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FORESIGHT
The Futures of Artificial Intelligence: Implications for Europe's R&I Ecosystem

Part 5: Final report

Independent Expert Report

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The Futures of Artificial Intelligence: Implications for Europe's R&I Ecosystem

Part 5: Final report

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2026 Directorate-General for Research and Innovation

Executive Summary

The study "Futures of AI: Implications for Europe's R&I Ecosystem and EU Policy" explores plausible trajectories of artificial intelligence (AI) development and assesses their implications for Europe's research and innovation ecosystem. It aims to inform EU R&I policy and contribute to the development of an AI, recognising AI as a technology with transformative potential across sectors and long-term structural consequences for investment, governance and strategic direction.

Method & Approach

The study follows a structured progression from evidence to futures to strategic orientation. It begins with an empirical mapping of AI development trends and adoption patterns across the EU, supported by an original AI taxonomy and sectoral analysis of uptake and barriers (see sections 2 and 3 in this report). This evidence base is complemented by a mixed-methods approach combining quantitative data sources, expert surveys and qualitative interviews.

Building on this foundation, a participatory foresight process develops three scenarios for AI development to 2040: EU attached to foreign AGI/ASI Networks, EU AI Leadership and a global AI Winter (see section 4). These scenarios are analysed using the TOSA framework and further explored in a sense-making workshop with policymakers to identify robust strategic orientations across all three scenarios. The study concludes with policy-relevant opportunities for action derived from this analytical process (section 5).

Key Findings

AI development is characterised by uncertainty, path dependencies and competing trajectories rather than a single predictable pathway.

AI adoption in the EU remains uneven and relatively low, with higher uptake in digitally mature and data-intensive sectors such as ICT and professional services; sectors like manufacturing and construction lag behind. Where AI is deployed, it is primarily used in supportive roles rather than as a transformative force reshaping core business models.

Future adoption trajectories diverge across sectoral profiles, ranging from deep integration in innovation-led sectors to incremental optimisation in operational sectors and largely supplementary use in service-oriented sectors.

Several structural barriers constrain broader diffusion, including market fragmentation, the dominance of SMEs with limited resources, insufficient access to high-quality and interoperable data and shortages of skilled professionals, while investment levels remain fragmented and comparatively modest. On the other side, ethical, security and trust concerns continue to shape adoption decisions.

The EU's regulatory leadership, particularly through the AI Act, creates both opportunities for trust-building and risks of administrative burden if implementation is not carefully managed.

Opportunities for Action

The study identifies three overarching areas for action.

1. **Strengthening anticipatory governance capacities to navigate persistent uncertainty.** This involves developing flexible institutional mechanisms capable of responding to rapid technological change, embedding monitoring and foresight tools within policy and decision-making processes, and enhancing AI literacy across society. Informed citizens, policymakers and institutions together build the resilience needed to govern AI effectively in dynamic and unpredictable environments.
2. **Enhancing European competitiveness through broader and deeper AI adoption across sectors.** This requires strengthening digital, data and compute infrastructures as foundational enablers, promoting sector-specific AI solutions tailored to European industrial strengths, and enabling experimental governance approaches that accelerate responsible innovation. Building trustworthy and robust AI systems ensures that competitiveness advances hand in hand with accountability and societal confidence.
3. **Shaping a distinct European pathway for AI that builds on trust, sustainability and public interest.** This includes investing in education and humanistic competencies, aligning AI with environmental goals, fostering innovation ecosystems and cultural engagement, strengthening technology diplomacy and supporting public–private collaboration within a European AI ecosystem across all Member States.

Together, these areas emphasise the need to actively shape AI as a socio-technical field. For R&I policy, this highlights that a successful AI strategy extends beyond technological development and depends on coordinated policy action, shared infrastructures, and a common societal vision.

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List of Abbreviations

AI:	Artificial Intelligence
AIT:	Austrian Institute of Technology
AGI:	Artificial General Intelligence
ASI:	Artificial Superintelligence
EU:	European Union
EuroHPC JU:	European High Performance Computing Joint Undertaking
EC:	European Commission
EWCS:	European Working Conditions Survey
FOD:	Foresight on Demand
GAN:	Generative Adversarial Networks
GenAI:	Generative Artificial Intelligence
ICT:	Information and Communications Technology
LLM:	Large Language Model
NACE:	Nomenclature statistique des activités économiques dans la Communauté européenne
NLP:	Natural Language Processing
OECD:	Organisation for Economic Co-operation and Development
PATSTAT:	Patent Statistical Database of the European Patent Office
R&I:	Research and Innovation
R&D:	Research and Development
SME:	Small and Medium-sized Enterprises
SWOT:	Strength, Weaknesses, Opportunities and Threats
TOSA:	Threats, Opportunities, Stakes and Actions
US:	United States (of America)
VA:	Visionary Analytics
VAE:	Variational autoencoders

1. Introduction

Artificial Intelligence (AI) has moved rapidly from a specialised field of research into a widely discussed and increasingly deployed set of technologies. New applications are emerging across society, from industry and public administration to science and everyday life and expectations about AI's transformative potential are high. At the same time, it remains difficult to determine how these changes will unfold. Currently, AI is widely understood as a general-purpose technology with transformative potential across different industry sectors, from manufacturing and energy to healthcare, education and public administration. Within these sectors, we already find different approaches to adaptation and even different applications that become subsumed under the term "AI". Recent developments — including the rise of Generative AI (GenAI), Large Language Models (LLMs) or emerging AI Agents — have created new applications almost on a weekly basis and with these applications also new potentials for the deployment in different industries. At the same time, the discourse often overemphasises on certain technological paradigms, particularly LLMs by companies like ChatGPT or Claude, even though AI encompasses a much broader and more heterogeneous set of technologies.

These developments among others have led to turbulent dynamics: Hypes among investors, intensified public attention and a geopolitical race for the ultimate Artificial General Intelligence (AGI) that promises to serve as an all-purpose solution for different industry sectors. In this environment, the current debates oscillate between optimism about rapid progress and concerns about overinvestment and inflated expectations, while technological advances continue at an increasing pace and shifts the face of the technology. In the EU, the rapidly evolving AI landscape makes its future development highly unpredictable. On the one hand, there are clear indications of increasing uptake and integration across sectors. On the other hand, there are growing concerns about overinvestment and the possibility of a correction or "AI winter". These signals coexist without converging into a stable direction. Understanding how to navigate this tension between the growing and ongoing adoption of AI while the future trajectories remain unclear becomes the central challenge for policymakers and industry alike. In such a context, the question is no longer which single trajectory AI will follow but how to act under conditions of uncertainty and competing technological pathways.

The study on "Futures of AI: Implications for Europe's R&I Ecosystem and EU Policy" was commissioned under the Foresight on Demand (FOD) framework contract to explore plausible trajectories of AI and their implications for Europe's R&I ecosystem. It aims to inform EU R&I policy and contributes to the development of an AI in Science strategy.

Methodologically, the study follows a progression from evidence to futures to strategic orientation. Chapters 2 and 3 establish the empirical foundation by mapping the current state of AI development and adoption in Europe. Chapter 2 introduces a taxonomy of AI that captures both technical characteristics and application domains, while Chapter 3 analyses the current uptake of AI across sectors and identifies key barriers to wider diffusion. A central finding is that AI adoption in the EU remains uneven and overall, relatively low, reinforcing the importance of focusing on deployment conditions and sector-specific applications.

Building on this foundation, Chapter 4 employs foresight methods to explore alternative AI futures for the year 2040 through a participatory scenario process. Across the scenarios, a recurring theme is the difficulty of maintaining strategic orientation in a rapidly evolving and uncertain technological landscape. The scenarios highlight different possible pathways through which Europe might position itself, including a future in which EU remains attached to a transnational AGI network, a future in which Europe leads a unique AI revolution and a third future in which AI funding and thus development comes to a halt. Through a Sense-Making workshop together with Policy Officers from the EC, these scenarios have been thoroughly discussed and translated into strategic actions that need to be taken to be prepared for all possible outcomes.

The study concludes with a set of opportunities for actions to shape the EU AI R&I policy for the future. Among others, these opportunities highlight the importance of strengthening Europe's capacity for AI adoption, fostering cross-border ecosystems, investing in skills and infrastructures and promoting a distinct European approach to AI that combines technological capability with societal values.

2. Mapping the State of the Art in AI

This chapter provides an overview of AI development at the time of writing (2025) captured through a review of empirical indicators of technological change and patterns of adoption across industries.

At EU level, the Union has positioned itself as a global AI leader through a comprehensive policy mix combining strategic vision, regulation and investment, including the Digital Decade, European Data Strategy, AI Act and the objective of making Europe the "AI continent." This framework is supported by substantial funding under Horizon Europe, targeted at trustworthy, human-centric and competitive AI, alongside infrastructure initiatives such as EuroHPC AI Factories that integrate computing power, data and talent.

At Member State level, AI policies expanded rapidly between 2015 and 2019, with national strategies and AI enablers dominating the policy mix, complemented by significant financial support and more limited but growing regulatory and ethical guidance.

Against this backdrop, the chapter examines key trends in AI development, highlighting shifts in the institutional focus of innovation, the growing importance of data, compute and capital and the increasing role of industry actors in driving technological progress. These dynamics are further analysed through a review of selected empirical indicators that capture developments in research, model production, patents, investment and infrastructure constraints.

For a systematic approach the chapter introduces an AI taxonomy that provides a coherent framework for classifying technologies, capabilities and application domains. This taxonomy enables a more granular understanding of how different strands of AI development relate to one another and supports consistent analysis across domains.

For a deeper insight into the study, see deliverable one "The futures of artificial intelligence: Implications for Europe's R&I ecosystem. Part I: A taxonomy for artificial intelligence: Technology trends, capabilities and applications" (Strauka et al. 2025).

