways that are relevant across European industry, with a particular emphasis on five strategic sectors where these challenges are most acute: aerospace & defence, automotive, cleantech, electronics & semiconductors and energy-intensive industries.

The five sectors were selected because they are critical to Europe's competitiveness, strategic autonomy and industrial resilience, while also facing structural fragilities and dependencies that require targeted action. Highly exposed to the green and digital transitions, they confront rising global competition and supply-chain vulnerabilities and demand significant innovation, industrialisation and workforce transformation to remain competitive.

To move beyond description and deliver strategic value, the report applies a shared impact-oriented framework focused on long-term change in European manufacturing, ensuring consistency and supporting a systemic view of competitiveness, resilience and industrial transformation.

Data source and analytical framework

This report is based on a qualitative, evidence-informed analytical approach, combining secondary data and internal intelligence to identify robust trends, emerging signals and structural challenges affecting European manufacturing. The objective is not to generate statistical analysis, but to synthesise existing knowledge and insight in a way that is actionable for industrial stakeholders and aligned with EIT Manufacturing's mission.

The analysis draws on four complementary categories of information:

1. **Sectoral and market analyses**, including industry reports, competitiveness studies and assessments, to understand market size, growth dynamics, production trends and structural shifts.

2. **Policy, regulatory and funding signals**, covering European and national programmes, regulatory developments and public investment priorities shaping manufacturing strategies and innovation trajectories.
3. **Investment and financing insights,** capturing public and private investment trends to identify where capital is being mobilised and where financing gaps persist, particularly at scale-up and industrial deployment stages.
4. **EIT Manufacturing portfolio data and internal intelligence**, drawing on funded projects and the experience of EIT Manufacturing teams working closely with industry and innovation providers across Europe.

These sources are complemented by technology and innovation assessments focused on manufacturing-enabling solutions, industrial readiness and scale-up constraints. Full references are provided separately in the report's reference table.

From an analytical perspective, the report applies a two-level framework.

At cross-sector level, insights from all sources are synthesised to identify 10 manufacturing priorities that capture the most pressing needs facing European manufacturing in the near to medium term. To address these priorities, the report identifies six technology solution clusters, grouping related relevant solutions across multiple sectors, that help translate strategic needs into actionable areas for innovation, deployment and support.

At sector level, each industry is analysed using a consistent structure. Market dynamics, policy and investment signals and structural constraints are assessed first. The resulting challenges are then organised into five challenge areas — digitalisation & automation; decarbonisation & circularity; upskilling & reskilling; attractiveness & inclusivity; and sovereignty & competitiveness — which mirror the long-term change pathways embedded in EIT Manufacturing's impact goals. This ensures that sector-specific insights remain comparable, impact-aligned and directly usable to guide priorities, scouting, portfolio steering and support actions in the years ahead.

This combined approach — integrating external evidence with internal portfolio intelligence and linking sector insights to cross-sector priorities — ensures that the report reflects what the data shows and what is observed in practice across European manufacturing, while providing a clear and coherent strategic narrative.

All visual content in this report was produced using artificial intelligence with Google NotebookLM and used for illustrative purposes only.

Cross-sector analysis

Cross-sector analysis

The European manufacturing industry is at a critical juncture, navigating a complex landscape of profound shifts that test its resilience, competitiveness and long-term viability. A synthesis of recent analyses reveals ten interconnected manufacturing priorities that define the sector's trajectory in 2026. These priorities span geopolitical, economic, social, technological and environmental domains, compelling manufacturers to innovate or risk obsolescence. The prevailing sentiment is "change or die", as European industrial manufacturers must undertake major transformations to maintain their competitive edge.

The European manufacturing industry, while retaining a strong base in research and technological capacity, faces increasing pressure from global competitors and persistent disruptive forces — the "polycrisis" environment. Accelerated digital transformation and the green transition are not merely objectives but imperatives defining competitiveness up to and beyond 2030.

Figure 1: Cross-sector priorities in manufacturing

The strategic importance of these manufacturing priorities varies across the key industrial sectors explored in this report. The following analysis synthesises the relevance and impact for each sector, providing a qualitative assessment (**1** – limited relevance, **2** – moderate relevance, **3** – high relevance, **4** – very high relevance, **5** – critical relevance) of where these challenges are most acute.

Priority	Description	A&D	Auto	CT	E&S	EII
1. Manufacturing lightweight and sustainable products	The industry must scale lightweight alloys, composites and recyclable materials to reduce weight, manufacturing cost and overall carbon footprint without compromising performance or quality.	5	4	3	3	3
2. Connecting and digitalising factory ecosystems	Manufacturers require seamless integration of legacy and new assets to enable real-time data flow, predictive control and eventually, autonomous operations across the production environment.	3	4	3	5	3
3. Implementing intelligent and agile automation for complex, variable and customised tasks	Growing product diversity, complexity, and demand for customisation necessitates adaptive and cognitive systems capable of rapid reconfiguration, on-demand production and flexible assembly to replace rigid or manual processes.	3	5	3	4	2
4. Decarbonising processes and auxiliary technologies	Industries must optimise energy-intensive operations and integrate clean technologies like batteries and hydrogen to meet climate targets and enhance competitiveness.	3	4	3	3	5
5. Achieving circular and resource-efficient manufacturing	Companies must design products, processes and value chains for reuse, recycling and reduce waste generation to comply with sustainability goals.	1	3	3	4	4
6. Ensuring zero-defect and predictable quality	Manufacturers need integrated inspection and intelligent monitoring systems to optimise defect detection and material use, enabling low-waste, high-quality production.	5	4	3	5	3
7. Building resilient, transparent and sustainable supply networks	Global disruptions expose supply-chain fragility; industries must localise, digitalise and ensure traceability to secure continuity and compliance.	3	5	3	4	3
8. Aligning workforce talent and skills needs through upskilling	Companies face acute skill shortages and must enable continuous upskilling, reskilling and attractive working conditions to prepare the workforce for human-centric, digital and green factories.	3	4	3	4	2
9. Securing sovereignty and data infrastructure	Hyper-connected factories and supply chains require robust cybersecurity and adherence to EU data sovereignty standards to protect Intellectual Property (IP) and trust.	4	4	3	5	3
10. Creating safe and human-centric workspaces	Manufacturers must design environments that prioritise operator safety, ergonomics and well-being while enabling seamless human–machine collaboration and reducing physical and cognitive strain.	3	4	2	3	3

The report identifies actionable solutions anchored in advanced technology clusters, prioritising areas where EIT Manufacturing can leverage its funding and commercialisation expertise by 2026. Addressing these challenges requires strategic investment to scale innovation into marketable solutions, particularly in high-growth areas where Europe currently lags behind the US and China.

Accelerating the path to market

Europe holds a strong position in the initial stages of advanced manufacturing development and research, reflected in its high scientific output. However, significant gaps persist in converting this knowledge into scalable market applications, trailing the US and China in both patent influence and venture capital investment for startups. Germany, France, Spain and Italy lead in AI uptake activities across the EU, but overall EU venture capital (VC) funding is limited, capturing only seven per cent of worldwide AI for manufacturing investments, versus 59 per cent in the US and 15 per cent in China.[1]

The key to navigating the turbulent geopolitical and digital landscape is to transform innovation excellence into commercial vitality, ensuring Europe's manufacturing powerhouse remains sustainable, resilient and competitive.

To address the ten priority areas, European manufacturers are leveraging distinct clusters of technological solutions. The following sections break down each priority, identifying the most relevant solution clusters (in order of relevance), the emerging technology innovations within them and their primary applications. Figure 2 illustrates the identified relationship between the ten manufacturing priorities and the six solution clusters, highlighting how each priority is enabled by multiple technological domains — with strong convergence around advanced manufacturing & automation and artificial intelligence & data — thereby underlining that industrial transformation relies on integrated, cross-cluster innovation rather than isolated technological approaches.

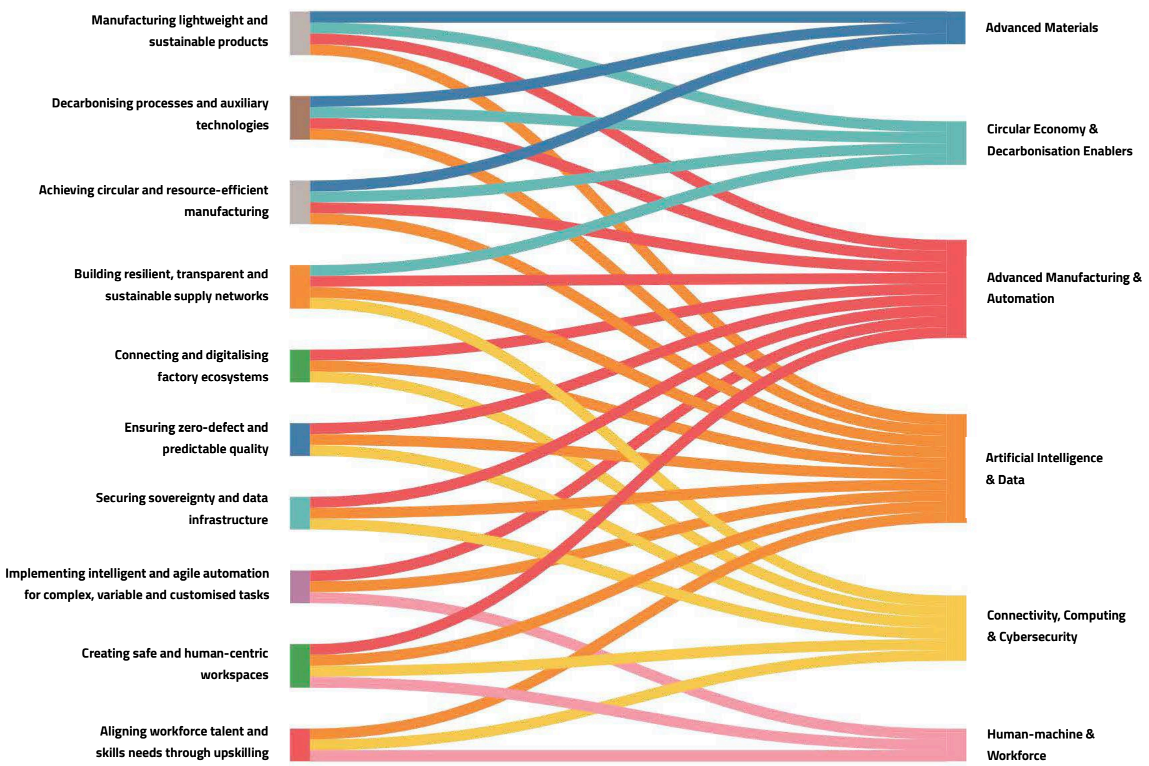

Figure 2: Links between priorities and solutions clusters

[1] De, N. S., Haarburger, R., Hradec, J., Craglia, M., & Nepelski, D. (2022). AI Watch: AI uptake in Manufacturing. *JRC Publications Repository*. https://doi.org/10.2760/267198

1. Manufacturing lightweight and sustainable products

The European advanced manufacturing sector requires innovation in materials science to reduce environmental footprint, especially for high-tech goods. The EU demonstrates a competitive edge in 'micro-structure and nanotechnology' patents, often originating from research centres.

Solution clusters	Primary applications	Innovations
Advanced materials	Providing dual function of structural support and energy storage in EVs and aircrafts; reducing reliance on fossil-based materials like graphite in batteries; enabling highly efficient, low-energy electronic devices; facilitating component reuse and recovery.	Lightweight alloys, high-strength steels, metal-matrix composites, structural battery composites (SBCs), recyclable circuit boards (dynamic composite materials), bio-based & recyclable materials (e.g., Lignin-based hard carbon)
Artificial intelligence & data	Accelerating the research, discovery and validation of new high-performance and sustainable materials; optimising material properties through simulation before physical prototyping.	AI/machine learning (ML) for materials discovery, data-driven frameworks for alloy design and digital twins for material simulation.
Advanced manufacturing & automation	Fabricating complex, lightweight components in aerospace and automotive; on-demand production of parts; reducing material waste compared to subtractive manufacturing.	Additive manufacturing (AM/3D Printing) for complex geometries, integration of advanced materials into production processes.
Circular economy and decarbonisation enablers	Integrating products designed for durability, repairability, and disassembly; optimising materials and structure to maximise recovery of resources; driving eco-design to reduce component count and simplify fabrication.	Regenerative manufacturing systems, Design for Manufacturing (DfM) principles, tools supporting material recovery and reuse/remanufacturing.

