

Enhancing European Technological Excellence

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Summary

This paper outlines the urgent need for Europe to enhance its technological prowess amidst increasing global competition from the US and China. It emphasises three key technological topics: information and communications technology, cleantech and defence. The first is critical as a productivity multiplier, cleantech is essential for the EU to achieve a net-zero economy while maintaining a competitive edge, and defence technology is crucial for the Union's strategic autonomy amid rising geopolitical tensions. Three horizontal methods are proposed: investing in talent and skills, fostering innovation and entrepreneurship, and creating a dependable playing field through regulatory reform and market integration. The urgency stems from Europe's current lag in digital and artificial intelligence investment, fragmented markets and slow adoption of transversal technologies. To secure its economic future and strategic autonomy, Europe must undertake sweeping reforms, prioritise technological resilience and build a robust ecosystem that supports technological advancement across all sectors.

Keywords Technology – Information technology – Green transition – Cleantech – Military technology – Regulatory simplification – Entrepreneurship – Skills

Introduction

The EU stands at a critical cross-roads and urgently needs a wake-up call regarding its technological policies as global competitors such as the US and China are surging ahead in key domains.

Without bold action, Europe's economic future is at stake, risking not only its competitive position but also its strategic autonomy in an increasingly interconnected and technologically driven world. The time for incremental changes has passed; Europe needs decisive, sweeping reforms to secure its place in the global technological landscape. Its social model depends on this.

There is no shortage of regulation, policy documents or strategies in this arena in the EU. These include the Digital Services Act and the Digital Markets Act, which aim to create a safer and more open digital space.¹ The EU has also advanced legislation including the Artificial Intelligence Act and the Cyber Resilience Act to govern the development and deployment of artificial intelligence (AI) technologies and to enhance the cybersecurity of digital products and services.² The European Chips Act is focused on bolstering the EU's semiconductor supply chain, while the European Data Act seeks to unlock industrial data and foster a competitive cloud market.³ The EU's strategic approach is further supported by the Digital Decade initiative, the Europe Fit for the Digital Age initiative and research priorities in the Horizon Europe programme (2021–7).⁴ Other relevant EU policies and initiatives that align with the ideas in this paper include the New European Innovation Agenda, the Research and Innovation Strategy 2020–2024, and Shaping Europe's Digital Future.⁵

¹ European Commission, 'The Digital Services Act Package' (updated 4 October 2024); European Commission, 'The Digital Markets Act' (2024).

² European Commission, 'AI Act' (updated 14 October 2024); European Commission, 'EU Cyber Resilience Act' (updated 8 July 2024).

³ European Commission, 'European Chips Act'; European Commission, 'Data Act' (updated 10 October 2024).

⁴ European Commission, 'Europe's Digital Decade: Digital Targets for 2030'; European Commission, 'A Europe Fit for the Digital Age' (2024); European Commission, 'Horizon Europe' (2024).

⁵ European Commission, 'The New European Innovation Agenda' (2024); European Commission, 'Research and Innovation Strategy 2020–2024'; European Commission, 'Shaping Europe's Digital Future' (2024).

However, critical analyses paint a rather discomfoting picture of the current state of affairs. As succinctly put in a *Financial Times* op-ed:⁶

The US, at the turn of the millennium, did not ‘plan’ to outgrow Europe. It did not have a version of Mario Draghi’s new competitiveness report. It did not produce an equivalent of the Lisbon Agenda, which in 2000 committed the EU to building the most ‘dynamic knowledge-based economy in the world’. The US has been deplorably negligent on the report front. Yet here we are. The transatlantic divergence in material outcomes has been going on for two decades. And Europe was poorer to begin with.