2.1. New developments in AI

The number of newly released "notable" machine-learning models serves as a useful indicator of the pace and direction of AI development, even if only a small share of these models represents genuine state-of-the-art advances. Over time, the institutional focus of innovation has shifted significantly. Until around 2014, academia played a leading role in producing influential models, whereas subsequent years have seen a clear dominance of industry actors. This shift is reflected in recent output figures: in 2023, industry produced 51 notable machine-learning models, compared to 15 from academia, alongside a record 21 models developed through industry–academia collaboration (Maslej et al. 2023).

This transformation is closely linked to the changing resource requirements of cutting-edge AI development. The creation of advanced models increasingly relies on access to very large datasets, high-performance computing infrastructure, substantial financial investment, and highly specialised talent. These conditions favour technology companies, which are better positioned to mobilise and integrate such resources at scale, thereby reinforcing these companies' central role in shaping the trajectory of AI innovation.

The following indicators also provide a snapshot of global AI developments:

1. Publications: In terms of AI research, between 2010 and 2022, the total number of AI publications nearly tripled, rising from approximately 88,000 in 2010 to more than 240,000 in 2022. Machine learning publications have seen the most rapid growth over the past decade, increasing nearly sevenfold since 2015 (Maslej et al. 2023).
2. AI models: The number of advanced AI models has grown steadily, with industry overtaking academia as the main source of leading machine learning models since 2014. The number of foundation models has risen sharply. This growth highlights a clear distinction between open-source models that aim to democratise AI through broad access and collaboration and proprietary models that focus on market positioning and commercial performance, with both approaches contributing differently to technological advancement (Maslej et al. 2023).
3. Between 2014 and 2023, around 9700 patent families in GANs have been published. Variational autoencoders (VAE) and LLMs are the second and third largest models in terms of patent families with 1800 and 1300 new patent families respectively between 2014 and 2023.
4. Private investments: private investment in AI has been increasing since 2013 (with a short decline in the years 2021-2023) (Maslej et al. 2023).

In terms of specific technological developments:

a. For Generative Artificial Intelligence (GenAI) the value chain is largely dominated by a few major US players, while China is in the race for global leadership and holds a dominant position. Europe’s technology sovereignty and its economic and geopolitical development and leadership are at stake. GenAI disruption is also an opportunity for Europe to provide alternatives to foreign technologies (European Commission, 2025b).

b. In 2023, a total of 149 foundation models were released, more than double the number released in 2022. Of these newly released models, 65.7% were open-source, compared to only 44.4% in 2022 and 33.3% in 2021.In 2023, 61 originated from US-based institutions, 21 from the EU, and 15 from China. However, on 10 select AI benchmarks, closed models outperformed open ones, with a median performance advantage of 24.2% (Maslej et al. 2023).

The figure below summarises the technological research and development trends in AI captured through desk research. In short, these trends encompass the core technical components of AI: (Machine learning (including neural networks), NLP and key AI components), aspects related to the use of AI (Governance & Ethics & Safety) and how and where the AI can be used (AI capabilities and application areas.

Table 1 – High-level overview of the key AI technological trends

Machine Learning, NLP and key AI components	Governance & Ethics & Safety	AI capabilities & application areas
• Feature Engineering • Machine learning • Natural Language Processing • Networks • AI Systems and Platforms	• AI Safety & Risk Management • AI Ethics & Fairness • AI Governance & Policy	• Emotion & Face recognition and creation • Image & object recognition and creation • Speech & voice recognition and creation • Forecasting, planning, recommending • Autonomous systems (ability to change behaviour in response to unexpected events / change) • AI integration / interaction with other systems and platforms across private and public sector and use cases

Nevertheless, both the private and public sectors face several barriers related to the development of AI. Figure below provides a snapshot of different barriers.

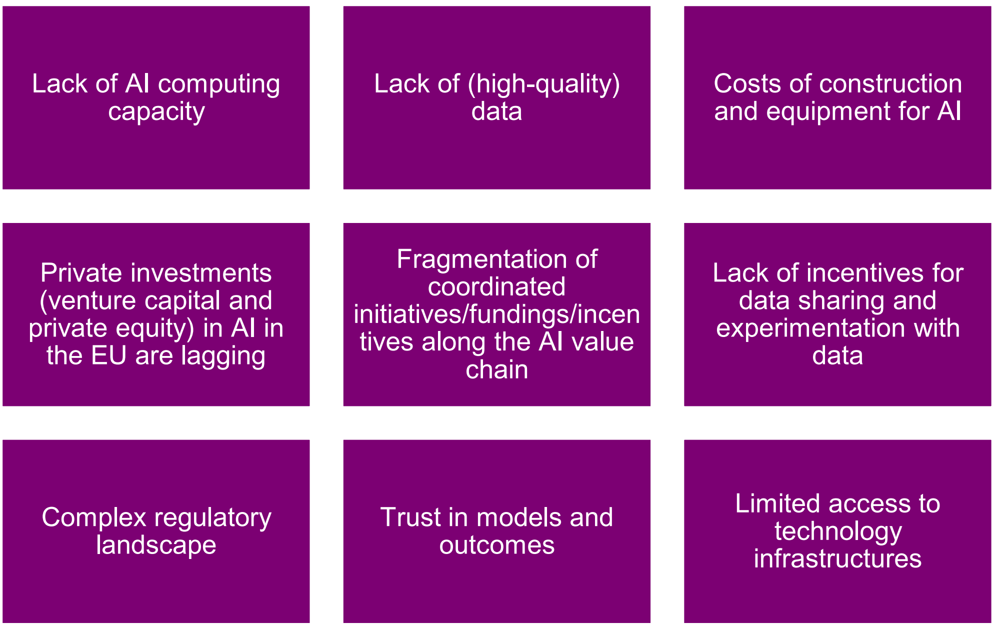

Figure 1 – Barriers related to the development of AI

2.2. Towards an AI Taxonomy

Building on the aspects outlined above, a more fine-grained analytical structure is required to systematically capture the diversity of AI technologies and their applications. Developing a robust AI taxonomy therefore involves accounting for both technical dimensions (such as machine learning approaches) and the capabilities and sectors, in which AI systems are deployed. This section introduces an AI taxonomy designed to organise this complexity across technical approaches, functional capabilities and domains of application. The taxonomy serves as both a conceptual and methodological tool, enabling consistent classification, comparison and mapping of AI-related developments.

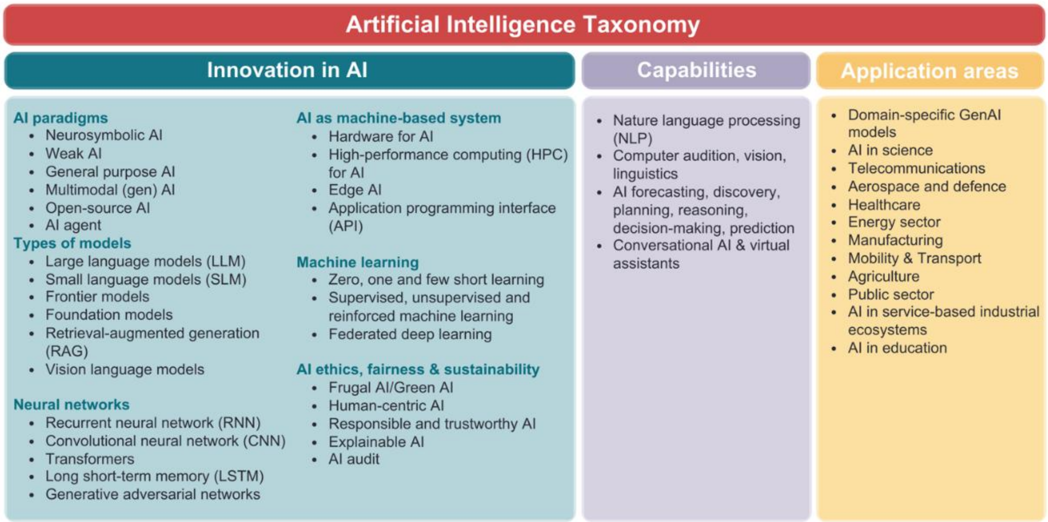

Figure 2 – High-level overview of the proposed AI taxonomy

This taxonomy is a framework that should be updated periodically to reflect the rapid evolution of AI technologies, methods, and application domains. Given the breadth and interconnected nature of the AI field, certain items may appear relevant to more than one category. Such overlaps are intentional and reflect the reality that AI sub-fields do not exist in isolation: a technique developed as a foundational innovation may simultaneously function as a capability and find expression across multiple application areas.

The AI taxonomy was developed through a rigorous, multi-step and iterative methodology combining desk research, data science techniques and expert validation. The steps were:

I. Reviewed existing AI taxonomies, typologies and frameworks to evaluate scope, detail and cross-domain relevance.

II. Compiled a representative corpus of foresight studies, scientific literature and policy sources; consolidated all data into a single database to ensure consistency and avoid duplication.

III. Applied text-mining to extract and organise AI-related keywords, forming the initial AI taxonomy for technology development and adoption.

IV. Conducted expert review to verify that the taxonomy clearly distinguishes AI from adjacent domains, refining keywords and definitions accordingly.

V. Expanded and updated the keyword set using additional sources, followed by final human validation and manual reclassification to ensure accuracy and relevance.

2.3. AI uptake

Current evidence shows that AI uptake remains uneven, with consistently higher adoption rates in ICT and professional services. These sectors benefit from complementary assets such as a digitally skilled workforce and advanced digital infrastructure, which facilitate the integration and scaling of AI systems. More specifically:

1. AI adoption has accelerated globally, with 55% of organisations using AI in at least one function in 2023, up from 20% in 2017 (Maslej et al. 2023).
2. In the EU, AI use also rose sharply in 2024, with 13.48% of enterprises and self-employed adopting technologies such as machine learning, natural language processing, image recognition and AI-driven automation (Eurostat, 2025).
3. AI adoption differs markedly across economic activities, indicating that its relevance and impact are highly sector-specific rather than uniform across the economy. Globally, financial services show particularly strong uptake, with robotic process automation used in 46% of organisations, while across all industries, the most commonly embedded AI capabilities are natural language text understanding, robotic process automation and virtual agents, each used by around 30% of firms.