USE CASE: Holy Technologies

European manufacturing industries increasingly struggle to scale composite production cost-efficiently and sustainably, independently of offshore production. Traditional composite manufacturing remains slow and labour-intensive, relying on cutting and machining sheets of fibres that generate high material waste, increase production costs, and limit recyclability.

Holy Technologies is a vertically integrated contract manufacturer for high-performance composite components that is part of EIT Manufacturing investment portfolio. The company brings composite manufacturing back to Europe with an autonomous manufacturing system that is highly efficient, scalable and cost-competitive. The system is orchestrated by the company's proprietary software platform, Holy OS, and uses its patented IFP (Infinite Fiber Placement) technology for robotic component production. The system replaces waste-intensive manual processes with robotic precision and speed, eliminates material waste and supports closed-loop recyclability.

Deployed in industrial contexts where high-performance composites are critical, Holy Technologies enables manufacturers to produce high-performance composite parts faster and at scale.

The solution delivers measurable benefits for manufacturers:

- Significant cost reduction, enabling composite components to be produced up to 50 per cent cheaper than traditional methods
- Weight reduction of up to 30 per cent compared to conventional composites, improving performance and energy efficiency of end products
- Elimination of material waste and 100 per cent recyclability of composite components through closed-loop recycling
- Faster, more efficient production with reduced labour intensity and higher throughput

2. Connecting and digitalising factory ecosystems

The digitalisation of production is foundational, enabling predictive insights and automation opportunities. A key challenge lies in optimising operations across processes and production sites, which requires interoperable data, standardised formats and consistent communication protocols.

Solution clusters	Primary applications	Innovations
Connectivity, computing & cybersecurity	Enabling real-time data collection from legacy and new assets; providing low-latency communication for autonomous systems; secure data sharing across the value chain.	Industrial IoT (IIoT), 5G, edge & cloud computing, data platforms, zero-trust security.
Artificial intelligence & data	Improving simulation, monitoring and optimisation while limiting cost; predicting production bottlenecks; enabling data-driven decision-making for process improvements.	Digital twins, AI/ML-driven analytics, Manufacturing Execution Systems (MES/MOM), simulation platforms (e.g., Nvidia Omniverse-style platforms).

USE CASE: smartFAB

Manufacturing companies collect large volumes of production data but face challenges in connecting it and turning it into actionable insights across the factory. Data silos and fragmented tools often limit end-to-end digitalisation and slow down decision-making on the shop floor.

smartFAB is providing an AI-driven industrial analytics solution, developed with the support of EIT Manufacturing, that addresses this challenge by enabling connected and data-driven factories. The solution integrates heterogeneous production data and applies advanced analytics to provide clear, prioritised insights that can be understood and acted upon by operators, technicians and engineers.

Deployed in industrial environments including automotive components and consumer goods, smartFAB connects production lines, equipment and processes into a unified analytical environment. By combining real-time analytics with human-centric AI approaches, the system identifies bottlenecks, supports root-cause analysis and guides corrective actions directly on the shop floor.

The solution delivers measurable benefits for manufacturers:

- Improved visibility and connectivity across production processes and data sources
- Faster, more informed operational decision-making
- Reduced downtime, waste and time to resolution of production issues
- Enhanced workforce capabilities through data-driven support tools

3. Implementing intelligent and agile automation for complex, variable and custom tasks

The next era of manufacturing is defined by the proliferation of intelligent systems, demanding radical shifts in operations and human capital. The implementation of intelligent and agile automation is rapidly expanding the scope of automation beyond predictable, rule-based systems to master variable and complex tasks through advanced training-based and context-based robotics capable of zero-shot learning* (ZSL) and real-time adaptation.

Solution clusters	Primary applications	Innovations
Advanced manufacturing & automation	Enabling robots to perceive, reason and adapt in real time across variable environments; automating precision tasks like complex assembly, adaptive welding, and cable routing; supporting mass customisation and small batch production; retrofitting existing machinery for digital connectivity	Physical AI (Intelligent Robotic Systems), training-based robotics (Reinforcement/Imitation Learning), collaborative robots (Cobots), flexible/reconfigurable production cells, integration of smart sensors into machinery.
Artificial Intelligence & data	Accelerating deployment by enabling robots to learn behaviours in virtual environments before real-world rollout; making automation more accessible and faster to implement; interpreting high-level instructions to execute tasks in unfamiliar scenarios.	Generative AI (GenAI), context-based robotics (zero-shot learning), simulation/high-fidelity physics simulators, low-code and no-code platforms
Human–machine collaboration & workforce	Augmenting human capabilities and moving operators towards oversight and optimisation roles; ensuring successful deployment through intuitive control via voice or natural language; automating data entry and administrative tasks to free up human workers for value-added activities.	Operator 4.0 concepts, human-AI interfaces, robotic process automation (RPA).

* Zero-shot learning is a **machine learning scenario** in which an AI model is trained to recognise and categorise objects or concepts without having seen any examples of those categories or concepts beforehand. (definition by IBM)

USE CASE: YK-Robotics

Automating complex, variable and customised tasks is increasingly challenging for manufacturers, particularly in high-mix and low-volume environments. Traditional robotic systems are often rigid, costly to deploy, and require specialised expertise, making them poorly suited for frequent reconfiguration and dynamic production conditions.

YK-Robotics is providing a software platform, developed with the support of EIT Manufacturing, that addresses this challenge by enabling intelligent and agile robotic automation for complex industrial tasks. The solution lowers the barrier to advanced robotics by allowing non-expert users to configure, plan and operate robotic systems through an intuitive, software-driven approach.

Deployed in industrial contexts such as metalworking, machining, packaging and assembly, YK-Robotics enables autonomous, collision-free trajectory planning and rapid reconfiguration of robotic cells. By optimising robot paths and simplifying commissioning and changeovers, the platform supports flexible automation even in environments with frequent product or layout changes.

The solution delivers measurable benefits for manufacturers:

- Faster deployment and reconfiguration of robotic cells
- Reduced dependence on specialised robotic expertise and system integrators
- Improved productivity and energy efficiency through optimised robot motion
- Greater feasibility of automation for high-mix, low-volume production

4. Decarbonising processes and auxiliary technologies

Decarbonisation is a top priority, particularly for energy-intensive industries (EII). AI is critical for optimising operations to reduce energy consumption.

Solution clusters	Primary applications	Innovations
Circular Economy and Decarbonisation Enablers	Scaling up the production of cleantech to meet EU Green Deal targets; "peak shaving" in factories to reduce energy costs and stabilise the grid.	Automated manufacturing of batteries, wind turbines and solar panels; industrial energy storage systems; green hydrogen production technologies; integration of clean energy production within factories.
Advanced materials	Improving the efficiency and lowering the cost of clean energy technologies; creating a sustainable and resilient supply chain for EV batteries.	Materials for green hydrogen production/storage, sustainable battery cathodes (e.g., lithium iron phosphate), bio-based materials.
Artificial intelligence & data	Reducing energy consumption in industrial processes; managing the integration of intermittent renewable sources into the grid; optimising the design of energy-efficient buildings.	AI for energy efficiency optimisation, digital twins for grid management, big data analytics for forecasting renewable energy supply/demand.

USE CASE: Bright Cape

Energy-intensive industries face growing pressure to reduce energy consumption and CO_2 emissions while maintaining productivity and operational reliability. High energy costs, volatile electricity prices and the increasing integration of renewable energy sources make it difficult to optimise production processes and auxiliary systems using traditional energy management approaches.

Bright Cape provides an AI-driven energy optimisation solution, developed with the support of EIT Manufacturing, that addresses this challenge by enabling data-driven decarbonisation of industrial processes and auxiliary technologies. The solution combines advanced analytics, machine learning and optimisation algorithms to synchronise production planning with energy availability, costs and carbon intensity.

Deployed in energy-intensive industrial environments — including steel production, medical device manufacturing and other high-energy processes — the solution optimises production schedules, balances grid and locally generated renewable energy and supports peak shaving and energy orchestration. By forecasting energy demand and renewable supply, the system enables manufacturers to reduce energy consumption, lower costs and decrease their carbon footprint without disrupting operations.

The solution delivers measurable benefits for manufacturers:

- Reduced energy consumption and CO_2 emissions through optimised energy use
- Lower energy costs via peak shaving and improved energy mix management
- Increased integration of renewable energy and reduced grid dependency
- Improved operational efficiency in energy-intensive processes

5. Achieving circular and resource-efficient manufacturing

Circular economy practices are shifting manufacturing towards "net-positive" operations that minimise environmental impact and maximise societal value.

Solution clusters	Primary applications	Innovations
Circular economy and decarbonisation enablers	Enabling product traceability throughout the lifecycle; designing products for easy disassembly and component reuse; recovering high-value materials from waste streams; recovering critical raw materials like lithium, cobalt and graphite from end-of-life batteries, reducing dependency on imports and building a circular value chain.	Design-for-reuse/recycling tools, remanufacturing processes, advanced material recovery technologies, advanced battery recycling technologies, material recovery processes.
Artificial intelligence & data	Automating the identification and sorting of recyclable materials; strengthening cybersecurity, validating; enabling product traceability throughout the lifecycle; validating sustainability claims; mapping carbon emissions along the value chain.	AI/ML for waste stream sorting, blockchain, digital product passports, Asset Administration Shell (AAS) for carbon footprint tracking.
Advanced manufacturing & automation	Reducing material waste; extending product life through repair and refurbishment; automating the process of taking apart complex products for recycling.	Additive Manufacturing (AM), robotics for automated disassembly, machine vision.
Advanced materials	Creating products that have a minimal environmental impact at their end-of-life, replacing traditional plastics and non-recyclable composites.	Development of bio-based, biodegradable and fully recyclable materials.

USE CASE: Kolektor

Manufacturers increasingly face pressure to reduce material waste, dependency on critical raw materials and environmental impact, while maintaining performance and cost-efficiency — particularly in components such as electric motors and actuators that are essential for electrification. Europe's high-performance magnets market is today totally dependent on China, which controls the raw materials, while secondary raw materials are widely available and could be used as a strategic advantage.

With the support of EIT Manufacturing, Kolektor developed an industrial solution that addresses this challenge by enabling circular and resource-efficient production of permanent magnets through anisotropic 3D printing in a magnetic field. The technology allows rapid prototyping and small-series production of high-performance magnetic components with lower material waste and tooling requirements compared to conventional injection moulding.

Applied to rotors for brushless DC motors and actuators used in automotive, industrial and appliance applications, the solution enables up to five times faster prototyping and three times lower costs. The process achieves high material efficiency — up to 97 per cent material yield — supports the use of recycled magnetic powders and allows material reuse multiple times, reducing both waste and reliance on virgin raw materials.

The solution delivers measurable benefits for manufacturers:

- Reduced material consumption and waste through additive manufacturing
- Increased use of recycled and reusable magnetic materials
- Shorter development cycles and lower prototyping costs
- Improved flexibility in the design and validation of electric motor components

6. Ensuring zero-defect and predictable quality

Quality assurance is undergoing a shift from reactive inspection to predictive and prescriptive control, leveraging the pattern recognition capabilities of AI.

Solution clusters	Primary applications	Innovations
Advanced manufacturing & automation	Identifying surface defects, dimensional inaccuracies and internal flaws without damaging the product; correcting deviations from quality standards in real-time without human intervention, ensuring consistent product quality.	Ultrasound and tomography, closed-loop quality control systems where robots or machines automatically adjust process parameters based on inspection feedback.
Artificial intelligence & data	Automated, real-time inspection of parts on the production line; predictive quality control, simulating process changes to assess impact on quality; quickly identifying the source of defects.	AI-based defect detection, inline metrology, sensor fusion, AI/ML for predictive maintenance, digital twins for process simulation, root cause analysis algorithms.
Connectivity, computing & cybersecurity	Providing the data infrastructure needed for comprehensive, real-time quality monitoring and predictive analytics.	Industrial IoT for collecting quality data from sensors across the production line.