The programmes suggested herein aim to build upon these efforts, focusing on ensuring the EU’s technological resilience by empowering research and innovation across the EU, while also ensuring that European businesses are equipped to leverage these advancements for competitive advantage. Namely, the commercial exploitation of what is generally quite good European research has, to date, been lacking. This was identified decades ago in the Bangemann report:⁷

Actions must be taken . . . to strike down entrenched positions which put Europe at a competitive disadvantage: it means fostering an entrepreneurial mentality to enable the emergence of new dynamic sectors of the economy; it means developing a common regulatory approach to bring forth a competitive, Europe-wide, market for information services; it does NOT mean more public money, financial assistance, subsidies, dirigisme, or protectionism.

State of play

European competitiveness, particularly in technology, has been a focal concern for policymakers and business leaders, as underscored in a report by the McKinsey Global Institute.⁸ Over the past decade, there has been a growing divergence between Europe and leading global economies, particularly those of the US and China, in key technological and corporate performance metrics. Europe’s ability to sustain growth, achieve strategic autonomy and maintain social welfare depends on bridging this gap. The report estimates that corporate value added of €2–€4 trillion a year could be at stake by 2040, which represents about one percentage point of growth annually or nearly 90% of current European social expenditure.⁹

The McKinsey report states that between 2014 and 2019, large European companies lagged behind their US counterparts by three percentage points in return on invested capital, grew 40% more slowly, and invested 40% less in research and development (R&D). This underperformance is particularly pronounced in technology-centric sectors but the weaknesses are not entirely sector-specific. Rather, there are issues with both the transversal technologies that permeate every industry and the ecosystem for doing business and innovating.

The report highlights 10 key transversal technologies: next-level automation, future of connectivity, distributed infrastructure, next-generation computing, applied AI, future of programming, trust architecture, bio-revolution, next-generation materials and future of cleantech. Of these, European performance is competitive only in cleantech and next-generation materials, and is particularly weak in information technology-related fields.

⁶ J. Ganesh, ‘Why Europe Will Not Catch up With the US’, *Financial Times*, 18 September 2024.

⁷ *Bulletin of the European Union*, ‘Report on Europe and the Global Information Society’, Supplement 2/94 (Brussels, 1994), 5–41.

⁸ McKinsey Global Institute, *Securing Europe’s Competitiveness: Addressing its Technology Gap* (September 2022).

⁹ *Ibid.*

The evaluation of European technological excellence is summarised in the following table.

Table 1 Analysis of European technological excellence

Strengths	Weaknesses
<ul style="list-style-type: none"> • <i>Leadership in sustainability and cleantech</i>, including political commitment. • <i>High-quality education systems</i>, particularly in life sciences and engineering. • <i>Regulatory leadership</i> influencing international norms and promoting consumer trust. • <i>Strong social and economic inclusion</i>. 	<ul style="list-style-type: none"> • <i>Lag in digital and AI investment</i>. • <i>Fragmented market and regulation</i> hinder the scaling of technologies. • <i>Slow adoption of transversal technologies</i>. • <i>Lower R&D investment in general</i> and particularly in high-impact sectors such as information and communications technology (ICT) and pharmaceuticals.
Opportunities	Threats
<ul style="list-style-type: none"> • <i>Scaling successful initiatives</i>, firms and technologies through greater integration of markets and regulatory environments. • <i>Increased collaboration</i>, leveraging public–private partnerships, particularly in defence, healthcare and digital infrastructure. • <i>Focus on strategic autonomy</i> in critical sectors such as semiconductors, defence, cybersecurity and digital infrastructure to reduce external dependencies. • <i>Capitalise on cleantech political leadership</i>. 	<ul style="list-style-type: none"> • <i>Competition from the US and China</i>, particularly in digital and AI, where these countries dominate investment and market share. • <i>Disruption of transversal technologies</i> threatens Europe’s traditional industrial strongholds, such as automotive and aerospace, if adaptation lags. • <i>Regulatory and bureaucratic hurdles</i> stifle innovation, slow market entry for new technologies and discourage investment. • <i>Risk of falling behind in critical technologies</i> such as AI, quantum computing and cybersecurity.