Overall, AI uptake remains concentrated in ICT-intensive and knowledge-based services, reflecting the importance of complementary assets such as advanced digital infrastructure, skilled workforces, training capacity and strong firm-level digital capabilities in enabling effective AI deployment (Calvino et al. 2024).

At the same time, the broader diffusion of AI across industries is still unfolding, reflecting its early stage as a general-purpose technology. Alongside these adoption patterns, emerging AI developments place increasing emphasis on addressing challenges related to data privacy, security and explainability. Taken together, these dynamics situate AI development within wider economic and organisational contexts, offering insight into how its transformative potential materialises in practice and which conditions shape its trajectory. In the following chapter, the uptake of AI within the EU will be moved into focus.

3. Current state of AI uptake across the EU and projected trajectories

This chapter provides an overview of the current state of AI adoption across the EU in different economic sectors as well as projected trajectories for AI uptake over the next five years (2025–2030). It also examines the cross-cutting barriers to AI adoption across the EU and outlines recommendations to support the acceleration of AI uptake. For a deeper insight into this topic, see also the deliverable 2 "Mapping the Current State of Adoption in The European Industrial Landscape" (Martinaitis et al. 2026a) and deliverable 3 "A Forward-Looking Analysis of European Industries' Artificial Intelligence Use" (Martinaitis et al. 2026b).

3.1. Method

This task adopts a multi-source, mixed-methods approach to assess the current uptake of AI across the EU and to project its potential evolution over the period 2025–2030.

Data sources

The analysis draws on several complementary data sources. Crunchbase startup data were used to identify emerging AI companies across sectors, their activities and funding levels, while PATSTAT provided data on AI-related patent filings in the EU. The EU Survey on ICT Usage and E-commerce in Enterprises offered indicators on AI adoption patterns and perceived barriers. Additional ecosystem insights were obtained from the OECD AI Policy Observatory, which provides cross-country data on AI workforce dynamics and investment flows and from DESI indicators, which measure population-level digital skills. Workplace-level use of digital technologies was examined using the European Working Conditions Survey (EWCS) data. These sources were complemented by bibliometric analysis of scientific publications and industry reports, an AI experts' survey (conducted by VA in May 2025) and semi-structured interviews with sectoral experts to provide additional qualitative insights.

Data classification and analytical methods

To enable cross-sectoral analysis, the collected data were mapped to NACE economic sectors[1]. To assess the level of AI adoption across sectors, the study developed a sectoral scoring framework structured along two core dimensions:

- Prevalence measures the spread and intensity of AI use across firms and innovation ecosystems[2].
- Centrality captures whether AI plays a strategic, value-creating role within sector activities[3].

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[1] In some cases, particularly for startups and scientific publications, sectoral classification was not directly available and had to be inferred from textual descriptions.

[2] Based on six indicators: (i) the share of enterprises using AI (EU ICT enterprise survey), (ii) AI-related patents by NACE sector, (iii) AI start-ups by sector (e.g., Crunchbase), (iv) expert interview assessments of prevalence, (v) expert survey ratings of adoption levels and (vi) AI-related academic publications (bibliometrics).

[3] Based on five indicators: (i) enterprise-level adoption of AI systems (EU ICT enterprise survey), (ii) international co-authorship (as a proxy for embeddedness in high-capability knowledge networks), (iii) interview-based assessments of centrality, (iv) AI strategic positioning in industry reports and (v) expert survey ratings of AI's strategic importance. It

For each sector, an average score was calculated for both dimensions and rounded to the nearest whole number. The resulting scores were used to position sectors on a prevalence–centrality matrix (see next sub-section).

To reflect functional differences in how industries deploy AI, sectors were grouped into three functional adoption profiles based on where AI is concentrated along the business value chain:

- Innovation-led adopters, where AI is primarily used in R&D, product development and customer-facing functions[4];
- Operational core adopters[5], where AI is concentrated in production, infrastructure management and cybersecurity; and
- Service envelope adopters[6], where AI is mainly used for internal coordination, logistics and administrative support.

The maturity assessment was combined with the sectoral adoption profiles described above, allowing the research team to develop forward-looking projections of AI adoption trajectories across sectoral clusters.

3.2. Current state of AI update across the EU

AI adoption across EU sectors is closely linked to the availability of large, high-quality datasets and digital maturity. According to the Eurostat ICT Survey data (2021–2024), AI technologies are most widely adopted in digitally advanced and data-rich sectors, including information and communication, professional and scientific services and wholesale and retail. Meanwhile, sectors such as manufacturing, water supply and construction, continue to report low levels of adoption, with only modest improvements in recent years (see Figure 3).

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[4] Include sectors such as such as information and communication, professional and scientific services, human health and education.
[5] Include sectors such as manufacturing, electricity, gas, steam and air conditioning supply, transportation and storage, financial and insurance activities and construction.
[6] Including sectors such as wholesale and retail trade, accommodation and food services, administrative and support services and arts and entertainment.

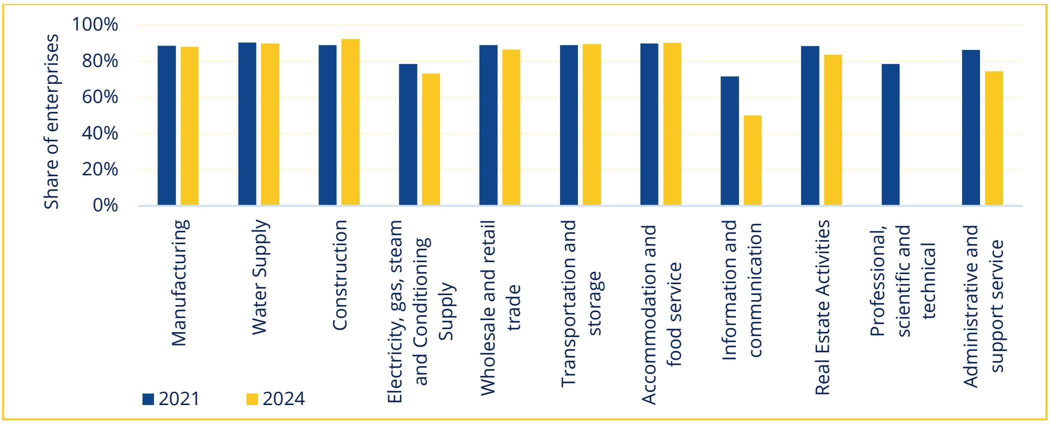


Figure 3 – Share of EU enterprises (with at least 10 employees) NOT using AI technologies by sector (Source: Visionary Analytics based on the Eurostat ICT Survey Data)[7]

While AI adoption across European sectors is growing, it remains largely supportive rather than transformative, typically enhancing efficiency, decision-making, or specific functions rather than redefining core business models. Expert survey data indicate that only a small number of businesses have put AI at the centre of most processes. To date, most enterprises use AI irregularly and only for specific functions.

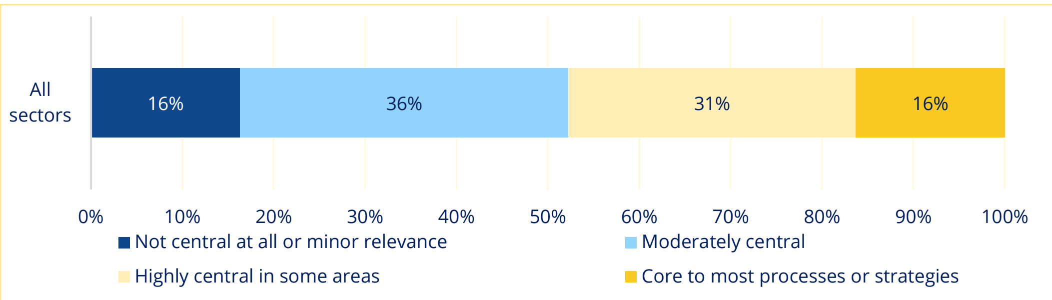


Figure 4 – AI centrality across all sectors (Source: Visionary Analytics based on the expert survey data (2025 May 7-20) N=427)

Building on the differences in adoption and functional use of AI, sectors were systematically assessed using the prevalence–centrality scoring framework[8]. The table below shows uneven AI adoption across sectors, with some leading, many progressing gradually and others in early experimentation, highlighting where policy or investment could support broader diffusion.

[7] Note: The data for Professional Scientific and Technical services is available only for 2021. The indicator measures the adoption of the following AI technologies: Enterprises do not use any of the AI technologies: AI_TTM Text Mining), AI_TSR (Speech Recognition), AI_TNLG (Natural Language Generation), AI_TIR (Image Recognition), AI_TML (Machine Learning), AI_TPA (Process Automatisation), AI_TAR (Autonomous Robots).

[8] See methodological approach above.