USE CASE: PredictiveDataScience

Maintaining consistent product quality while operating complex, high-throughput production systems is a pain point for manufacturers. Quality deviations are often detected late, resulting in scrap, rework, unplanned downtime and inefficient use of energy and materials.

PredictiveDataScience, with the support of EIT Manufacturing, developed an AI-driven software solution that addresses this challenge by enabling real-time quality monitoring and predictive fault detection in manufacturing processes. The solution combines machine learning, advanced analytics and time-series data from sensors to detect anomalies, predict failures and anticipate quality deviations before they affect production outcomes.

Deployed in industrial environments including automotive manufacturing plants, the solution monitors critical processes such as motor-driven equipment, assembly lines and paint shops. By analysing real-time and historical process data, the system identifies early signs of deterioration, supports predictive maintenance planning and stabilises production quality across multiple sites.

The solution delivers measurable benefits for manufacturers:

- Reduced unplanned downtime through early fault detection and proactive maintenance
- Improved and more predictable quality, limiting defects and process variability
- Lower operational costs, thanks to optimised maintenance and reduced waste
- Higher resource and energy efficiency, contributing to sustainability objectives

7. Building resilient, transparent and sustainable supply networks

Global trade fragmentation and geopolitical instability necessitate radical redesigns of traditional supply chains, moving away from single-source dependencies toward diversified strategies, localisation and enhanced transparency.

Solution clusters	Primary applications	Innovations
Artificial intelligence & data	Predicting supply chain disruptions; simulating the impact of geopolitical or climate events; providing a single source of truth for real-time monitoring of goods and materials.	AI for demand forecasting and risk management, supply chain digital twins, big data analytics, control towers for end-to-end visibility.
Connectivity, computing & cybersecurity	Creating a secure and transparent record of transactions and product movements; facilitating collaboration between suppliers, manufacturers and logistics providers.	Blockchain for traceability, data-sharing platforms, cloud-based logistics management systems.
Circular economy and decarbonisation enablers	Tracking materials and components through multiple life cycles to support circular economy models and prove compliance with regulations like the EU's ESG reporting directives.	Digital Product Passports
Advanced manufacturing & automation	Enabling dynamic orchestration of value chains by accessing networked manufacturing capacity on demand; localising production of critical parts to reduce dependency on long supply chains.	Manufacturing as a service (MaaS) platform, on-demand 3D printing for spare parts.

USE CASE: ChainTraced

Global disruptions and rising regulatory pressure highlight the fragility of industrial supply chains. Fragmented data, manual tracking processes and limited information exchange across suppliers create inefficiencies and reduced visibility from raw materials to finished products.

ChainTraced, supported by EIT Manufacturing through funding and investment, addresses this challenge by providing a digital traceability platform that automates supply-chain data tracking and enables seamless information exchange across all actors in the value chain. The solution replaces manual, document-based processes with a structured digital approach that improves data quality, enhances collaboration and ensures end-to-end transparency across industrial supply networks.

Designed for the metal industry, ChainTraced consolidates critical product and process information through digital product passports. These passports integrate quality data, material specifications and carbon footprint information, supporting regulatory compliance and sustainability reporting requirements. In addition, the platform enables automated validation and approval of inbound deliveries, which reduces administrative effort and improves reliability between supply-chain partners.

The solution delivers measurable benefits for manufacturers and supply-chain stakeholders:

- End-to-end traceability from raw materials to finished products, increasing supply-chain transparency
- Reduced manual workload through automated data tracking and delivery validation
- Improved compliance with regulatory and sustainability standards, including carbon footprint reporting
- Stronger collaboration and information exchange across multi-tier supply networks

8. Aligning workforce talent and skills needs through upskilling

As organisations face a critical skills gap compounded by shrinking talent pools and high employee turnover, they require focused investment in digital literacy, data analytics and knowledge management to sustain competitiveness.

Solution clusters	Primary applications	Innovations
Human–machine collaboration & workforce	Upskilling and reskilling the workforce for digital and green factories; providing immersive, safe training environments; guiding workers through complex tasks; designing safer workspaces.	Augmented reality / Virtual reality (AR/VR) for training and maintenance, digital work instructions, ergonomic analysis tools, safety & compliance systems, business simulation games (e.g., RealGame).
Artificial intelligence & data	Identifying skills gaps and providing tailored training content; making data-driven decisions on workforce planning and development; providing instant access to technical information and support.	AI-powered personalised learning platforms, talent analytics, large language models (LLMs) for knowledge management.
Connectivity, computing & cybersecurity	Facilitating broad access to flexible, specialised training and lifelong learning opportunities; streamlining access to information on EU/national requirements and opportunities.	Cloud-based learning platforms, digital infrastructure (Single Digital Gateway).

USE CASE: INFINITY

Technological change and the green transition are reshaping skills needs in manufacturing, while schools and companies struggle to update curricula and training fast enough. INFINITY responds with a modular digital learning offer on green and circular manufacturing, delivered through the EIT Manufacturing Academy and complemented by industry workshops at Kilometro Rosso.

The project developed 50 digital lessons and multiple Learning Paths on topics such as green industry fundamentals, environmental, social and governance (ESG), green purchasing and energy, green technologies and additive manufacturing. It was piloted with Brembo employees and then rolled out to 17 VET schools, reaching over 1,300 students. Learning Paths were shortened, targeted and translated, and offered via flexible delivery modes (asynchronous, synchronous, blended) with partners supporting teachers and monitoring learners' progress.

Kilometro Rosso, in partnership with the Polytechnic University of Turin, Tecnalia and FEUP (Faculty of Engineering - University of Porto), also created four half-day workshops on additive manufacturing for circular economy, design for sustainability, recycling of industrial waste, and green manufacturing — now included in its commercial training catalogue for companies.

Key benefits include:

- Up-to-date, EU-validated content on green manufacturing, formally adopted in schools and used in corporate training
- Strong cooperation between companies and VET schools, enabling recurring use and replication to new cohorts and institutes
- High scale and impact (13 Learning Paths, >10,000 lessons consumed, >1,500 certificates issued)

INFINITY shows how modular digital learning plus targeted workshops can align workforce skills with green and circular manufacturing needs while establishing a sustainable training offer.

9. Securing sovereignty and data infrastructure

Europe's advanced manufacturing sector is heavily influenced by foreign investors, more so than the US or China. Protecting technology and intellectual property is critical for Europe to maintain its autonomy

Solution clusters	Primary applications	Innovations
Connectivity, computing & cybersecurity	Protecting sensitive intellectual property, production data and customer information from cyberattacks; ensuring operational technology (OT) is secure; enabling secure data sharing without exposing raw data.	Zero-trust security architectures, robust cybersecurity for IT/OT convergence, confidential computing, adherence to EU data standards (e.g., GDPR, Data Act, Cyber Resilience Act).
Artificial intelligence & data	Proactively identifying and mitigating cyber threats in real-time; creating tamper-proof ledgers for critical transactions; ensuring compliance with data sovereignty regulations.	AI for threat detection and response, blockchain for secure data exchange, data governance frameworks.
Advanced manufacturing & automation	Building cybersecurity into manufacturing equipment from the ground up, rather than adding it as an afterthought.	Secure by design principles for industrial control systems and connected devices.

USE CASE: LexaTexer

Manufacturers increasingly rely on data-driven planning and optimisation, yet secure access to production data across systems and partners remains challenging. Fragmented data infrastructures, limited interoperability and concerns around data ownership and cybersecurity hinder the adoption of advanced AI solutions, particularly in complex and high-mix production environments.

LexaTexer addresses this challenge through an AI-based data space and planning solution, supported by EIT Manufacturing. The platform enables secure, sovereign and trusted use of industrial data for production planning and optimisation. By integrating heterogeneous data sources through a controlled data-sharing architecture, manufacturers can apply AI-driven planning while maintaining full governance over their data assets.

Deployed in industrial use cases including appliance manufacturing and chemical production, the solution supports collaborative and adaptive production planning across machines, lines and supply-chain inputs. By combining AI-driven optimisation with a secure data aggregation layer, the platform enables rapid replanning in response to disruptions while ensuring data integrity, traceability and controlled access.

The solution delivers measurable benefits for manufacturers:

- Secure and trusted sharing of production data across systems and stakeholders
- Improved production planning agility through AI-driven decision support
- Reduced vulnerability to data silos and cyber-related operational risks
- Strengthened control over critical manufacturing data and infrastructure

10. Creating safe and human-centric workspaces

Critically, this entire shift in the manufacturing industry must prioritise creating safe and human-centric workspaces. New AI solutions and collaborative robotics should integrate seamlessly with existing workflows, leverage workers' tacit domain knowledge and align with the holistic vision of Industry 5.0 that places human well-being at the centre of technological deployment.

Solution clusters	Primary applications	Innovations
Advanced manufacturing & automation	Taking over dangerous, physically demanding, or cumbersome tasks; enabling safe physical interaction and enhancing flexibility on the shop floor; supporting workers in performing higher-value tasks.	Collaborative robots (Cobots), autonomous transportation (AMRs), autonomous operations (Industry 5.0 vision).
Artificial intelligence & data	Optimising cooperation across the manufacturing process chain; providing augmented information to operators during critical decision-making.	AI-powered optimisation of human-machine interaction, AI-assisted decision-making processes.
Connectivity, computing & cybersecurity	Providing the flexibility and scalability to manage dynamic production environments; enabling real-time visibility into shop floor operations to support agile decision-making.	Cloud-based manufacturing execution systems (MES), industrial IoT platforms for real-time production tracking.
Human–machine collaboration & workforce	Ensuring AI deployment meets workers' needs and workflows; reducing safety risks and psychological strain (e.g., long hours, repetitive stress); augmenting human assessment capacities during complex decision-making.	Human-centric system co-design methodology, ergonomics and health surveillance technologies, digital work instructions.

USE CASE: RoboTwin

Manufacturing industries increasingly rely on robots for physically demanding and hazardous tasks such as spray painting, powder coating, grinding, sanding and polishing. These processes often expose workers to repetitive strain, harmful substances and unsafe working conditions. At the same time, conventional industrial robotics remains difficult to deploy, requiring specialised programming skills and limiting workers' involvement in how automation is introduced on the shop floor.

RoboTwin, supported by EIT Manufacturing through funding and investment, addresses this challenge by enabling a human-centric approach to industrial automation. Its no-code robot teaching solution allows operators to demonstrate tasks through natural human motion, which robots learn through motion tracking and imitation. This approach removes the barrier of complex programming while explicitly leveraging workers' tacit domain expertise. Deployed in industrial environments, including automotive and manufacturing, RoboTwin supports the safe automation of surface-treatment processes by transferring hazardous and repetitive tasks from humans to robots. It works without disconnecting workers from the production process. The simple workflow enables fast setup and reconfiguration, ensuring that collaborative robotic systems integrate seamlessly into existing workflows and production routines.

The solution delivers measurable benefits for manufacturers and workers:

- Improved workplace safety by reducing human exposure to hazardous and physically demanding tasks
- Human-centric automation that embeds workers' know-how directly into robotic behaviour
- Faster and more intuitive deployment of collaborative robots without specialised programming skills
- Increased acceptance of automation through operator-driven interaction

RoboTwin demonstrates how Industry 5.0-aligned robotics can support safer and resilient manufacturing systems. By combining automated learning with human demonstration, the solution advances collaborative robotics that enhance productivity while prioritising workers' skills and trust in digital transformation.

Skills analysis

Skills analysis

Skills availability plays a key role in industrial competitiveness, resilience and technological leadership of Europe's manufacturing ecosystem. Despite high employment, the sector continues to face skills shortages, especially in manual and technical roles. Structural factors such as demographic ageing, replacement demand and uneven pace of digital and green transitions are worsening skills shortages, slowing upskilling and lowering workforce participation. These factors hamper innovation, investment and Europe's progress toward climate and digital goals.