Priorities

As stated above, Europe risks being left behind, particularly in terms of transversal technologies such as AI, next-generation computing and advanced connectivity. These technologies are not confined to single industries; they shape entire sectors and economies, making Europe’s lag all the more perilous. This thinking guides the selection of priority topics.

However, the greatest potential for transformative change lies in structural reforms to Europe’s innovation and business ecosystem. The EU must dismantle regulatory barriers, foster cross-border collaboration and scale up successful initiatives to turn its fragmented market into a powerhouse of technological advancement. This focus guides the general horizontal mechanisms outlined in this paper.

Technological areas

Three technological topics have been selected:

1. *Digital*. ICT has been selected as it is a multiplier for productivity growth across the economy. Europe is currently behind in terms of R&D spending on ICT compared to the US, which invests about four times more. Bridging this gap is essential for fostering a dynamic and competitive technology ecosystem within the EU.
2. *Green*. Cleantech includes a range of technologies such as solar, wind, hydropower, nuclear fusion and hydrogen, all of which are crucial for the transition to a net-zero economy. It has been selected due to

the high political urgency of this transition and the support for it within the EU. The EU has the potential to lead in cleantech innovation, although it currently lags in production.

3. *Defence*. While one could select many other transversal technologies, the EU today does not have this luxury. Advanced defence technology is crucial for the EU amidst, on the one hand, the digitalisation of the battlefield and, on the other, the current global uncertainties. The use of such technology directly impacts the Union's ability to safeguard its strategic interests, ensure the security of its citizens, maintain stability within its borders and project strength beyond them. A robust and advanced defence technological base is essential for the EU to respond effectively and autonomously.

Structural horizontal mechanisms

Addressing the structural issues hindering Europe's technological competitiveness requires a comprehensive approach that focuses on three critical pillars: skills, innovation and entrepreneurial environment, and an integrated and dependable playing field.

The horizontal mechanisms and policies for the three pillars include the following:

- *Investing in talent and skills*. Everything starts with a focus on human capital, advocating for the enhanced development and attraction of talent, particularly in the science, technology, engineering and mathematics (STEM) fields and digital skills. This includes not only improving educational outcomes but also making Europe more attractive to top global talent, alongside policies that encourage innovation, creativity and entrepreneurship within the EU workforce.
- *Facilitating innovation and entrepreneurship*. This highlights the importance of fostering a more supportive regulatory environment that encourages disruption and innovation. This could involve streamlining regulatory processes, promoting risk-taking and entrepreneurship, and providing more substantial support for startups and scale-ups, including better access to finance and markets.
- *A dependable playing field*. Europe should achieve scale, increase efficiency and establish a dependable playing field to foster competitiveness and growth. This includes increasing and pooling resources within the EU and with other democracies to support cross-border scale-up and consolidation, balancing the precautionary principle with accelerated cost–benefit decision-making and ensuring fair competition for all market players, especially in the digital and tech sectors.

Policy recommendations

ICT in depth

The primary challenges stem from fragmented markets, lagging investment in key technologies, skills shortages, cybersecurity vulnerabilities and regulatory complexities. Addressing these challenges collaboratively offers the EU a path to enhancing its technological sovereignty, bolstering economic growth and ensuring its security in an increasingly interconnected world.

To catch up with global advancements in the digital domain, the EU must focus on several key areas. Deepening the digital market is essential, and requires the harmonisation of regulations across member states and support for initiatives such as the digital single market, which facilitates cross-border digital services. Alongside this, boosting investment in critical technologies such as AI, quantum computing and digital infrastructure should be prioritised, leveraging frameworks such as the European Innovation Council and the Digital Europe Programme to mobilise resources and foster public–private partnerships. Addressing the growing digital

skills gap is equally important, necessitating substantial investment in education and training, particularly in emerging technologies. Programmes such as the European Year of Skills and the Talent for Growth Task Force, which promote collaboration among governments, businesses and educational institutions, should play a pivotal role. Furthermore, in response to increasing cybersecurity threats, especially from the east, the EU must strengthen its cyber-defence by standardising regulations and investing in advanced cybersecurity technologies. Finally, simplifying regulatory frameworks is crucial, particularly in fast-evolving fields such as AI, where a more flexible, risk-based approach could balance the need for oversight with the fostering of innovation.