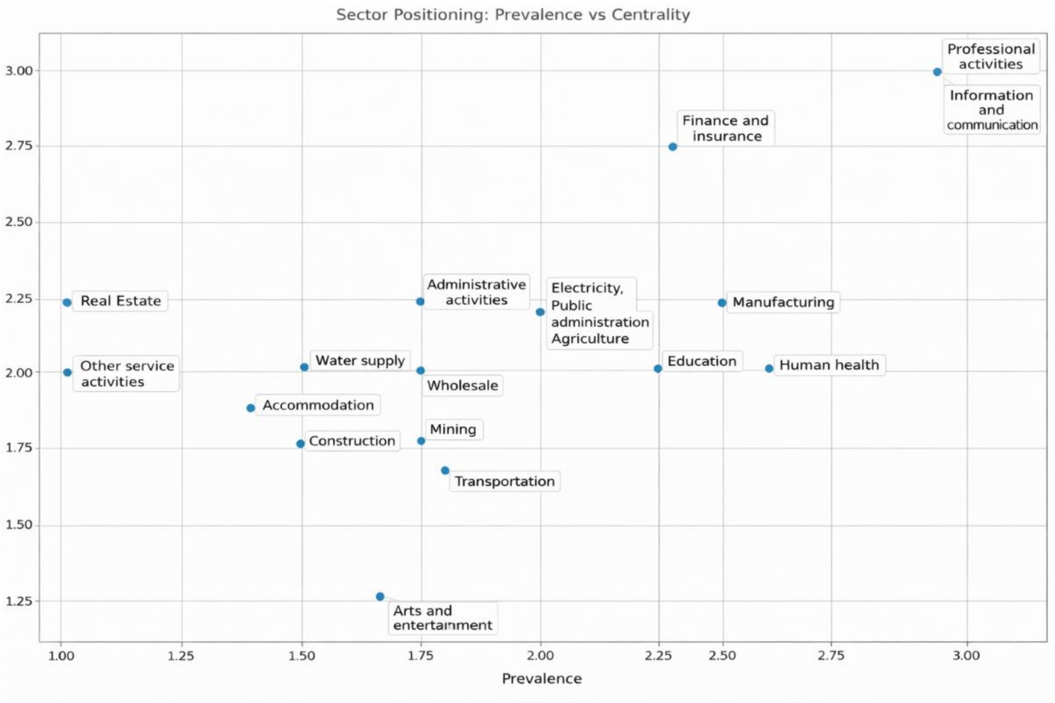


Figure 5 – Scoring of AI uptake across the sectors [9] [10] [11]

Note: Prevalence measures the spread and intensity of AI use across firms and innovation ecosystems (constructed based on six indicators). Centrality captures whether AI plays a strategic, value-creating role within sector activities (constructed based on five indicators). For more details, see Section 3.1. In absolute terms, the centrality and prevalence of AI remain low in the EU. This index provides a relative ranking of sectors on a scale from 1 to 3.

[9] Insufficient data (1 expert response, no papers or reports) prevented development of a robust sectoral profile for the sector U – Activities of extraterritorial organisations and bodies Further desk research may be conducted upon request.

[10] A – Agriculture, forestry and fishing; B – Mining and quarrying; C – Manufacturing; D – Electricity, gas, steam and air conditioning supply; E – Water supply, sewerage, waste management and remediation activities; F – Construction; G – Wholesale and retail trade; repair of motor vehicles and motorcycles; H – Transportation and storage; I – Accommodation and food service activities; J – Information and communication; K – Financial and insurance activities; L – Real estate activities; M – Professional, scientific and technical activities; N – Administrative and support service activities; O – Public administration and defence; compulsory social security; P – Education; Q – Human health and social work activities; R – Arts, entertainment and recreation; S – Other service activities.

[11] Note: *Substantially confirmed by data: Data is fully or moderately available for at least 8 out of 11 indicators.
**Interpret with caution due to moderate/limited data availability: Data is fully or moderately available for at least 5 but fewer than 8 indicators.
***Evidence incomplete - limited support due to the data gaps: Data is fully or moderately available for fewer than 5 out of 11 indicators.

3.3. Projected trajectories of AI Adoption across the sectoral clusters (2025- 2030)

AI adoption trajectories diverge across three sectoral profiles:

Innovation-led sectors

First, innovation-led sectors are expected to move from using AI as isolated tools to embedding it deeply within their core operational systems by the end of the decade. Because these sectors already apply AI across multiple functions, the main challenge is not adoption but the depth and pace of integration, which will depend on managing cultural biases, ensuring sufficient financial resources and navigating regulatory and data-sovereignty constraints.

Over the coming years, AI is likely to become more integrated across organisational functions, supported by hybrid and distributed infrastructures that enable low-latency decision-making and greater operational autonomy. In areas such as ICT, professional services, healthcare and education, organisations are already moving toward unified platforms that combine knowledge management, decision support and operational coordination. At the same time, widespread deployment will generate new data and practices that reinforce innovation through a feedback loop, accelerating sectoral progress.

This shift is particularly important for sectors that require low-latency decision-making, such as telecommunications and healthcare and is also driven by concerns over data sovereignty, costs and system resilience. As these infrastructures mature, service delivery may become increasingly autonomous. Another key dynamic is the feedback loop between adoption and innovation: each deployment generates new data, benchmarks and operational practices that further improve AI systems and expand their potential applications. However, this transition will depend on building organisational trust, securing stable investment and establishing clear regulatory and ethical frameworks. Where these conditions are met, innovation-led sectors are likely to pioneer governance models and technical standards that can influence AI adoption across the wider economy by 2030.

Operational core sectors

Operational core sectors will continue expanding AI primarily within specific operational functions rather than undergoing system-wide transformation. The most plausible trajectory is the gradual deepening of AI-driven optimisation in existing processes, particularly in areas where large volumes of operational data are already available and efficiency gains are clear.

In sectors such as manufacturing, aviation, mining and utilities, AI is likely to further support tasks such as predictive maintenance, anomaly detection, supply chain forecasting and operational monitoring. Across infrastructure and resource-based sectors, such as energy supply, AI adoption is expected to expand in areas such as grid balancing, asset management and monitoring of environmental or operational risks. However, the integration of AI must be balanced with strict protection of critical infrastructure information and personal data, which can slow down deployment.

Other sectors, such as construction and transport, are likely to adopt AI more gradually, as adoption will depend heavily on infrastructure renewal, sensor networks, connectivity and supportive public policies such as procurement incentives. Overall, operational core sectors are not resistant to AI adoption but operate under constraints such as long investment cycles, high safety and regulatory requirements and the unavailability of certain techniques. As a result, their trajectory is likely to be characterised by incremental optimisation rather than disruptive transformation. Progress will depend less on technical breakthroughs and more on reducing the cost and complexity of integration, enabling organisations to scale-proven AI applications across their operational environments.

Service-envelope sectors

In service-envelope sectors, AI adoption will largely remain supplementary, supporting efficiency improvements in routine functions such as scheduling, customer interaction, marketing and document processing.

Much of this diffusion will occur indirectly through third-party solutions, including SaaS platforms, booking systems and enterprise software providers, which will act as the primary channels through which businesses access AI capabilities. Despite this generally modest trajectory, some areas present opportunities for selective innovation. In real estate activities, AI is likely to enable more intelligent property management and space utilisation.

Generative AI tools may also enhance customer-facing services by allowing potential tenants or buyers to visualise customised property layouts, interior styles, or renovations in real time. In arts, entertainment and related creative industries, AI could play a more transformative role due to the convergence of generative AI, digital platforms and immersive media technologies.

The overall trajectory of service envelope sectors will remain gradual and uneven. Structural constraints such as fragmented markets, weaker data infrastructures and limited investment capacity will continue to slow deeper AI integration. Consequently, these sectors are likely to lag behind innovation-led and operational core industries in terms of systemic AI transformation. Their contribution to the broader AI landscape will instead lie in niche applications and user-facing innovations that may later diffuse into other sectors of the economy.

The figure below summarises projected trajectories of AI adoption across the three functional profiles.