Figure 3: Skills Analysis — Infographic

Current skills gap

According to the World Manufacturing Report 2024, more than half of manufacturing executives anticipate that skills deficits will reduce sectoral profitability in the coming decade. 74 per cent of SMEs already face hiring difficulties, especially for technical and IT-intensive roles. The long-term outlook is shaped by sluggish participation in adult learning (only 40 per cent of adults engage in regular upskilling) and accelerating demographic change. [2] With 30 per cent of Europeans projected to be over 65 by 2050, the working-age population is shrinking just as transformation pressures intensify. [3] These dynamics create a mounting "skills bottleneck", slowing down automation efforts, stalling equipment upgrades and undermining Europe's progress toward sustainable manufacturing. This systemic risk reinforces the need for forward-looking workforce planning and stronger alignment between training provision and industrial transformation.

[2] World Manufacturing Foundation. (2024, April). *New Perspectives for the Future of Manufacturing: Outlook 2030*.

[3] *Population projections in the EU.* (2023, March). Eurostat. Retrieved 4 January, 2026.

Evolving skill demands

Digital and technical skills: Automation, AI, robotics and data-driven manufacturing are redefining the technical baseline. Workers capable of integrating and managing intelligent systems — combining programming, data analytics and mechatronics — are essential for Industry 4.0 readiness. The 2023 CECIMO survey reports that around 53 per cent of firms face major difficulties recruiting such hybrid profiles, particularly digital mechanical systems integrators.[4]

Green and sustainability skills: The transition toward low-carbon, circular production is creating new occupational domains. World Manufacturing Report 2024[5] notes strong demand for specialists in eco-design, energy efficiency and emissions management, while the Organisation for Economic Co-Operation and Development (OECD) warns of acute green skills shortages in high-emission sectors where workers face persistently low training participation rates — constraining rapid upskilling for net-zero transitions.[6] New profiles — such as energy auditors, recycling process designers and ESG compliance engineers — are central to regulatory readiness but insufficiently supplied by existing vocational education and training (VET) systems.[7]

Transversal and human-centric skills: Adaptability, creativity, problem-solving and collaboration skills increasingly determine transformation success. Analyses by the European Centre for the Development of Vocational Training (CEDEFOP) and the Joint Research Centre (JRC) highlight that technological adoption is often constrained less by access to tools than by deficits in these transversal skills — limiting firms' "absorptive capacity" to deploy innovation effectively.[8] Building lifelong learning cultures and change-management competences has become a strategic priority across manufacturing ecosystems. In parallel, CEDEFOP, the European Commission and the OECD underline that entrepreneurship-related skills and competences — such as opportunity recognition, initiative, risk management and value creation — are becoming an essential complement to these transversal skills, enabling workers and firms not only to adapt to change but to proactively drive innovation and new business models across manufacturing value chains.[9]

Sectoral, demographic and firm-level dimensions

Skills shortages in manufacturing are most severe in high-precision and engineering-intensive roles — such as welding, electrical maintenance and automation systems — where the majority of firms report serious hiring constraints.[10] In response, many manufacturers are redesigning workflows and introducing digital guidance tools to allow semi-skilled staff to take on routine technical tasks, reserving scarce expert capacity for more complex operations. The problem is magnified among SMEs, which make up over 99 per cent of EU manufacturing firms.[11] With limited resources for

[4] CECIMO. (2024, March). *From Survey to Strategy: Understanding Skills Trends in Advanced Manufacturing*.
[5] World Manufacturing Foundation. (2024). *Ibid.*
[6] OECD. (2025). *How the green transition reshapes vocational education and training.* https://doi.org/10.1787/4819bf34-en
[7] LinkedIn. (2024). *Global Green Skills Report.*
[8] Cedefop. (2023). *Skills in transition: The way to 2035. Publications Office of the European Union.*
[9] Bacigalupo, M., Kampylis, P., Punie, Y., Van den Brande, G. (2016). *EntreComp: The Entrepreneurship Competence Framework.* Luxembourg: Publication Office of the European Union; EUR 27939 EN; doi:10.2791/593884
[10] World Manufacturing Foundation. (2024). *Ibid.*
[11] European Commission: Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs. (2025). *Annual report on European SMEs 2024/2025 : SME performance review.* Publications Office of the European Union.

training and limited access to specialised labour markets, SMEs are disproportionately exposed to skill shortages in advanced and hybrid roles. Labour mobility worsens the imbalance, as skilled workers tend to cluster in larger firms or high-tech hubs, leaving regional SMEs at a disadvantage. [12] At the same time, persistent underrepresentation of women, migrants and older workers narrows the available talent pool. Expanding participation from these groups is not only a social imperative but a practical lever to ease labour bottlenecks and strengthen workforce resilience.

Future skill needs

The future of European manufacturing will depend on fusion skills — hybrid capabilities that integrate engineering, digital and sustainability expertise. Demand is rising for profiles capable of integrating mechatronics, AI and industrial software with environmental and regulatory understanding. CEDEFOP forecasts significant growth in demand for interdisciplinary digital engineering roles through 2035, driven by AI and automation adoption in manufacturing. [13] At the same time, sustainability-related competencies are becoming critical: a vast majority of firms expect skills in ESG compliance, lifecycle analysis and circular innovation to be "mission-critical" within five years — yet most feel inadequately prepared. [14]

These trends suggest that technical expertise alone will no longer suffice; future competitiveness will rest on the ability to combine domain knowledge with digital fluency and environmental literacy. In parallel, automation and supply chain restructuring are reshaping work organisation and the kinds of competencies required on the factory floor. As manual tasks decline, the value of adaptive problem-solving, cross-functional collaboration and decision-making under uncertainty grows. The OECD Skills Outlook 2025 warns that gaps in transversal and human-centric capabilities — such as change leadership and inter-team coordination — are now limiting the absorption of digital and green technologies in manufacturing. [15] Complementing these are entrepreneurship skills and an entrepreneurial mindset - one of the EU's eight key competences for lifelong learning, defined as "turning ideas into action" through creativity, innovation, risk-taking and project management. [16] They are essential for workers to drive new business models and resilient manufacturing value chains, as prioritised by the EU's Small Business Act (2008) [17] and the Europe 2020 strategy. [18] On top of that, the re-shoring of production and the need for resilient supply chains are generating new demand for logistics, procurement and quality management skills across all tiers of industry. The emerging skill landscape is not only technical but also systemic, requiring manufacturers to invest in continuous learning, organisational agility and workforce mobility to remain competitive through Europe's twin transitions.

[12] Pissareva, L., Bernal, M. S., Trapasso, R., & Velayos, J. (2025). Equipping SMEs with the skills to navigate the twin transition. In *OECD SME and Entrepreneurship Papers*. https://doi.org/10.1787/caf420e6-en

[13] Cedefop. (2025). *Skills empower workers in the AI revolution first findings from Cedefop's AI skills survey.* Publication Office of the European Union. Policy brief. DOI: 10.2801/6372704.

[14] World Manufacturing Foundation. (2024). *Ibid.*

[15] OECD. (2025). *OECD Skills Outlook 2025: Building the Skills of the 21st Century for All.* https://doi.org/10.1787/26163cd3-en.

[16] *Council Recommendation on Key Competences for Lifelong Learning*. (2025). European Education Area.

[17] *A small business act for European SMEs*. (2008). EUR-Lex.

[18] *Europe 2020: the European Union strategy for growth and employment.* (2017). EUR-Lex.

Strategic implications

Europe's manufacturing sector stands at a pivotal moment, as digitalisation, decarbonisation and shifting supply chains fundamentally transform skill requirements. Trends and evidence underscore that future competitiveness depends on upskilling the existing workforce, particularly in digital, green and transversal capabilities, while reskilling displaced workers from carbon-intensive industries to prevent talent loss. Education and skills frameworks must position entrepreneurship as a core competence for engineers and manufacturing professionals, rather than a complementary or optional element. Without proactive investment in lifelong learning, manufacturing risks stalling its green transition and innovation capacity. At the same time, strategic action is needed to diversify the talent pipeline, including greater inclusion of women and underrepresented groups. These challenges call for coordinated efforts by industry, education providers and policymakers to build a resilient, future-ready manufacturing workforce across Europe.

Sector analysis

Aerospace & defence

Sector analysis

Aerospace & defence

Figure 4: Aerospace & defence — Infographic

Sector snapshot & strategic importance

The European aerospace and defence (A&D) sector is at its turning point due to geopolitical instability and green-digital transitions. With a 2023 turnover of €290.4 billion[19], the industry shows robust growth but confronts structural challenges. Russia's war in Ukraine has spurred NATO defence spending commitments up to 5 per cent of GDP[20], while civil aviation pursues net-zero emissions by 2050 through sustainable aviation fuels (SAF) and next-generation propulsion.

Key challenges include persistent supply chain disruptions, critical dependencies on non-European suppliers for raw materials (titanium, rare earths) and semiconductors, and severe skills gaps in advanced manufacturing and digital technologies — all threatening Europe's strategic autonomy and innovation capacity.

The sector would benefit from networked R&D in quantum technologies, nuclear micro-reactors and integrated photonics; sovereign manufacturing capacity; circular economy solutions; and AI-driven supply chain tools. The main strategic stakes at the European level are industrial scaling, material substitution, talent development and breakthrough technologies.

[19] *Facts & Figures*. (2024). ASD Europe. Retrieved February 2025.
[20] Stout. (2025, October). *Mechatronics: Aerospace Report.*

Strategic importance for Europe

The A&D sector is fundamental to Europe's economy, employing over one million professionals[19] and generating €693 billion in total turnover.[19] Its strategic importance spans technological sovereignty, defence capabilities and sustainable innovation.

The capacity to provide critical technologies without dependencies is central to the sector's role in space, defence and advanced materials. However, underinvestment, fragmented strategies and reliance on non-European suppliers weaken Europe's position. Russia's war in Ukraine has intensified the urgency for initiatives like EDIP (European Defence Industry Programme) to strengthen the European Defence Technological and Industrial Base.

Civil aeronautics' net-zero commitment by 2050 through Destination 2050 aligns with the EU Green Deal and positions Europe as a sustainability leader. The space economy, although fragmented, is essential for implementing public policy and ensuring technological sovereignty across all economic sectors.

Funding, policy & geopolitical considerations

EU policy and funding signals

The EU is accelerating defence and sustainability agendas with targeted programmes and regulations. EDIP and the European Defence Fund aim to strengthen Europe's defence industrial base and coordinate procurement, while the ReFuelEU Aviation regulation mandates a steep rise in sustainable aviation fuel — from 2 per cent in 2025 to 70 per cent by 2050.[21] Flagship R&D partnerships such as Clean Aviation (€1.7 billion public funding) and SESAR (Single European Sky ATM Research) are driving next-generation aircraft and efficient air traffic management. The Critical Raw Materials Act (CRMA) sets 2030 targets for domestic capacity — 10 per cent extraction, 40 per cent processing, 25 per cent recycling — and caps reliance on any single third country at 65 per cent.[22] Strategic stockpiling is gaining traction, with EDIP expected to fund reserves of military components.

Geopolitical factors

Russia's war in Ukraine has triggered a surge in defence spending, with NATO allies pledging up to 5 per cent of GDP.[20] Supply chain weaponisation is a growing risk, as China leverages export controls on gallium, germanium and graphite to exert political pressure. Europe remains heavily dependent on non-European suppliers for defence procurement, raising security-of-supply concerns. Meanwhile, deepening military alliances between Russia, North Korea and Iran further destabilise global security.

[21] World Economic Forum. (2025). *Strategic Intelligence on Aerospace Innovation*.
[22] IISS. (2025). *Critical raw materials and European defence.*.

Macro challenges

The strategic context of A&D — defined by the urgent need for net-zero emissions, rapid industrial scale-up and technological sovereignty — places crucial demands on European manufacturers. Below are the details of the relevance of priority areas in addressing these demands:

Digitalisation & automation

- **Certification bottlenecks:** Certification for autonomy hardware and new processes lags behind market speed due to limited regulatory bandwidth.
- **Quality barriers & repeatability:** Advanced manufacturing processes like additive manufacturing (AM) and large composite lay-ups face challenges in repeatability, inspection bottlenecks and achieving certified design.
- **Cybersecurity risk:** Extensive use of big data, AI and IoT for autonomous systems poses safety and cybersecurity threats.