Cleantech in depth

Europe's transition towards a green economy requires a balanced approach that supports industries while advancing sustainability goals. A pragmatic, market-driven strategy is essential to avoid the pitfalls of greenwashing and economic degrowth, instead focusing on innovation, competitiveness and preserving the industrial base that underpins Europe's prosperity.

A successful market-driven green transition should be centred on innovation and technological neutrality, empowering industries to adopt the most efficient solutions, from advanced nuclear options such as small modular reactors to carbon capture and utilisation technologies, alongside renewable sources such as wind and solar.

This approach would prevent an over-reliance on specific technologies and would foster a variety of emissions-reduction strategies tailored to different sectors. To ensure genuine impact, cleantech developments must meet rigorous standards, with transparent reporting key to directing financial and policy support towards innovations that truly contribute to sustainability, thereby avoiding greenwashing or superficial solutions. It is also essential to protect industrial competitiveness by implementing green policies that are designed to avoid imposing disproportionate costs on businesses, thus ensuring they remain competitive globally and are not driven to relocate outside of Europe.

Market-based mechanisms, such as uniform carbon pricing, should play a key role in creating incentives for companies to innovate and reduce emissions efficiently, aligning with a preference for fewer regulations and a reliance on market forces to drive real change. Additionally, energy security and supply-chain resilience are critical to a sustainable transition, and require the diversification of energy sources and a reduced reliance on non-EU countries for essential materials and technologies.

Fostering a fair transition is equally important, ensuring that all regions, industries and communities benefit, particularly through the reskilling of workers from traditional sectors and providing targeted support for small and medium-sized enterprises (SMEs). Finally, the focus should be on promoting sustainable growth rather than degrowth, emphasising the idea that economic expansion and environmental protection can coexist. By leveraging innovation and market dynamics, Europe can pursue a green future that supports both environmental goals and economic prosperity.

Military technology in depth

Investment in military technology is crucial for the EU as it will strengthen the bloc's strategic autonomy, enhance its defence capabilities and ensure the security of its member states in an increasingly complex global security environment. Such investment not only supports the development of cutting-edge defence systems and innovations but also fosters collaboration among member states, driving forward a more integrated and

resilient European defence industry.¹⁰ By bolstering its military technological edge, the EU aims to protect its interests, contribute to global stability and reduce its dependency on external powers for critical defence needs, aligning with its broader goals of strategic sovereignty and security self-reliance.

Collaborative actions to enhance the EU's defence capabilities require a unified approach across several dimensions. The EU must work towards a more coordinated defence procurement strategy by consolidating resources and reducing the duplication of efforts through the use of frameworks such as the European Defence Fund and the European Defence Industrial Development Programme. These initiatives facilitate joint investments in critical technologies, ensuring more impactful results.

Additionally, cybersecurity is a key focus, necessitating the development of a comprehensive EU strategy that enhances both offensive and defensive digital resilience. This involves greater investment in cyber-defence technologies, improved collaboration between member states and the integration of private-sector innovations into military operations.

Standardisation and interoperability efforts, such as expanding the High-Level Forum on European Standardisation to include dual-use technologies, are vital for enabling seamless joint operations and the rapid deployment of new technologies across borders. Moreover, prioritising investment in emerging technologies such as AI, quantum computing and autonomous systems is essential to maintaining the EU's competitiveness in future warfare landscapes.

Finally, achieving strategic autonomy through technological development requires reducing reliance on external suppliers by strengthening the European defence technological and industrial base through targeted funding and policy support, thus ensuring the EU's long-term security and sovereignty in critical areas such as advanced semiconductors and AI.