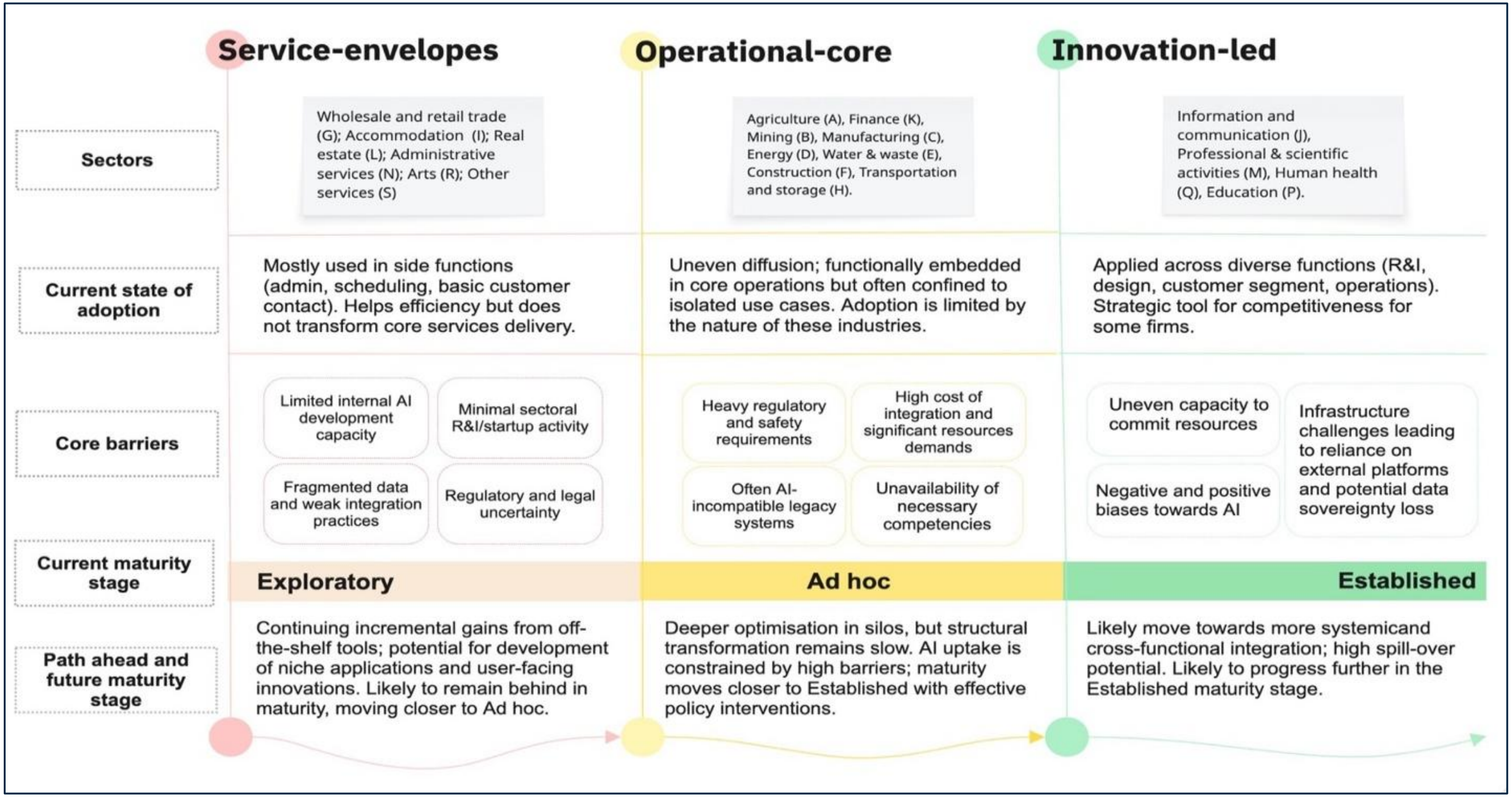


Figure 6 – AI sectoral trajectory outlook

3.4. Cross-cutting barriers

The analysis has identified several interrelated barriers that collectively shape the pace and scale of AI development and deployment across European sectors.

One of the main structural obstacles to AI adoption is EU **market fragmentation**. Member States operate under different regulatory regimes, languages and industrial structures, complicating the scaling of AI solutions across borders. The dominance of SMEs, accounting for over 99% of EU businesses, further limits adoption, as many lack the financial and technical capacity to invest in advanced AI systems. Unlike the US and China, Europe also lacks globally dominant digital platforms that provide large-scale computing infrastructure, datasets and innovation ecosystems. Linguistic diversity adds further complexity, particularly for AI applications based on NLP, which must be adapted to multiple linguistic contexts.

Another challenge concerns **access to high-quality, interoperable data** and the development of robust algorithmic capabilities. Across sectors, organisations frequently report that available datasets are fragmented, poorly structured, or insufficiently labelled for AI use. Data scarcity is particularly pronounced in sectors where privacy or security concerns restrict data sharing, such as healthcare or education. To address these limitations, European organisations are increasingly exploring data-efficient AI approaches, such as transfer learning and hybrid AI architectures, which can operate effectively with smaller or distributed datasets.

Human capital shortages represent another persistent barrier. Although the EU maintains strong academic and research capabilities, it faces a comparatively limited pool of AI-skilled professionals and an uneven geographical distribution of talent. AI expertise is concentrated in a few innovation hubs, while many Member States struggle to retain or attract specialised professionals. This uneven technological foundation limits the diffusion of advanced AI applications and highlights the need for sustained investment in education and interdisciplinary skills combining technical, regulatory and domain expertise.

Investment in AI research and development has grown rapidly but remains fragmented and comparatively modest compared to the corporate investment capacity of the US or the state-driven financing strategies of China. Although recent initiatives, such as the EU's large-scale AI investment programmes and national funding commitments, seek to address this gap, access to financing remains uneven, particularly for smaller firms and emerging innovators. In addition, many enterprises face significant challenges integrating AI into existing technological environments due to high deployment costs.

Ethical, security and trust considerations remain central to the adoption of AI systems across the EU. Concerns about privacy, data protection, algorithmic bias, intellectual property rights and the explainability of AI decisions continue to influence organisational willingness to deploy AI technologies. These issues are especially significant in high-stakes sectors such as healthcare, education, finance and public services, where transparency and accountability are critical. As AI systems become more complex and capable, organisations must also address new cybersecurity risks associated with training data, model outputs and AI infrastructure.

Finally, **regulatory and governance frameworks** play a complex role in shaping AI development. The EU has taken a global leadership position through the adoption of the Artificial Intelligence Act, which establishes a comprehensive regulatory framework. While this approach aims to promote trust, accountability and protection of fundamental rights, it may also introduce compliance costs and administrative complexity, particularly for smaller firms. At the same time, a harmonised regulatory framework offers the potential to reduce legal uncertainty and support cross-border deployment of AI solutions across the Single Market if implemented effectively.

4. Scenario work and TOSA Analysis

This section presents three of the five scenarios that were also later used for the sense-making workshop. All scenarios and more details about the methodological approach can be found in deliverable 4: ‘Futures of Artificial Intelligence’ Scenarios and Opportunities of this project (Cuhls et al. 2026).

4.1. Method

In this project, opportunities and threats for the EU R&I ecosystem and key R&I policy actions for the EU and Member States should be identified with a time horizon until 2040. The methods used were a combination of a participatory scenario-building process called Scenario Sprint with a structured assessment and idea generation method (TOSA).

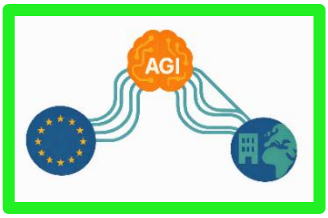
The Scenario Sprint (see example projects like EU Post Covid-19 Scenarios 2040 (Cuhls et al. 2022), Consumer Scenarios (Kimpeler et al. 2023) or Multistakeholder Scanning on behalf of the European Agencies (Cuhls et al. 2025)) is a morphological scenario approach that follows a systematic procedure to build a set of internally consistent, plausible futures. Possible scenarios have been co-created by participants – these were European Commission representatives and external experts on AI, AI application sectors, Foresight and the context of AI – through a facilitated, iterative process. The resulting scenarios are used as analytical ‘think pieces’ to open perspectives and stimulate strategic reflection. They describe possible futures, not desirable or exhaustive ones.

Following the scenario development, scenarios were described in a narration. Three of the scenarios were selected for the further work in a workshop, where a method called TOSA (Djuricic et al. 2025) was applied. The workshop was the interface to the sense-making workshop in Brussels.

4.2. Selected Scenarios ‘AI 2040’ and TOSA Analysis

The following sections give an overview of the three scenarios worked with in more detail.

4.2.1. Scenario A: EU attached to transnational global AGI and ASI networks



In 2040, AI technology is highly advanced and offers general intelligence (AGI) as well as superintelligence (ASI) beyond human understanding and control. A few globally operating technology companies and networks capitalise on AI-generated value. The EU makes itself attractive to receive the services of transnational AGI and ASI networks to the benefit of its economy and society from AGI’s and ASI’s superior capabilities.

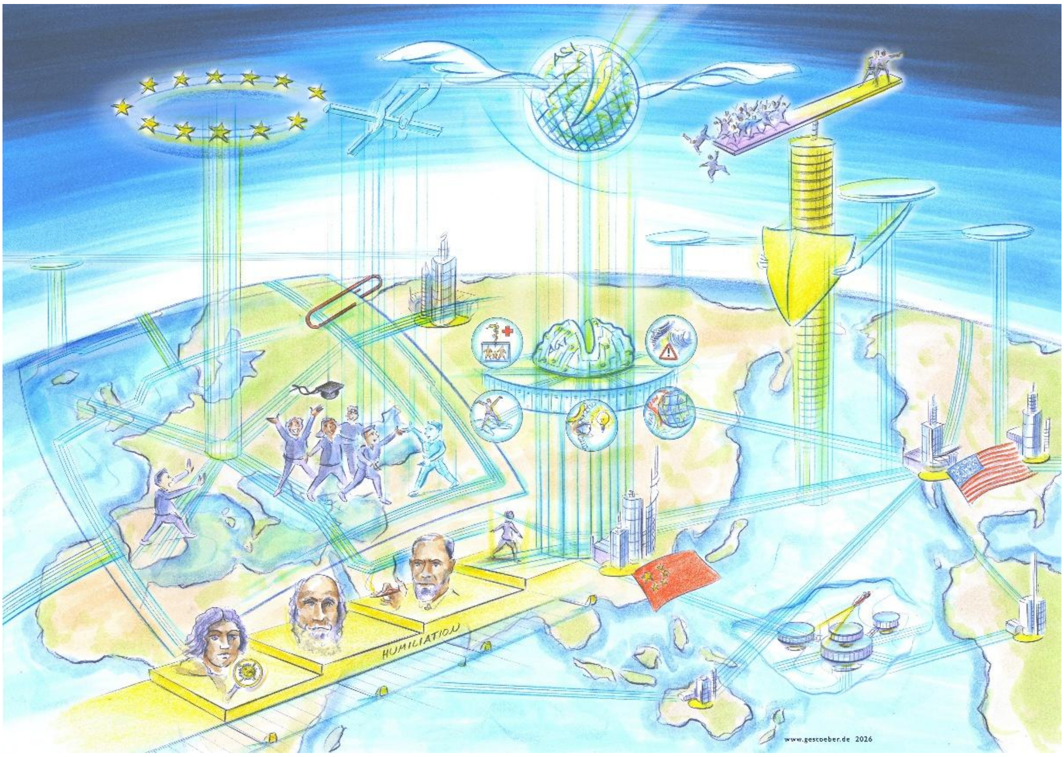
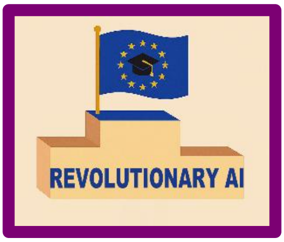


Figure 7 – EU attached to transnational global AGI and ASI networks (© Heyko Stöber)

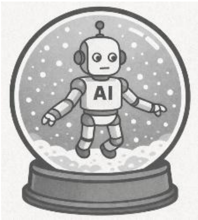
4.2.2. Scenario B: Europe leads a unique AI revolution



In 2040, the EU's AI technology is more innovative and useful than that developed and applied in other world regions. While other global AI powerhouses such as the USA and China are still locked in the insufficient returns of their huge investments into Large Language Models (LLM), the EU benefits economically and socially from its massive investments in education to create new AI paradigms that are hardly named, as development progress is so fast.