Decarbonisation & circularity

- **Scaling zero-emission subsystems:** Specific requirements for aviation (safety and performance) are high while demand is currently lower, making scaling components like high-density batteries, advanced fuel cells and cryogenic systems difficult.
- **Material recycling:** Recycling advanced aerospace-grade materials (e.g. Carbon Fibre Reinforced Plastics) is technically challenging, energy-intensive and often results in a poor retention of mechanical properties.
- **SAF production gaps:** Manufacturers face high capital costs and high risks due to low technology readiness levels (TRL) for advanced pathways (PtL/G-FT) and uncertainty regarding feedstock supply.

Upskilling & reskilling

- **Acute labour shortages:** Manufacturers face urgent shortages across critical areas: machining, composites, electronics and emerging roles like hydrogen systems engineers and digital twin experts.
- **Talent retention & competition:** Ageing workforce and intense competition for digital and sustainability skills from other industrial sectors (automotive, energy) worsen the gap.
- **Need for certification expertise:** The deployment of disruptive technologies requires massive financial and personnel resources for certifying bodies like EASA (European Union Aviation Safety Agency), demanding specialists skilled in navigating new regulatory and certification frameworks.

Attractiveness & inclusivity

- **Gaps in core STEM and interdisciplinary skills:** Vital need to train, retain and attract highly qualified experts globally, particularly in interdisciplinary profiles (e.g., AI, quantum technologies, cyber).
- **Innovation leakage:** European innovation often struggles to find market uptake or adequate capital compared to competitors, risking brain drain.

Sovereignty & competitiveness

- **Supply chain dependencies:** Heavy reliance on external suppliers for CRMs (titanium, rare earth elements) and components (e.g., single photon detectors, semiconductors).
- **Fragmentation & lack of predictability:** Fragmented national demand prevents manufacturers from justifying large capital investments for production ramp-up, leading to volatile order books and high costs.
- **Manufacturing capacity gaps:** The EU lacks manufacturing and packaging capacity for critical components like space-grade electronics, radiation-hardened components and integrated photonics.

The aerospace and defence sector is at an inflexion point where the need for sustainability and security convergence demands manufacturing excellence. Like a dual-mode engine, the sector needs to invest in both the 'green' pathways (hydrogen, SAF scale-up, circularity) and the 'security' pathways (dual-use tech, critical raw material sovereignty) to ensure it retains its technological altitude and industrial capability.

Automotive

Automotive

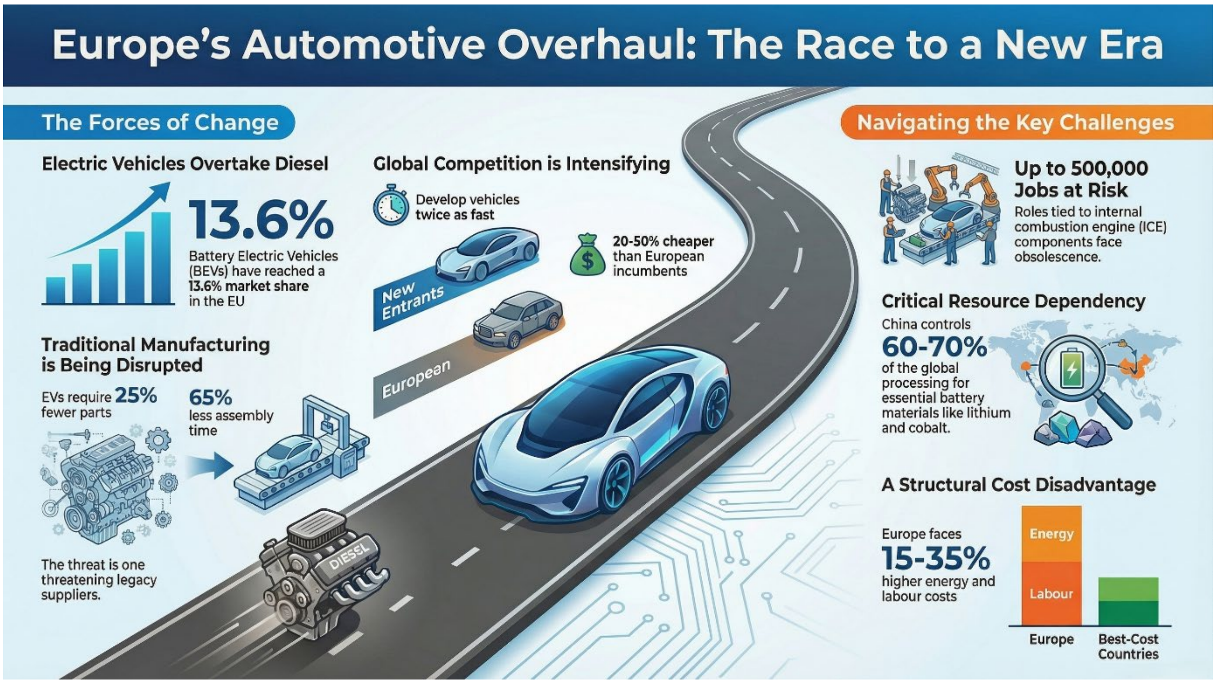

Figure 5: Automotive — Infographic

Sector snapshot & strategic importance

Automotive is one of Europe's most significant industrial pillars, contributing up to €1 trillion to the economy[23] and supporting 13–14 million jobs across original equipment manufacturers (OEMs), suppliers, services and affiliated industries.[23] [24] The sector is central to European competitiveness, technological leadership, energy transition and regional employment.

The industry is undergoing an unprecedented transformation driven by electrification, zero-emission regulations, software-defined architectures, automation and the transition toward circular and resource-efficient manufacturing. Electrification disrupts the value chain structurally: electric vehicles (EVs) require 25 per cent fewer parts and 65 per cent less assembly time, lowering the value contribution of traditional internal combustion engine ICE suppliers and placing thousands of SMEs at risk of obsolescence.

With road transport representing roughly 15 per cent of global CO_2 emissions, manufacturing pathways that reduce life-cycle impact (including circularity, advanced recycling and low-carbon processes) have become strategic imperatives. At the same time, the rapid rise of software, electronics and autonomous systems demands a fundamental reconfiguration of production systems, skills and industrial capacity.

[23] European Commission. (2025). *Industrial Action Plan for the European automotive sector: COM(2025) 95 final.*
[24] *A new 'ERA': An action plan for the European automotive industry*. (2025, September). McKinsey. Retrieved 25 February, 2026.

These shifts make automotive manufacturing a priority domain for innovation in the coming years.

Funding, policy & geopolitical considerations

Automotive manufacturing in Europe is being reshaped by a combination of public funding initiatives, regulatory developments, private-sector investment strategies and geopolitical pressures.

Public funding points consistently toward reinforcing industrial capacity in batteries, connected and automated mobility, critical raw materials and charging infrastructure. Upcoming EU programmes earmark:

- €1 billion for connected/autonomous vehicles and advanced batteries (2025–2027), including €350 million for next-generation battery technology. [25]
- €1.8 billion via the "Battery Booster" package to increase domestic cell production and recycling capacity. [26]
- €2.2 billion already committed by AFIF (Alternative Fuels Infrastructure Facility) to charging infrastructure, with an additional €570 million focused on heavy-duty vehicle corridors. [27]

These investments indicate strong public-sector emphasis on electrification readiness, digital capability and supply-chain resilience.

Regulatory evolution — such as zero-emission vehicle targets, life-cycle considerations, repairability and recycling requirements and emerging frameworks for autonomous systems — creates long-term direction for industrial planning. Developments under discussion, including local content requirements for batteries or streamlined type-approval for automated systems, shape expectations for OEM and supplier investments in Europe.

Private-sector signals align with this trajectory. OEMs and Tier-1 suppliers are prioritising electrified powertrains, battery integration, digital architectures and semiconductor partnerships. However, instability in the supplier base, combined with several stalled battery gigafactory projects, highlights the volatility of the transition and the risk of fragmented capacity buildup.

Geopolitical conditions amplify these pressures. China controls 60–70 per cent of global lithium and cobalt processing [28] and produces 65 per cent of EVs worldwide [29], driving structural dependency. Countervailing duties on Chinese EV imports signal growing attention to competition distortions. Meanwhile, strong incentives abroad — particularly the US Inflation Reduction Act — continue to

[25] European Commission. (2025). *Industrial Action Plan for the European automotive sector: COM(2025) 95 final.*
[26] *Ibid.*
[27] *Ibid.*
[28] OECD. (2024), "The future of the automotive value chain: Implications for FDI-SME linkages", *OECD SME and Entrepreneurship Papers*, No. 64. https://doi.org/10.1787/cb730d65-en.
[29] World Economic Forum. (2025). *Strategic Intelligence on Aerospace Innovation*.

redirect parts of the value chain outside Europe. These dynamics reinforce the need for regionalised, resilient and technologically advanced manufacturing ecosystems.

Overall, convergence between public investment, regulatory direction, private capital allocation and geopolitical constraints indicates that Europe has entered a decisive decade for automotive industrial transformation.

Macro challenges

The transformation of the automotive sector touches every dimension of European manufacturing, from decarbonisation and digitalisation to skills, competitiveness and social resilience.

Digitalisation & automation

- A digital leadership gap: EU manufacturers lag behind global ICT players in software-defined vehicle (SDV) concepts, AI integration and centralised electrical/electronic architectures.
- Semiconductor dependency, with automotive chip demand rising at 11 per cent compound annual growth rate and supply concentrated in Asia. [30]
- High operating cost and complexity of autonomous mobility, where savings from removing drivers are offset by expensive sensors, computing hardware and remote supervision needs.
- Shortening innovation cycles — 5–6 years instead of 8–9 — requires continuous R&D investment and agile manufacturing processes.

Decarbonisation & circularity

- Critical raw material dependency, especially for lithium, cobalt and copper, creates vulnerability for EV and battery production.
- Significant EV affordability gap, with vehicles costing €10,000–€15,000 more than ICE equivalents [31], limiting adoption and scale effects.
- Underdeveloped life-cycle infrastructure for repair, remanufacturing and high-quality recycling, which is essential for circularity and resource efficiency.
- Severe commercial-vehicle decarbonisation lag, especially for vans and trucks (still 84–95 per cent diesel. [32]

Upskilling & reskilling

- Up to 500,000 jobs in ICE-related components are at risk [33], requiring large-scale workforce transition programmes.

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[30] Xerfi. (2024). *The global automotive equipment industry : market report, trends, rankings.*
[31] do Prado, V., Fabry, E., González Laya, A., Köhler-Suzuki, N., Lamy P. & Praetorius, S. (2025). The Road to a New European Automotive Strategy: Trade and Industrial Policy Options. *Jacques Delors Institute Report no 129.*
[32] ACEA. (2025). *Economic and Market Report Global and EU auto industry 2024*.
[33] CLEPA. (2021). *EV Transition Impact Assessment Report 2020-2040.*

- Skill requirements are rapidly shifting toward battery technologies, power electronics, high-voltage components, software and AI systems.
- SMEs, which form the majority of suppliers, lack financial and organisational capacity for large-scale upskilling, creating gaps in digital and electrification capabilities.
- Emerging roles in recycling, circularity, predictive maintenance and advanced robotics require entirely new competency profiles.

Attractiveness & inclusivity

- Declining attractiveness of manufacturing careers, as software and digital occupations gain prominence elsewhere.
- High restructuring pressures reduce the perception of job stability, particularly across regions heavily dependent on ICE-related supply chains.
- Uneven access to reskilling and technological upgrading risks excluding workers and SMEs from the transition.
- Competition for digital and electronics talent: automotive manufacturing competes with ICT, consumer electronics, aerospace and robotics for the same profiles.

Sovereignty & competitiveness

- A structural cost disadvantage of 15–35 per cent relative to best-cost countries [34], driven by high European energy and labour costs.
- Under-industrialisation of critical EV components, such as high-voltage electronics, thermal management, transmissions and power electronics, leaving the EU exposed to external suppliers.
- Delocalisation risks, threatening 23 per cent of economic value and 300,000–350,000 jobs over the next few years if industrial erosion continues. [35]
- Growing competitive pressure from Chinese OEMs, which benefit from cost advantages and rapid scale-up capacity.