Conclusion

Europe stands at a pivotal moment where its technological future will determine not only its economic competitiveness but also its strategic autonomy and societal welfare. The technological landscape is rapidly evolving, with critical areas such as AI, next-generation computing and advanced connectivity defining the contours of global power and influence. Europe must act decisively, leveraging its strengths in sustainability and education, while addressing weaknesses in digital investment and market fragmentation. Structural reforms that foster a unified market, enhance cross-border collaboration and scale up successful initiatives are not optional but essential. Without a bold, integrated approach, Europe risks falling behind in key technological domains, imperilling its economic resilience and strategic influence in an increasingly interconnected world.

The EU's success in closing the competitiveness gap depends on its ability to create a conducive environment for innovation and entrepreneurship. Prioritising strategic autonomy in critical sectors, investing in talent and skills, and fostering a supportive regulatory landscape will be crucial. Europe's leadership in cleantech and sustainability offers a strong foundation, but it must expand this success to other critical technologies. The time for incremental change has passed; what is required now is a transformative vision that galvanises Europe's technological potential, securing its place as a leader in the global economy.

¹⁰ S. Lorenzo Perez, L. Lazaro Cabrera and A. Duprat-Macabies, 'EU Tech Policy Brief: July 2024', *Center for Democracy and Technology*, 5 July 2024.

	Programme 1	Programme 2	Programme 3
	Growing ICT	Making cleantech competitive	Bolstering defence
Project 1	<p>Enhance STEM education with a focus on integrating ICT competences. This could involve updating curricula, providing teacher training and investing in ICT resources within educational institutions to foster a tech-savvy generation.</p> <p>Create centres of excellence for higher education in STEM across Europe to attract talent from abroad.</p>	<p>Establish programmes that will approach sustainable development from a rational viewpoint—focusing on development and growth that can sustain itself and approach the climate-change problem from the perspective of mitigating the effects and reducing greenhouse gases where it is least expensive. In particular, focus on knowledge related to the circular economy and the regenerative economy.</p>	<p>Collaboration should be established between the defence sector and educational institutions. This includes promoting STEM education, as well as specialist training in emerging technologies relevant to defence.</p> <p>Moreover, providing continuous education and upskilling opportunities is critical as the defence sector evolves with new technologies such as quantum computing and digital twins.</p>
Project 2	<p>Establish low-red-tape incubation programmes that provide resources, mentorship and funding to ICT startups. These programmes should catalyse innovation by supporting entrepreneurs in developing and scaling viable technology solutions. Create a platform for best-practice sharing among member states.</p>	<p>Support the establishment of cleantech innovation hubs that bring together researchers, startups and investors to accelerate development. These hubs can provide essential resources, mentorship and networking opportunities to foster innovation and commercialise sustainable technologies, as seen in the Cleantech for UK initiative.</p>	<p>Create a robust ecosystem that integrates advanced technologies and entrepreneurial ventures into the defence sector. Promote dual-use technologies that have both civilian and military applications. Strengthen public–private partnerships including the European Defence Fund. Encourage startups and SMEs. Expand funding opportunities through initiatives such as the NATO Innovation Fund and the European Defence Industrial Development Programme, which supports early-stage innovators in developing new technologies relevant to defence.</p>
Project 3	<p>Carry out a review with the aim of reducing the regulatory burden on the EU’s digital industry and making it comparable to those of competitors. Ensure fair market access for emerging ICT companies, prevent monopolistic practices and encourage competition.</p>	<p>Revise and institute new trade policies to deter EU businesses from offshoring their energy-intensive operations—a practice that, while diminishing the EU’s apparent environmental footprint, undermines its industrial foundation without yielding global benefits. Existing initiatives such as the European Sovereignty Fund and the Green Deal Industrial Plan should evolve in this direction.</p>	<p>The EU defence industry should be bolstered through a combination of government procurement, regulatory modernisation and market-driven approaches. A common defence market, common procurement practices and common standards should be established. Interoperability standards should be set up. Targeted incentives, such as tax breaks and funding for R&D, could attract private-sector investment and encourage the participation of SMEs in the defence sector.</p>

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