Figure 8 – Europe leads a unique AI revolution Europe leads a unique AI revolution (© Heyko Stöber)

4.2.3. Scenario C: Global AI Winter



In 2040, globally, the AI boom of the 2020s is over. The earlier shiny AI promises have not materialised in terms of substantial measurable economic returns and social benefits. By and large, AI technology and applications are as capable as 15 years earlier. The big investments in AI stopped in the late 2020s. AI industry is now mature with ever more shrinking benefits. AI development continues with a slow pace exploring future capabilities of novel AI hesitantly and carefully.

Figure 9 – Global AI Winter (© Heyko Stöber)

4.2.4. The TOSA analysis: Strength, Weaknesses, Opportunities and Threats

For each scenario, a TOSA analysis was conducted.

TOSA is a similar to a classical SWOT (Strength, Weaknesses, Opportunities and Threats) analysis but examines the following:

1. Threats: encompass the potential negative effects, impacts or (calculated) risks identified within a scenario. The purpose of identifying threats in the TOSA framework and Foresight exercise is to highlight vulnerabilities and areas where the current system is fragile, needs change or preparedness.
2. Opportunities: represent the potential positive outcomes, innovative solutions or areas for improvement that emerge in this context.
3. Stakes: are the critical elements or values that are challenged or are essential for the functioning of the system in the face of the identified threats or opportunities. Stakes can also be stakeholders and the stakes/ interests they have in the system, e.g. companies that have invested a lot in AI have big interests in profiting from AI. The purpose of defining stakes is to clarify what truly matters for EU policy and what needs to be changed, protected or re-stored.
4. Actions: are the concrete, implementable measures and strategies that should be developed to mitigate threats, capitalise on opportunities and address the identified stakes to figure out who would win or lose in this scenario.

The framework was applied in a workshop with members of the European Commission (different units and interdisciplinary perspectives) on December 8, 2025. We went through the different categories and discussed also long-term and short-term opportunities and potential activities. Some results were used during the moderation of the sense-making workshop to trigger the discussion about the scenarios and their implications. We had long-term and immediate threats and opportunities. Some of them require direct action now, others still have time. A more detailed summary of the results can be found in Cuhls et al. 2026.

Summary of main findings

There are different threats for the development of useful AI, some are exogeneous. A very recent danger is the loss of interest in AI investments because the expectations of fast new capabilities of AI and high profits were raised, and it becomes obvious that not all the promises will be fulfilled. What can be done in the case of an AI winter or stagnation? Is this really bad news?

On the other hand, AI offers many opportunities for new and existing applications) and innovation. One of the promises is to 'gain time' (which is impossible but means set time free for other purposes) or accelerate innovation or production or services. But this as well as overall productivity gains was doubted during the discussions – and like the promises for digitalisation, the 'time saving' or acceleration by AI is not yet empirically proven. It has to be decided, which pathway EU policy is choosing and what opportunities are practically realised.

Existing stakes are challenged by AI approaches, especially when it comes to an Artificial General Intelligence. As other regions of the world have different values, religious and cultural backgrounds, they are not necessarily shared. **Big interests are there by tech companies and investors** – but with a view on the different scenarios, it is unclear if the interest will remain on this level, decrease or the 'bubble bursts'. The threat of less investments, running out of cheap energy for AI or just losing interest is high.

In all scenarios, the EU needs to embrace the **high level of uncertainty** as characteristic of developments in and around AI. EU policymakers need to **develop the ability of navigating**

uncertainties. Given the fast pace of developments, it is important to continuously monitor these developments and adjust strategies and plans accordingly. This adjustment might be needed more frequently. For instance, at some point, we will have a better understanding of the potential performance of AGI and ASI and their limitations (if there are any – this also depends on the definitions). This will either exclude certain paths or make them more likely. There might also be other limitations earlier on, for example the unsolved problem of energy supply versus energy hunger of the current AIs and their application. Where does the energy stem from and how much energy is available – for whom?

Concerning the big tech companies, it is still unclear if they will be ‘unleashed’ or ‘tamed’ by future US, Chinese or other governments. This will not only be important for the ‘international order’ or government policies but also for the development of AI. Will we have horizontal and general AIs or rather vertical, special and application-oriented ones that are not dependent on big tech companies and their data sets, anymore?

In the TOSA workshop, participants listed and discussed many opportunities and **actions** that can be taken. Most of them need an agreement on the future pathway in EU policies, not only R&I policies but also those affected by AI and from fields, in which AI is applied (e.g. health, environment, industry).

4.3. Sense-Making Workshop

A sense-making workshop was held on 10 February 2026 in Brussels (with hybrid participation) to establish a shared strategic orientation for EU research and innovation (R&I) policy under conditions of deep uncertainty regarding AI development. Rather than advocating for a single preferred future, the workshop sought to identify strategic considerations that remain robust across three distinct AI scenarios developed in Chapter 4: AI Winter, EU AI Leadership and AGI/ASI Networks. The exercise was explicitly reflexive in nature, designed to translate scenario analysis into policy-relevant recommendations for the European Commission.

Sense-making workshops play an important role in translating scenario-based foresight into strategic orientation. While scenarios help explore uncertainty and illuminate different possible futures, sense-making workshops create a structured space for reflecting on these futures and identifying implications that remain relevant across multiple scenarios. Rather than focusing on predicting which future will materialise, such workshops aim to support collective reflection on what actions, capabilities and policy approaches may prove valuable under a wide range of conditions. In this context, the sense-making workshops helped to move from exploration to orientation. It enabled participants to compare scenario-specific insights and highlight areas where strategic action appears robust across different futures. This process supports the identification of cross-scenario strategies, meaning opportunities for action that remain meaningful regardless of how technological, economic, or geopolitical dynamics unfold.

The results of the discussion have been clustered into the following six categories.

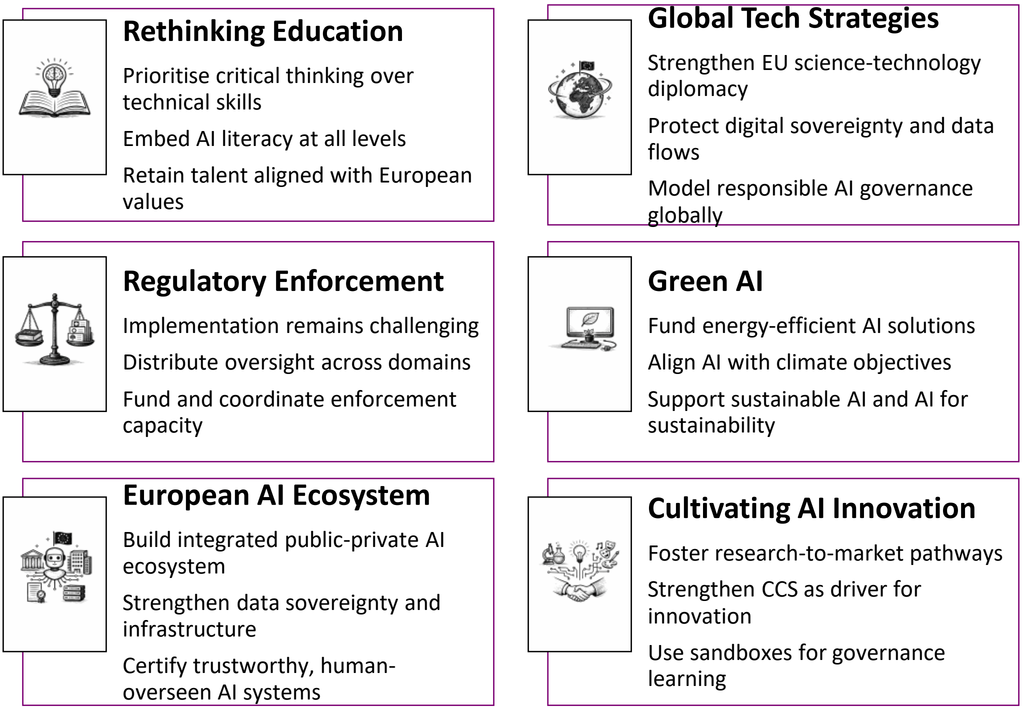


Figure 10 – Results of the Sense-Making Workshops

Rethinking Education in times of AI: a call to (re)discover humanities

Findings highlight the need to adapt European education systems to prepare individuals and institutions for working with AI. Beyond technical upskilling, education should emphasise critical thinking, ethical reflection, creativity and interdisciplinary competencies that enable the contextualisation of AI-generated outputs. Humanities and digital humanities offer important entry points for fostering skills that remain less susceptible to automation and support human-centred AI development. Education systems across Member States should embed AI literacy and awareness of societal implications at all levels, including for developers, users, policymakers and leadership. Talent development, including training, attracting and retaining skilled professionals, remains essential to align AI with European values. At the same time, AI can enhance access to Europe's research infrastructures, provided that education continues to cultivate independent and reflective learning.

Global Tech Strategies: Diplomacy Between Competition, Cooperation and Regulation

AI development increasingly unfolds within a geopolitical landscape shaped by technological capabilities, regulatory approaches and access to data and infrastructures. This cluster emphasises the need for the EU to position itself strategically through strengthened science and technology diplomacy. Rather than focusing solely on competition, cooperative approaches can promote trustworthiness, ethical standards and value-driven AI development. Digital sovereignty emerged as a key concern, particularly regarding the enforcement of EU regulations on external technologies and the capacity to monitor data flows and negotiate access to infrastructures and markets. This points to the need for supranational coordination mechanisms and stronger institutional capacities. By demonstrating viable regulatory models, the EU can promote responsible AI governance globally and act as a stabilising force in balancing openness, collaboration, security and oversight.