[34] CLEPA. (2025). *Automotive component – Driving EU competitiveness and value creation.*
[35] *Ibid.*

Cleantech

Cleantech

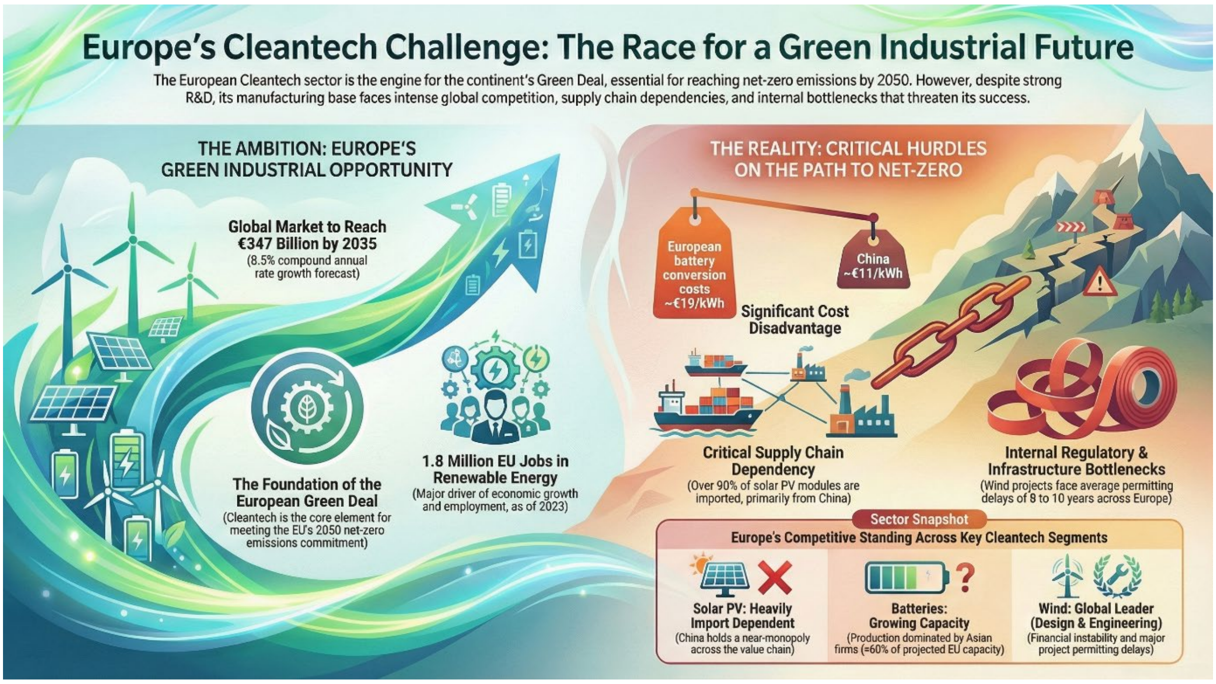

Figure 6: Cleantech — Infographic

Sector snapshot & strategic importance

The European cleantech sector is fundamental to realising the European Green Deal goals and achieving net-zero emissions by 2050[36], serving as the central engine for industrial transformation and competitiveness. While Europe holds strong R&D expertise, its manufacturing base faces intense global competition, particularly from Asia, marked by high conversion costs and critical dependence on non-EU suppliers for raw materials and components.

The critical manufacturing challenges require intervention spanning the commercial and technological realms: mitigating high upfront capital costs, securing fragile supply chains, accelerating the industrial scaling of complex technologies (like dry coating for batteries) and developing the skilled workforce needed to manage digitalised and sustainable factories. Europe's strategic focus must leverage digitalisation (AI, digital twins) to drive efficiency and transparency, invest in European capacity building across strategic value chains (batteries, wind, solar, hydrogen) and proactively develop the talent pool required to secure sovereignty and competitiveness.

The cleantech sector encompasses the development and deployment of sustainable and environmentally friendly solutions across diverse applications. It is inherently crosscutting, impacting a broad spectrum of economic activities and is central to the manufacturing industry. Key cleantech manufacturing segments include the value chains for batteries, solar photovoltaics (PV),

[36] Ambrois, Matteo et al. (2023). Using machine learning to map the European cleantech sector. EIF Working Paper, No. 2023/91. European Investment Fund.

wind turbines, electrolysers for hydrogen production and technologies enabling circularity and deep industrial decarbonisation.

Cleantech is strategically critical for Europe's climate objectives, economic resilience and energy sovereignty. It underpins the European Green Deal and the transition to climate neutrality, enabling the decarbonisation of hard-to-abate sectors and the large-scale deployment of clean power and electrification solutions. At the same time, the sector is a major driver of jobs and industrial transformation but faces intense global competition and cost pressures that make efficiency, process innovation and scaling capabilities essential. Strengthening secure and resilient value chains is a strategic priority to reduce external dependencies, particularly for key technologies and materials. Delivering impact ultimately requires an integrated systems approach, where electricity, energy storage, transport and resource management are digitally and physically interconnected to support a flexible, resilient and competitive energy system.

Funding, policy & geopolitical considerations

The trajectory of Europe's cleantech manufacturing sector is heavily shaped by ambitious EU policy and funding initiatives, critical geopolitical dependencies and persistent market and financial challenges.

The EU has deployed an ambitious policy framework to accelerate the green transition, anchored by the European Green Deal and Clean Industrial Deal. The Net-Zero Industry Act (NZIA) sets a critical benchmark requiring EU manufacturing to meet 40 per cent of annual deployment needs for strategic net-zero technologies by 2030[37], while the Critical Raw Materials Act (CRMA) aims to secure essential supply chains and reduce strategic dependencies. Complementing these are the Alternative Fuels Infrastructure Regulation (AFIR), mandating charging infrastructure for zero-emission vehicles, and strict standards requiring 100 per cent zero-emissions for new cars and vans from 2035. Financial support flows through multiple channels: the European Investment Fund (EIF) provides €900 million in cleantech equity finance through InvestEU and €300 million annually via the EIB's Risk Capital Resources (RCR) mandate, Horizon Europe allocates ~€600 million for cleantech R&I and dedicated instruments like the Hydrogen Bank and Innovation Fund support low-carbon hydrogen and decarbonisation projects.

However, formidable geopolitical and structural challenges threaten this transition. The EU remains critically dependent on China for over 90 per cent of solar PV modules and lithium/graphite refining capacity, while global overcapacity of solar PV at ~60 per cent, batteries at ~35 per cent, and electrolysers below 10 per cent creates intense price pressure that jeopardises European plant viability.[38] Financing gaps are severe, with only 0.71 per cent of cleantech companies VC-backed[39] and persistently high capital costs (9-12 per cent) in emerging economies hindering deployment[40].

[37] International Energy Agency. (2023). *The State of Clean Technology Manufacturing – November 2023 Update*.
[38] *Ibid.*
[39] European Investment Bank. (2024). *EIB Investment Report 2023/2024: Transforming for competitiveness*.
[40] International Energy Agency. (2023). *The State of Clean Technology Manufacturing – November 2023 Update*.

Infrastructure bottlenecks compound these challenges: approximately 3,000 GW of renewable projects are stalled in grid queues globally, wind projects face 8-10 year permitting delays in Europe[41], and the wind sector suffers financial instability from rising costs and problematic tendering processes. Perhaps most critically, the supply of copper, nickel, lithium, and cobalt is projected insufficient for 2030 demand. With the EU producing just 2 per cent of global raw materials, the industry faces extreme price volatility — lithium prices surged nearly ninefold between 2021 and 2022[42] — threatening to make clean technologies prohibitively expensive and creating significant economic disruption.

Macro challenges

The European cleantech sector is vital for realising the **European Green Deal** and driving industrial transformation, yet it is structurally constrained by intense global competition and high conversion costs compared to Asia. Europe faces critical challenges, including reliance on non-EU supply chains, high energy prices and severe skill gaps impeding facility scale-up. Given the proactive targets set by EU policies (e.g. **Net-Zero Industry Act** (NZIA), **Critical Raw Materials Act** (CRMA)), this section outlines the main challenges and pain points that require strategic intervention.

Digitalisation & automation

- **High conversion costs & low efficiency:** European battery manufacturers underutilise smart factory designs, leading to high production costs compared to Asian competitors.
- **Fragmented traceability/compliance:** Lack of standardised digital tools hinders tracking of material origin and verification of compliance (e.g., for ethical sourcing and carbon footprint disclosure).
- **Grid integration and resilience:** Integrating variable renewable energy sources (VRE) requires advanced control. EV fleets must provide flexibility services (V2G).

Decarbonisation & circularity

- **Significant GHG footprint:** The production of batteries and energy-intensive materials (like steel, contributing 8 per cent of global emissions) is energy-intensive and causes substantial CO_2 emissions.
- **Low recycling & end-of-life viability:** Recycling for certain battery chemistries (e.g., LFP) is economically inefficient; generally, end-of-life management for batteries and solar panels remains underdeveloped.
- **Hard-to-abate industrial emissions:** Deep decarbonisation requires transformative process change in sectors like cement (carbon capture, utilisation and storage) and steel (green hydrogen/DRI-EAF).

[41] Isabel, M. (2026, February). *There's no competitiveness without accelerated electrification*. Wind Europe.
[42] International Energy Agency. (2023). *The State of Clean Technology Manufacturing – November 2023 Update*.

Upskilling & reskilling

- **Skill gaps in high-tech manufacturing:** The urgently needed scaling-up of new facilities (gigafactories, electrolyser plants) is heavily constrained by the shortage of skilled technicians, engineers and digital specialists.
- **Complex system integration:** There is a need for expertise in managing and installing sophisticated digital systems (smart grids, vehicle-to-grid) and handling high-voltage, end-of-life batteries safely.

Attractiveness & inclusivity

- **Integrity risks in raw material sourcing:** The scale-up exposes the value chain to severe social risks, including child labour in artisanal cobalt mining and environmental pollution related to extraction.
- **Workforce quality and mindset:** The goal is to ensure the creation of 10 million safe, fair, and good-quality jobs globally. Decarbonisation decisions often require overcoming skill mismatches and aligning specialised sustainability teams with commercial teams.

Sovereignty & competitiveness

- **Structural cost disadvantage:** High conversion costs in European battery production (approximately double compared to China) hinder global cost competitiveness.
- **Extreme regional concentration:** Heavy reliance on China for key components (solar PV wafers, battery anodes/cathodes) creates significant vulnerability and dependence risks.
- **Regulatory drag/uncertain demand:** Slow permitting processes delay critical greenfield projects (wind, CCUS). Public procurement often fails to reward high-standard EU products.

Electronics & semiconductors

Electronics & semiconductors

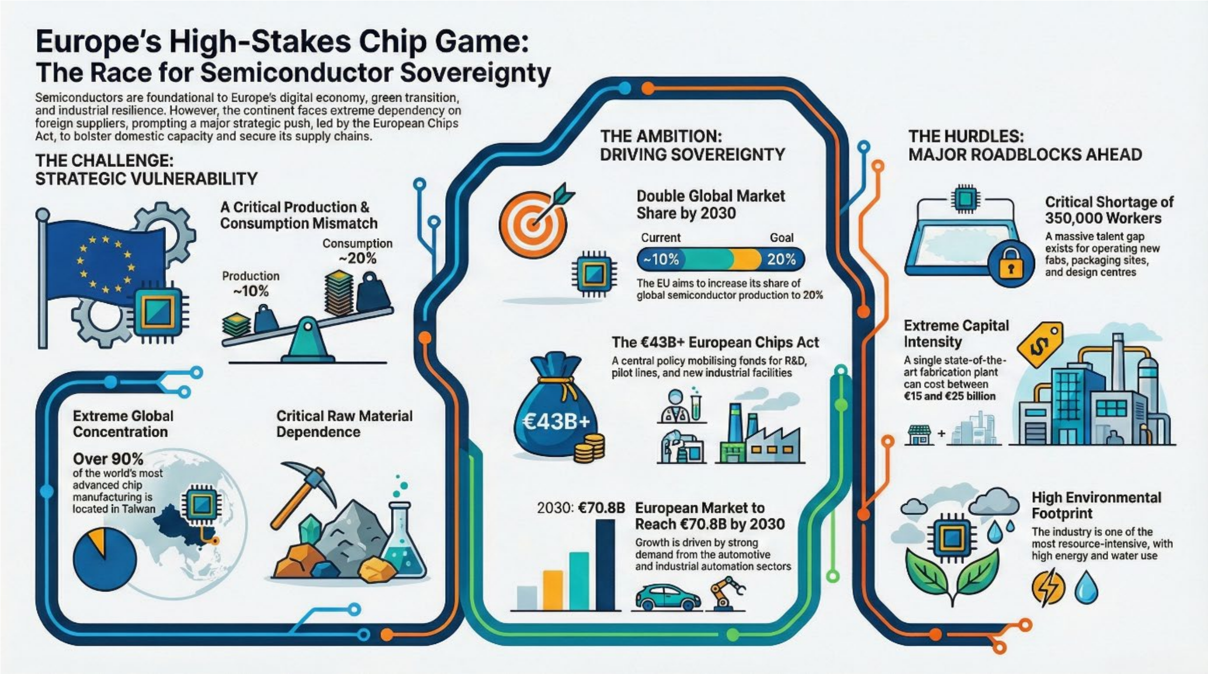

Figure 7: Electronics & semiconductors — Infographic

Sector snapshot & strategic importance

Electronics and semiconductors underpin nearly every aspect of modern manufacturing and digital infrastructure. They are foundational to automation, connectivity, electrification, AI, robotics, defence, medical technologies and renewable energy systems. Semiconductors are a key enabling technology essential to Europe's digital competitiveness, industrial resilience and green transition.