Regulatory Enforcement: Building Institutional Capacity for AI Oversight in Europe

While the EU has established an advanced regulatory framework for AI, effective implementation and its control across Member States remains a challenge. Regulatory ambition requires corresponding institutional capacities to monitor compliance and enforce rules in practice. This raises questions about how responsibilities for AI oversight should be distributed across domains such as industrial policy, consumer protection, cybersecurity and law enforcement. The increasing complexity of AI systems, including autonomous and cross-sector applications, calls for adaptive oversight mechanisms and clear governance arrangements. Ensuring accountability, mandate clarity and coordinated enforcement is essential. Sustained funding and political support will be necessary to monitor AI systems entering the internal market and to respond to emerging risks in dynamic technological environments.

Green AI: Balancing Technological Innovation and Environmental Responsibility

Aligning AI with sustainability objectives is a central concern across all scenarios. AI can support environmental goals in areas such as energy and climate research, while also generating significant environmental costs through resource consumption, especially energy. This creates a dual challenge of promoting sustainable AI applications while reducing the environmental footprint of AI systems themselves. Integrating sustainability criteria into funding programmes and research priorities can help steer AI development towards energy-efficient and resource-conscious solutions. Raising awareness of the environmental impact of AI infrastructures and encouraging regulatory approaches to reduce lifecycle impacts are key steps. Overall, AI governance should be aligned with broader climate and sustainability objectives.

Building a European Extended AI Stack: Capacity, Trust and Public Interest

Strengthening European capacities for AI development requires building an integrated ecosystem – or extended AI stack – that combines technical, economic and social dimensions. The EU can foster AI systems aligned with trust, transparency and data protection while supporting competitiveness. Public–private collaborations and open platforms for data and model development can promote innovation while maintaining oversight and ethical standards. Data sovereignty remains central, with an emphasis on negotiated access to strategic datasets rather than ownership transfer. Certification mechanisms for reliable AI systems, including human oversight, can strengthen trust. Additional priorities include integrating AI into public services, enabling transparency in AI-generated content and addressing copyright and ethical data use to ensure alignment with public interest.

Cultivating AI Innovation: Culture, Data Spaces and Experimental Governance

AI innovation is shaped by cultural, organisational and institutional dynamics. Strengthening entrepreneurial ecosystems and supporting pathways from research to market can accelerate the development and scaling of AI applications. Cross-border collaboration, including sector-specific data spaces, can further enable innovation. Promoting domain-specific AI solutions and human–machine collaboration across industries remains important, alongside monitoring technical developments. Cultural and creative sectors can contribute to shaping societal engagement with AI, particularly through collaborations between arts and sciences. Regulatory sandboxes can offer opportunities to test AI applications and support learning processes in governance across sectors.

5. Opportunities for action

The preceding analysis has mapped the current state of AI development and adoption. This chapter translates these observations into opportunities for action. It focuses on areas where targeted interventions can influence the direction, distribution and impact of AI development within the European context. Rather than treating AI as a self-propelling technological force, the chapter approaches it as a field that remains open to strategic orientation, policy design and collective shaping.

Therefore, we will provide three key takeaways that emerge from the analysis. They address the conditions required to strengthen Europe's capacity to develop and deploy AI, the need to balance innovation with societal values such as trust and accountability and the importance of fostering broader and more inclusive adoption across sectors. In doing so, the chapter outlines pathways through which AI can contribute to social wellbeing and public value creation.

5.1. Strengthening anticipatory governance capacities to navigate persistent uncertainty

The capacity to act under uncertainty becomes a defining requirement for effective policy. A central implication emerging from this study is that artificial intelligence must be approached as a moving target. Across the analysis of AI development, the different approaches to sectoral adoption and lastly also the scenario analysis, no single, stable trajectory of the future of AI can be identified. Instead, the landscape is characterised by the coexistence of rapid technological advances, fluctuating investment dynamics, shifting geopolitical constellations and unresolved questions regarding the long-term capabilities and limitations of AI applications.

Need for flexible and responsive policy approaches. The empirical analysis in Chapters 2 and 3 already indicates that AI development is shaped by structural dynamics that remain impossible to predict or control. The increasing concentration of resources in large industry actors, emerging constraints related to data and compute and uneven patterns of adoption across sectors suggest that technological progress does not follow a linear or uniform path. At the same time, organisational uptake remains tentative in many domains, with AI often deployed in supportive rather than transformative roles.

Policy must remain robust across divergent futures, being ready to support the opportunities and capable of adjustment as developments unfold. The scenario analysis in Chapter 4 further underscores the extent of this uncertainty. The explored futures range from continued acceleration towards advanced forms of general-purpose AI to a scenario of European active leadership based on alternative AI approaches and innovation, to the possibility of AI development coming to a halt following a decline in investment and unmet expectations. All scenarios highlight different structural dependencies, threats and opportunities. Taken together, they illustrate that strategic orientation cannot rely on the anticipation of a single dominant outcome.

Regulatory ambition alone is insufficient without corresponding implementation and enforcement capabilities. Insights from the sense-making workshop reinforce this perspective. Across all scenarios, participants converged on the importance of strengthening institutional and organisational capacities to interpret ongoing developments, assess emerging risks and respond in a timely and coordinated manner. As AI systems become more complex and increasingly embedded across sectors, governance challenges extend beyond rule-setting to include continuous monitoring, evaluation and adaptation.

In the following, we present four opportunities for actions that result from the study and can improve anticipatory governance in the context of AI R&I policy for the future.

Adaptive Governance

A first area for action concerns the development of adaptive governance capacities. This includes strengthening institutional coordination across policy domains such as industrial policy, consumer protection, cybersecurity and law enforcement, as well as clarifying responsibilities for oversight of AI systems within the European governance landscape. Effective implementation of existing regulatory frameworks, including the AI Act, requires not only legal instruments but also analytical capabilities, technical expertise and sustained organisational resources. Building such capacities enables institutions to respond to evolving technological developments and to ensure consistent application of rules across Member States.

Monitoring & Foresight

A second area relates to the establishment of systematic monitoring and foresight mechanisms. Given the speed and variability of AI developments, continuous observation of technological, economic and societal trends becomes essential. This includes the ability to track emerging capabilities, identify potential risks at an early stage and assess the broader implications of AI deployment across sectors. Scenario-based approaches, as applied in this study, can serve as a complementary tool for exploring alternative futures and stress-testing policy strategies under different conditions. Embedding such practices within institutional processes can support more anticipatory and reflexive forms of governance.

Strengthening AI Literacy

A third area for action concerns the strengthening of AI literacy and decision-making capacity across different levels of society. The workshop discussions emphasised that navigating AI-related uncertainty requires more than technical expertise. It depends equally on the ability of policymakers, organisational leaders and citizens to critically assess AI-generated outputs, understand their limitations and make informed decisions in complex environments. This calls for educational approaches that combine technical knowledge with critical thinking, ethical reflection and interdisciplinary perspectives. In this regard, the role of the humanities and social sciences becomes particularly relevant in fostering contextual understanding and interpretative capacity.

Hype Assessment

Lastly, the current discourse around the future of AI is flooded with exaggeration and overpromising, creating expectations and narratives that actively shape how AI is developed, funded, and governed. Discourses of breakthrough and risk influence agendas and public responses, while systematic analysis of these dynamics enables foresight to distinguish between strategic exaggeration and grounded developments, and to reveal which visions dominate and how alternative pathways for AI can emerge. Hype Assessment therefore becomes important for AI foresight, as it fosters a more reflective and critical engagement with the imaginaries shaping AI futures.

These areas of action point towards a shift from static regulatory approaches to more dynamic and learning-oriented governance models. Rather than attempting to predict and control specific technological outcomes, European AI policy must build the capacity to observe, interpret and respond to ongoing developments in due time. Acting under persistent uncertainty thus becomes a strategic orientation that allows for more resilient and adaptive approaches to shaping the future of AI.

5.2. Enhancing European competitiveness through broader and deeper AI adoption across sectors

The transformative impact of AI is shaped primarily by patterns of adoption in real-world contexts. A second key opportunity lies in the fact that Europe's competitive position in the field of artificial intelligence depends less on taking a leading role in developing innovative models and more on its ability to effectively deploy, integrate and scale AI across various sectors. While global competition often focuses on advances in large-scale models and computational capabilities, the empirical evidence presented in this report suggests that AI's transformative potential emerges through innovative adoption.

Key opportunity for Europe is to deepen the integration of AI where adequate and to enable broader diffusion across sectors. The analysis of AI development and uptake in Chapters 2 and 3 highlights that adoption across the European economy remains uneven and, in many sectors, still at an early stage. Digitally mature and data-intensive sectors, such as information and communication or professional services, have begun to integrate AI more systematically into their operations. In contrast, large parts of the economy – including manufacturing, construction and infrastructure-related sectors – continue to report low levels of adoption, with AI primarily used for isolated or supportive functions rather than as a transformative driver.

European AI applications that work across Member States are required to access, implement and scale AI solutions. Widespread and effective AI adoption requires European AI applications that function across Member States, enabling organisations to access, implement, and scale AI solutions. Workshop participants emphasised that this depends not only on technical infrastructure but also on institutional, organisational, and economic environments that support experimentation, learning and collaboration.

In the following, we present four of opportunities to strengthen AI adoption across industry sectors.

Strengthening the European AI ecosystem

A first area for action concerns the strengthening of digital, data and compute infrastructures as the foundation for AI deployment, alongside data governance and digital sovereignty. Access to high-quality, interoperable data remains a critical bottleneck across sectors, particularly where data are fragmented, sensitive, or difficult to standardise. Initiatives aimed at developing sector-specific data spaces and improving data interoperability can enable AI applications while supporting cross-border collaboration within the EU Single Market. Investments in cloud, edge and high-performance computing infrastructures are necessary to ensure that European actors can develop and deploy AI systems at scale without excessive dependence on external providers. Access to and control over strategically relevant datasets are increasingly central to AI development and European approaches to data governance, which emphasise protection, accountability and negotiated access, need to embrace AI applications while safeguarding fundamental rights and reducing dependencies on external actors. Building trust on AI in the system is as important as the technical or market development.

Promotion of Vertical AI

A second area relates to the promotion of sector-specific, or 'vertical' AI solutions tailored to the needs and characteristics of different domains. A one-size-fits-all approach to AI development is unlikely to be effective. Instead, targeted support for AI applications in sectors such as healthcare, energy, mobility, manufacturing and public administration can enable more meaningful and context-sensitive integration. Such an approach builds on Europe's strengths in domain expertise, regulatory frameworks and high-quality datasets and allows for the development of solutions that are closely aligned with real-world needs. AI is and should remain a tool for defined purposes.

Agile Governance Structures

Experimental and flexible governance approaches can support the adoption process by reducing uncertainty, fostering trust and enabling controlled testing of AI applications. Regulatory sandboxes and similar instruments provide environments in which new technologies can be developed and evaluated under real-world conditions while maintaining oversight and compliance with regulatory standards. Such approaches can facilitate learning for both innovators and regulators, contributing to more informed and adaptive policy development.

Robust AI Systems

The reliable adoption of AI depends on the development and promotion of trustworthy and accountable AI systems. This includes ensuring transparency, explainability and robustness in AI applications, as well as establishing mechanisms for certification and validation that allow users and organisations to assess the reliability of AI systems. Strengthening trust is particularly important in high-stakes sectors such as healthcare, education or public administration, where the acceptance and effectiveness of AI depend on confidence in its operation and governance.

Taken together, these areas of action highlight that Europe's competitive advantage in AI is likely to emerge from its ability to enable broad-based, context-sensitive and scalable adoption across its diverse economic landscape. Rather than focusing exclusively on competing at the technological frontier, a strategy centred on deployment and integration allows the EU to leverage its existing strengths, develop useful tools for the different sectors and to generate tangible economic and societal value from AI.

5.3. Shaping a distinct European pathway for AI that builds on trust, sustainability and public interest.

Differentiation arises from the capacity to align technological development with principles like trustworthiness, sustainability and public interest. A third key opportunity emerging from this study is that Europe's strategic position in AI will depend on its ability to articulate and implement a distinct pathway for AI development – one that builds on its institutional strengths, regulatory frameworks and societal values. In a global landscape shaped by competing technological models and geopolitical interests, the question is not only how to advance AI capabilities but how these capabilities are purposefully embedded within economic, social and political systems.

The EU provides a foundation for an alternative approach of AI development that emphasises accountability and societal alignment. The empirical analysis in earlier chapters points to structural conditions that both constrain and enable such a pathway. Europe's fragmented market, its cultural diversity and comparatively lower levels of private investment limit its ability to compete directly with other global AI powerhouses on purely scale-driven approaches. At the same time, the EU benefits from a diversity of applications tailored to the needs of industry and society. Its AI research is supported by strong public institutions, a comprehensive regulatory framework, high levels of domain expertise in key sectors, and a long-standing commitment to fundamental rights and data protection.

Participants from the sense-making workshop emphasised that Europe's approach to AI should be grounded in technological capacity-building and value-driven governance. This includes compliance with ethical and legal standards and actively shaping innovation for to broader societal objectives.

Five areas have been identified as key opportunities to strengthen and shape a distinct European pathway for R&I AI policy, which will be presented below:

Rediscover humanities

One important area of action is the European education systems as a central lever for shaping the long-term trajectory of AI development and deployment. This includes strengthening humanistic education, creativity, critical thinking and ethical reflection as well as interdisciplinary competencies. Enabling the contextualisation and critical assessment of AI-generated outputs becomes increasingly important. In this regard, the humanities and emerging domains like digital humanities are promising entry points for cultivating competencies that remain less susceptible to automation and to enhance human-centred development of AI. In a nutshell, future-oriented education should enable people to make use of AI within their systems and provide the capacity to assess and interpret AI-generated knowledge in decision-making contexts. At the end of the day, AI is a tool and has to follow human needs, not the other way around.

Twin transition

A second area of action is to align AI development with environmental sustainability objectives. While AI can contribute to addressing challenges such as energy management, climate modelling and resource optimisation, it also entails significant environmental costs, particularly in relation to energy consumption and computational resources. Integrating sustainability criteria into research funding, innovation programmes and regulatory frameworks can help ensure that AI development remains compatible with Europe's broader environmental and climate goals. This includes encouraging the design of energy-efficient AI systems including the efficiency within the system (not only the direct energy consumption) and increasing awareness of the environmental footprint associated with large-scale computational processes.

Public-Private Partnerships

The last area for action concerns the development of AI ecosystems oriented towards public interest and supported by European infrastructures. This includes the integration of AI into public services, the creation of open and trusted platforms for data and model development and the establishment of governance mechanisms that ensure alignment with societal needs. Public–private collaboration can play a key role in this context, particularly where market incentives alone are insufficient to drive investment in socially beneficial applications. Strengthening such ecosystems integrating small and dedicated players can contribute to both economic competitiveness and societal well-being.

Human values for AI innovation

Another area of action is the cultural and societal embedding of AI. The cultural and creative sectors in shaping public understanding, experimentation and engagement with AI technologies. Collaborations between arts and sciences can foster new perspectives on AI, support innovation in user-facing applications and contribute to a broader societal dialogue about the role of technology. Such approaches can help ensure that AI development remains connected to human needs, values and forms of expression.

Tech Diplomacy

The international dimension of AI development highlights the importance of positioning Europe as a promoter of value-based governance models. Through science and technology diplomacy, the EU can contribute to shaping global standards and fostering cooperation around trustworthy and responsible AI. This includes engaging with international partners, promoting regulatory approaches that balance innovation with societal safeguards and strengthening Europe’s role in global discussions on AI governance.

Taken together, these areas of action suggest that a distinct European pathway for AI is not defined by a single policy instrument or technical choice, but by the alignment of multiple dimensions: technological capacities, regulatory frameworks, societal values and international engagement. By integrating these elements into a coherent strategy, Europe can position itself as a role model in shaping AI systems that are not only innovative and competitive but also trustworthy, sustainable and aligned with the public interest.

6. Conclusion

This study has examined the evolving landscape of artificial intelligence and its implications for Europe's research and innovation ecosystem under conditions of deep uncertainty. Across empirical analysis, scenario development and participatory sense-making, a consistent picture emerges: AI is not unfolding along a single, predictable trajectory but through a plurality of possible pathways shaped by technological, economic and geopolitical dynamics.

In this context, the central challenge for European policymaking is not to anticipate one dominant future but to remain capable of acting across multiple, shifting and steadily changing futures. The analysis has shown that AI development is characterised by structural asymmetries in data, compute and capital, uneven adoption across sectors and persistent barriers related to skills, infrastructure and governance. The scenario work highlights different plausible outcomes, from a full integration and application of AI to going back to other science and technologies, reinforcing the need for strategies that are robust under divergent conditions. Three overarching orientations follow from this. The study therefore identifies three key strategic implications.

Table 2 - Main conclusions

	Opportunities for action
1	**Strengthening anticipatory governance capacities to navigate persistent uncertainty.** AI is and remains a moving target. The current AI landscape is characterised by simultaneous acceleration and instability: rapid adoption coexists with unclear long-term trajectories, hype dynamics and potential correction phases. Policymaking cannot rely on linear projections or singular technological visions but must engage with AI as a moving target. As a result, policymaking needs to build the capacity to act, adapt and revise under conditions of ongoing uncertainty.
2	**Enhancing European competitiveness through broader and deeper AI adoption across sectors.** Leadership in AI will not necessarily come from developing the most advanced models but from the ability to deploy, integrate and apply AI effectively across sectors. Europe's opportunity lies in sector-specific (vertical) AI and in the capacity to embed AI in real-world contexts — provided structural fragmentation is addressed.
3	**Shaping a distinct European pathway for AI that builds on trust, sustainability and public interest.** Rather than imitating dominant global AI trajectories, the EU should articulate its own approach, grounded in trustworthiness, robustness, sustainability and high-quality infrastructures. This includes investing in skills, data spaces and cross-border ecosystems, while maintaining openness to multiple technological pathways and avoiding overcommitment to narrow paradigms such as large language models.

These orientations point towards a shift: The findings emphasise AI as a socio-technical field that remains open to shaping, highlighting opportunities for active governance, strategic coordination, and deliberate societal direction. This places particular importance on strengthening Europe's capacities: investing in skills and infrastructures, enabling cross-border ecosystems, fostering innovation cultures and ensuring effective governance and enforcement.

The future of AI in Europe depends on the collective ability to steer its development and deployment in ways that generate economic value while safeguarding societal goals. By embracing uncertainty as a structural condition rather than a temporary obstacle, the EU can position itself to shape AI in a manner that is not only competitive but also resilient, responsible and aligned with the public interest.

7. References

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The report explores possible futures of artificial intelligence (AI) and their implications for Europe’s R&I ecosystem. AI adoption in Europe is currently uneven and constrained by fragmented markets, limited data access, skills shortages, and investment gaps. The report presents three scenarios, discussing deep uncertainties about the future pathways of AI development. Three strategic priorities are presented: acting under uncertainty, strengthening competitiveness through adoption, and shaping a distinct European AI pathway. For Europe, AI future will depend on technological breakthroughs, and on coordinated policy in various areas and broad-based adoption.

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