Europe holds strong positions in power electronics, microelectromechanical systems (MEMS), sensors, advanced manufacturing equipment, lithography (ASML) and complex embedded systems used in automotive, aerospace/defence, industrial automation and healthcare. According to the European Chips Act, the EU aims to strengthen technological sovereignty by expanding R&D leadership and increasing local manufacturing capacity, targeting 20 per cent global market share by 2030.[43]

Despite these strengths, the region faces some strategic challenges. The global semiconductor value chain is extremely concentrated — over 90 per cent of leading-edge production is located in Taiwan[44], while 75 per cent of dynamic random-access memory (DRAM) output comes from South

[43] European Semiconductor Industry Association. (2023). Towards a more competitive semiconductor industry for Europe.
[44] Arthur D Little. (2024). Localizing the Global Semiconductor Value Chain.

Korea.[45] The EU currently represents only ~10 per cent of global semiconductor production, but consumes ~20 per cent.[46]

Given rising geopolitical tensions, the accelerating digitalisation of European manufacturing and the critical role of chips in electrification and AI systems, the sector is regarded as strategically important for Europe.

Funding, policy & geopolitical considerations

Europe's ambition to strengthen its semiconductor ecosystem is driven by a combination of public investment, regulatory changes, private capital flows and intensifying geopolitical dynamics. The European Chips Act plays a central coordinating role, mobilising more than **€43 billion** across R&D infrastructures, pilot lines, first-of-a-kind industrial facilities and supply-chain monitoring mechanisms.[47] The European Commission establishes competence centres, a design platform and crisis response tools, significantly shaping industrial expectations and investment patterns. Additional regulations — notably the Cyber Resilience Act — reinforce the need for secure hardware and trusted supply chains in all electronics and embedded systems.

Overall, several programmes are supporting with funding the sector, including:

- **Horizon Europe (Pillars I–III)** supporting R&D at different maturity stages
- **IPCEI on Microelectronics & Communication Technologies (IPCEI ME/CT)** supporting large industrial projects and associated innovation pathways.
- **InvestEU & the Chips Fund** improving access to finance for startups, scale-ups, equipment manufacturers and design companies.
- **National incentive programmes** (Germany, Italy, France, Ireland) influencing fab and packaging site locations.

Private-sector investment decisions closely follow these public signals. Leading integrated-device manufacturers (IDMs), foundries, outsourced semiconductor assembly and test (OSATs) and equipment players — including Intel, TSMC, Samsung, Infineon, STMicroelectronics and NXP — have announced or are evaluating substantial investments in European fabs, packaging facilities and R&D sites. Venture investment is rising in AI accelerators, chiplet-based architectures, GaN/SiC devices and specialised design houses, though capital requirements remain a barrier, especially for SMEs.

Geopolitical tensions further reinforce the urgency of supply-chain diversification. With more than 90 per cent of advanced-node manufacturing concentrated in East Asia[48] and China dominating

[45] Deloitte. (2025). *Global Semiconductor Industry Outlook*.
[46] Nachtigall, H., Kreutzer, S., Iglauer, T., Izsak, K., & Technopolis Group. (2022). Monitoring the twin transition of industrial ecosystems: proximity and social economy. *Analytical Report*.
[47] European Court of Auditors. (2025). *The EU's strategy for microchips.*
[48] European Strategy and Policy Analysis System. (2022). *Global Semiconductor Trends and the Future of EU Chip Capabilities.*

over 70 per cent of critical raw materials[49], Europe remains highly exposed to external shocks, export controls and climate-driven disruptions such as water scarcity affecting fabs. Global technology bifurcation, subsidy competition and the strategic importance of semiconductors in defence and AI systems amplify Europe's need to accelerate domestic capacity, secure trusted partnerships and strengthen industrial resilience.

Macro challenges

The European electronics and semiconductor ecosystem faces a convergence of structural challenges that risk slowing innovation, scale-up and long-term competitiveness. Increasing technological complexity, resource-intensive production processes and persistent skills shortages are compounded by rising cybersecurity risks, limited access to specialised infrastructures and growing global competition. At the same time, decarbonisation pressures, talent attraction barriers and strong dependence on non-EU supply chains highlight the need for faster transformation and more coordinated strategic action. The following section outlines the key macro-challenges and systemic pain points shaping the sector's evolution.

Digitalisation & automation

- Rapidly rising complexity in chip design, verification and heterogeneous integration.
- Need for AI-driven process optimisation (digital twins, metrology, fault detection) to maintain yield and reduce variability.
- Hardware cybersecurity vulnerabilities requiring secure-by-design approaches across development cycles.

Decarbonisation & circularity

- Electronics and semiconductors are resource-intensive industrial sectors, with high energy, water and chemical consumption.
- Low adoption of sustainability measures, with only 23 per cent of SMEs increasing green investment and circularity rates below 5 per cent in several segments.[50]
- Complex challenges in replacing hazardous chemicals (e.g., PFAS) and minimising material waste.

Upskilling & reskilling

- Up to 350,000 workers needed by 2030 to operate new fabs, pilot lines, packaging sites and design centres.[51]

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[49] Arthur D Little. (2024). *Localizing the Global Semiconductor Value Chain.*
[50] Nachtigall, H., Kreutzer, S., Iglauer, T., Izsak, K., & Technopolis Group. (2022). Monitoring the twin transition of industrial ecosystems: proximity and social economy. *Analytical Report.*
[51] Pricewaterhouse Coopers. (2024). *State of the Semiconductor Industry.*

- Major shortages in technicians, equipment operators, lithography specialists, metrology engineers and application-specific integrated circuit designers.
- Limited access to specialised training environments and pilot lines, especially for SMEs.

Attractiveness & inclusivity

- Entering the sectors is challenging due to cleanroom environments, strict protocols and expensive qualification pathways.
- Difficulty attracting and retaining talent due to housing, mobility and localisation challenges in semiconductor regions.
- SMEs face limited access to shared infrastructures, reducing inclusive participation and ecosystem growth.

Sovereignty & competitiveness

- High dependence on foreign suppliers for advanced-node chips, critical materials and chemicals.
- Long approval cycles and high energy costs hinder Europe's speed of scale-up.
- Underdeveloped design ecosystem (<10 per cent global design revenue). [52]
- Growing competition from regions offering larger incentives and more mature clusters.

[52] European Strategy and Policy Analysis System. (2022). *Global Semiconductor Trends and the Future of EU Chip Capabilities.*

Energy-intensive industries

(steel & aluminium)

Energy-intensive industries (steel & aluminium)

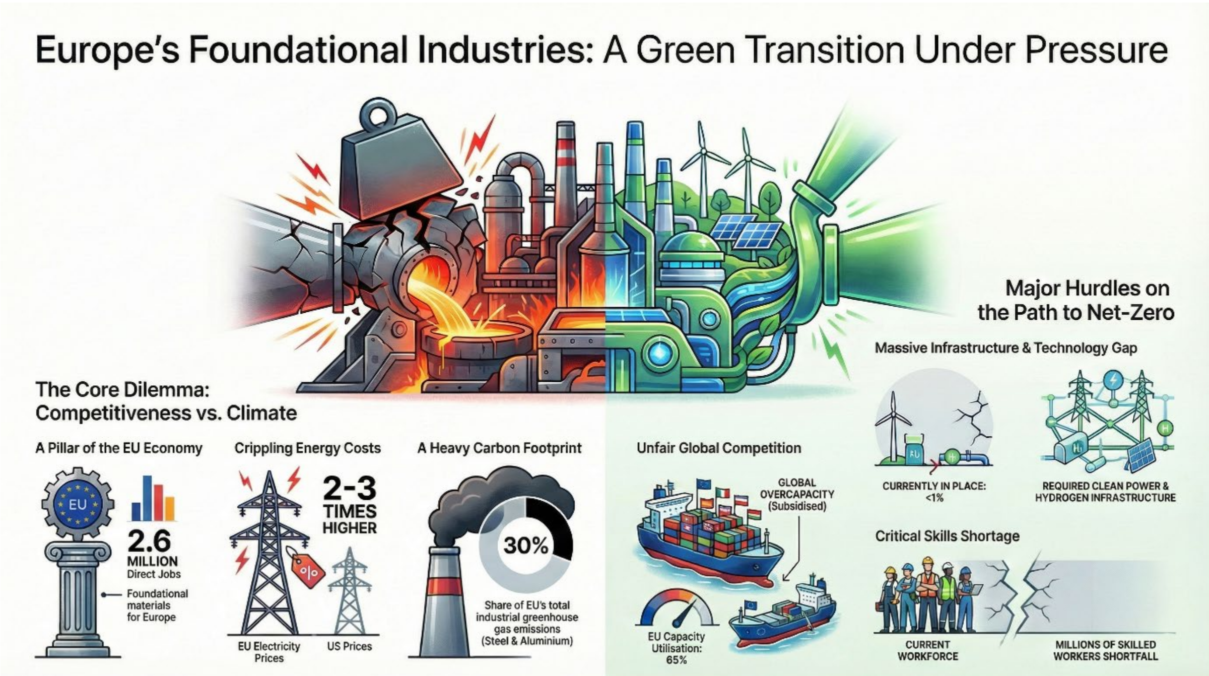

Figure 8: Energy-intensive industries — Infographic

Sector snapshot & strategic importance

The 2022 energy crisis, which pushed European electricity demand to 20-year lows [53], exposed the European energy-intensive industries (EII) sector — particularly steel and aluminium — to a competitiveness crisis and urgent decarbonisation challenges. High price volatility, with the EU electricity prices remaining 2-3 times higher than in the US [54], led to substantial production cuts — primary aluminium fell 12 per cent and crude steel 10 per cent in 2022 [55] — and raises the risk of deindustrialisation through plant closures and relocation, jeopardising Europe's strategic autonomy and defence capabilities. This sector encompasses the manufacture of basic iron and steel and of ferro-alloys and the manufacture of basic precious and other non-ferrous metals, primarily aluminium.

EIIs, particularly steel and aluminium, form the backbone of Europe's industrial ecosystem, supplying essential materials to strategic value chains such as automotive, construction, defence and renewable energy infrastructure. The sector is therefore central to the EU's economic security, strategic autonomy and industrial competitiveness. At the same time, its transformation is critical to achieving Europe's climate objectives, as EIIs represent a major source of industrial emissions and face urgent pressure to decarbonise. This transition is closely tied to the EU's broader industrial policy agenda, requiring coordinated action on energy, technology deployment, competitiveness and

[53] International Energy Agency. (2023). *Electricity Market Report Update.*
[54] Draghi, M. (2024). *The Future of European Competitiveness—A Competitiveness Strategy for Europe*.
[55] European Commission. (2024). *Study on Energy Prices and Costs.* Com (2024) 136.

circularity to ensure that foundational industries remain viable, sustainable and resilient in a global context.

Funding, policy & geopolitical considerations

The EII sector's transformation requires stable policy frameworks, substantial funding and navigation of complex geopolitical dynamics. The EU's Green Deal Industrial Plan and Net-Zero Industry Act target 40 per cent domestic manufacturing of clean technologies by 2030. The TCTF (Temporary Crisis and Transition Framework) enabled EU Member States to compensate energy costs and support net-zero investments, transitioning to the Clean Industrial Deal State aid framework in Q2 2025. The Commission supports Power Purchase Agreements and Contracts for Difference for price relief and clean energy investment, while the Carbon Border Adjustment Mechanism provides trade protection with planned extensions to downstream products and EU exports. Key funding includes the European Hydrogen Bank for industrial hydrogen production, the Innovation Fund's €1 billion 2025 pilot auction via the Industrial Decarbonisation Bank and R&D mobilisation through reformed RFCS (Research Fund for Coal and Steel) and Horizon Europe calls[56].

The investment landscape indicates substantial needs alongside existing gaps. The global energy transition requires $275 trillion by 2050[57], with EU steel facing €5.2 billion CapEx and €9 billion OpEx annually until 2030, and aluminium requiring €1.3 billion annually until 2050.[58] The EU faces an annual investment gap of €750-€800 billion for geopolitical and economic goals.[59] Global clean energy investment reached $1.8 trillion in 2023, but remains concentrated in advanced economies and China, far short of the $4.5 trillion needed annually[60], with high interest rates posing obstacles. Russia's war in Ukraine exposed Europe's energy vulnerabilities, accelerating the shift to local renewables for self-reliance. However, strategic leverage is shifting to nations controlling clean technologies and critical minerals (cobalt, lithium, rare earths). China's dominance in mineral processing and clean tech manufacturing poses challenges to the EU. Global overcapacity from China and India, supported by distortive subsidies, has left the EU steel plan operating at 65 per cent of its potential output. It prompts the need for long-term protective trade measures.

Macro challenges

The transformation of the EII sector requires a holistic approach addressing technology, supply chains, workforce and competitiveness. The following priority areas outline the key challenges and necessary responses.

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[56] European Commission. (2025, March). *A European Steel and Metals Action Plan*. COM(2025) 125.
[57] McKinsey. (2022, January). *The net-zero transition what it would cost, what it could bring.*
[58] Draghi, M. (2024). *The Future of European Competitiveness—A Competitiveness Strategy for Europe*.
[59] *Ibid.*
[60] World Economic Forum. (2025, June). *Fostering Effective Energy Transition 2025 Insight Report.*

Digitalisation & automation

Digital tools are critical enablers for efficiency, cost reduction and managing the complexity of the green transition. Generative AI alone offers a potential 5–7 per cent improvement in capital efficiency.

- **Fragmented supply chain awareness:** Many businesses lack visibility into their extended energy and climate impact; only 53 per cent understand their supply chain's energy use.
- **Operational inefficiency:** Traditional manufacturing processes are not optimised for fluctuating renewable energy sources or for maximising energy and material productivity.
- **Complexity of new systems:** Managing new industrial assets like electrolysers and CCUS systems requires advanced monitoring and control.

Decarbonisation & circularity

This is the sector's central challenge and opportunity. EIIs are "hard-to-abate" and responsible for nearly 40 per cent of global GHG emissions.[61] Decarbonisation is non-negotiable for meeting climate targets and enhancing energy security, yet nearly half of the required emission reductions rely on technologies that are not yet commercially viable.

- **High green premiums & demand uncertainty:** Low-carbon products are significantly more expensive (e.g., 40-70 per cent for steel), with customers' willingness to pay the premium remaining uncertain.
- **Insufficient infrastructure:** Less than 1 per cent of the necessary clean power, hydrogen and CCUS infrastructure is in place, creating a bottleneck.[62] Grid connection delays can take several years.
- **Breakthrough technology gap:** Deep decarbonisation relies on unproven technologies like clean hydrogen for direct reduced iron (DRI), CCUS and inert anodes for aluminium.
- **Circularity & input scarcity:** Competition is fierce for key low-carbon inputs like scrap metal and supplementary cementitious materials (SCMs). Scrap exports from the EU are increasing due to higher prices paid by third countries, undermining circularity.

Upskilling & reskilling

The transition is as much a human capital challenge as a technological one. A profound workforce transformation is required, but progress has lagged, with a projected global shortage of millions of skilled workers.

- **Labour market disruption:** The shift away from carbon-intensive processes risks job losses, particularly for older or low-to-medium skilled workers in dependent industrial regions.

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[61] World Economic Forum. (2024). *Net-Zero Industry Tracker-Third edition.*
[62] Draghi, M. (2024). *The Future of European Competitiveness—A Competitiveness Strategy for Europe*.

- **Emerging skills gap:** There is a critical shortage of workers with skills in data science, AI, cybersecurity and advanced digital tools needed to manage a modernised, decarbonised industry. In mining, nearly half of skilled engineers are expected to retire within the next decade.
- **Workforce and skills shortage:** The energy transition requires a substantial increase in tradespeople (electricians, welders) and technical experts, with the power grid sector projected to face a shortfall of **1.5 million workers by 2030**. [63]

Attractiveness & inclusivity

The socio-economic dimension of this transition is important. Inequitable distribution of costs and benefits could lead to public resistance, policy reversals and challenges to maintaining the social license to operate, potentially affecting the pace of decarbonisation.

- **Risk of policy reversal & lack of consensus:** Policies that place higher costs on certain communities or SMEs may face public concern and reduced acceptance. Public trust is relatively low, with only 42 per cent of citizens expressing confidence in their government's ability to reduce emissions. [64]
- **Regressive cost impacts & energy poverty:** Mitigation policies like carbon pricing may have a greater impact on low-income consumers and small businesses that lack the capital to invest in energy-efficient alternatives.
- **Uneven distribution of opportunities:** The benefits of the green transition, such as new jobs and economic growth, may not automatically flow to the regions and workers most affected by the phase-out of carbon-intensive industries.

Sovereignty & competitiveness

High energy costs and unfair global competition pose an existential threat to European EIIs. Maintaining a competitive industrial base is vital for economic stability, strategic autonomy and the EU's defence capabilities.

- **Non-competitive energy costs:** EU electricity prices and natural gas prices reduce profitability and affect the business case for electrification.
- **Global overcapacity & unfair trade:** Distortive subsidies in non-EU countries create an unlevel playing field, leading to low-capacity utilisation and aggressive import competition.
- **Investment de-risking & low profitability:** Significant decarbonisation investments are needed, but low returns on capital and margin compression make the business case less attractive to private investors.

[63] International Energy Agency. (2025). *Building The Future Transmission Grid.*
[64] OECD. (2024), *OECD Survey on Drivers of Trust in Public Institutions – 2024 Results: Building Trust in a Complex Policy Environment.* https://doi.org/10.1787/9a20554b-en.

Conclusion

European manufacturing stands at a defining moment. Across aerospace and defence, automotive, cleantech, electronics and semiconductors, and energy-intensive industries, the same pattern emerges: structural pressures are intensifying, technological complexity is rising and global competition is accelerating.

Yet this convergence of challenges also reveals a convergence of opportunity.

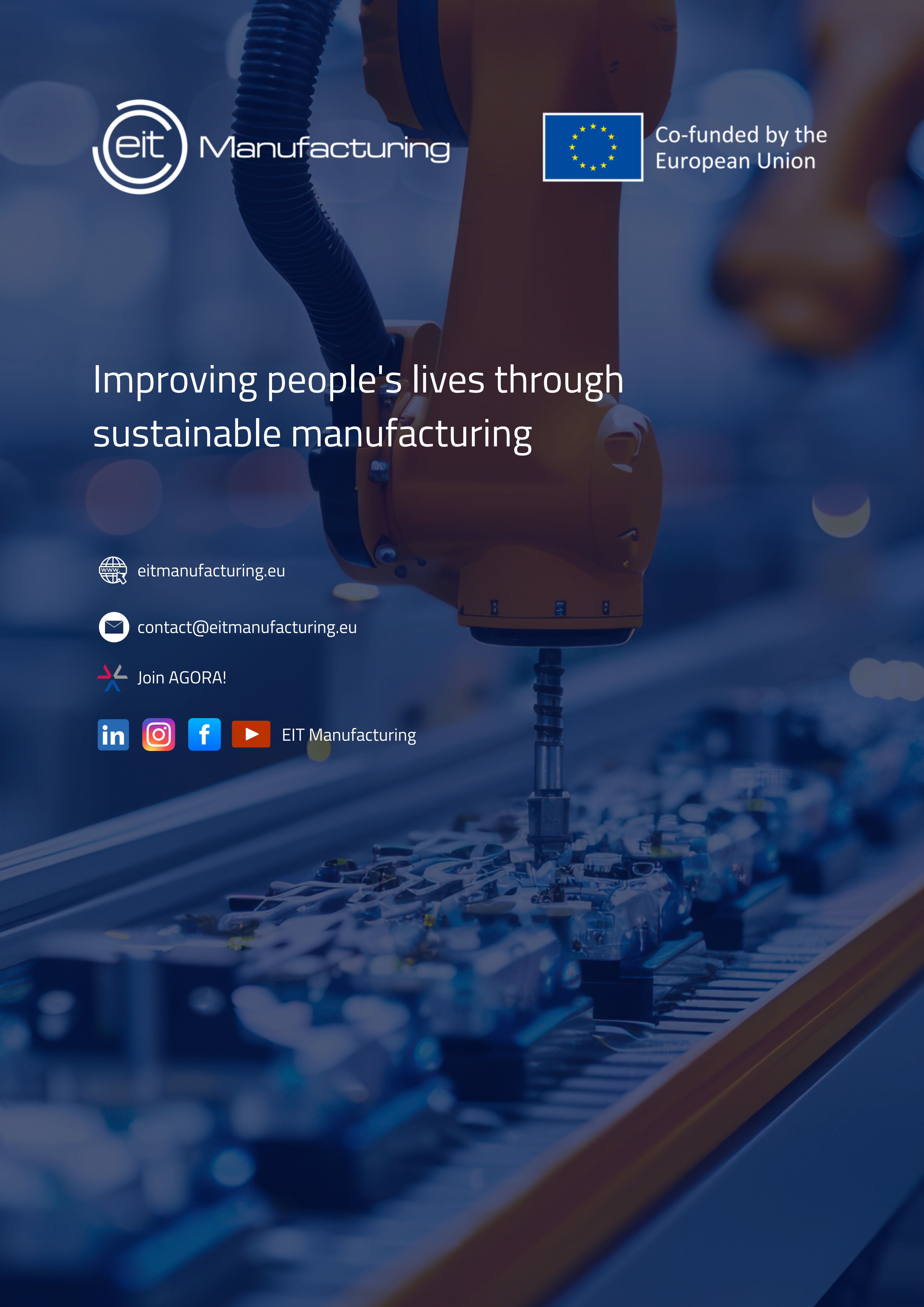
The 10 cross-sector priorities identified in this report are not isolated technical themes; they represent the core transformation levers required to ensure that European industry remains competitive, resilient and capable of scaling innovation. Lightweight and sustainable products, digitalised factories, intelligent automation, decarbonised processes, circular value chains, resilient supply networks and human-centric work environments together define the blueprint for the next generation of manufacturing.

Innovation is therefore not optional — it is the decisive factor that determines whether Europe leads in industrial transformation or follows it. Converting research excellence into scalable production systems, integrating AI and advanced automation into real factories, securing trusted data infrastructures and embedding circularity into value chains are the true differentiators of competitiveness in the coming years.

At the same time, no single actor can deliver this transformation alone. The complexity of today's industrial ecosystem requires coordinated action across corporates, startups, SMEs, research organisations, investors and public institutions. Skills, infrastructure, financing and technology must evolve together. The transition demands not only technological advancement, but also stronger ecosystem coordination — more effective collaboration models, faster knowledge diffusion and closer alignment between industrial needs and solution providers.

Europe's manufacturing strength has always been rooted in its industrial base, engineering talent and collaborative networks. Reinforcing and activating this ecosystem is essential to accelerate market uptake, de-risk industrial deployment and build sustainable competitive advantage.

The path forward is clear: targeted innovation, scaled industrial adoption and a connected ecosystem working toward shared priorities. By aligning action around the strategic domains identified in this report, European manufacturing can turn today's pressures into a catalyst for renewal — strengthening its global position while delivering sustainable value for industry and society.



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