POLICY BRIEF

AI in the chips sector: Future-proofing the EU's semiconductor industry

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Deliverable Abstract

This policy brief explores the role and impact of AI in the semiconductor supply chain, focusing on its uses, opportunities, and challenges. It aims to provide EU policymakers with actionable strategies to maximise AI's potential in chip production. AI offers significant benefits, such as cost savings and improved supply chain management, but also presents challenges like talent shortages and data quality issues. The brief suggests focusing on open innovation, especially for SMEs, and addressing the AI talent shortage. It highlights AI's dual role in digitising manufacturing and enhancing semiconductor production, including improving supply chain management and supporting environmental sustainability. The brief also discusses AI's potential in streamlining chip design and optimizing parameters like power and performance. Policymakers are urged to prioritize AI's strategic integration to enhance efficiency, resilience, and competitiveness in the semiconductor industry.

DISCLAIMER

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1. Introduction

This policy brief seeks to explore the role and impact of AI throughout the semiconductor supply chain. More specifically, it will identify the main uses, opportunities and challenges that arise from applying AI solutions in the chips industry. The primary objective is to provide an overview, conduct analysis, and offer policy recommendations to EU policymakers, assisting the development of actionable strategies that maximise the effective use of AI in the field of semiconductors.

Drawing on the insights from "The Impact of AI and GenAI on the Semiconductor Industry" [1] webinar organised by ALLPROS.eu, this policy brief suggests that while the use of AI technology can offer significant benefits to the EU's chip production, it also presents challenges that must be addressed before its widespread implementation. For example, AI can drive significant cost savings by adding value to various aspects of supply chain planning, including production, inventory management, and product distribution. Companies can also leverage AI-powered tools to process large volumes of real-time data, enhancing the accuracy of demand forecasting and improving supply chain visibility[2]. This enables them to respond to disruptions, such as crises, shortages, or severe weather conditions in real time, thereby managing and protecting the supply chain.

However, successfully implementing AI for these purposes comes with significant challenges, including addressing the talent shortage, ensuring the quality of the underlying data, and enabling resource-constrained enterprises (SMEs) to adopt these technologies and compete on equal footing with larger organisations. These challenges can be solved with specific points of focus for European policymakers such as focusing on supporting open innovation[3] practices, especially for SMEs and addressing the AI talent shortage.

Given the emerging nature of AI applications in the semiconductor sector, a qualitative approach allows for flexibility in capturing expert insights, exploring nuanced challenges, and understanding complex, context-specific dynamics that quantitative data might overlook. Semi-structured interviews, in particular, help gather in-depth perspectives from industry leaders, researchers, and SMEs, which are crucial for shaping realistic and actionable policy recommendations in a fast-changing field[4].

1 The Impact of AI and GenAI on the Semiconductor Industry

2 All Eyes on AI: How Artificial Intelligence Could Be the Solution to Semiconductor Industry Challenges. AI helps to proactively and efficiently plan for risk, enhance supply management, and improve the integrity of the products within the supply chain.

3 Open innovation in SMEs

4 Research methods-Thiel (2021)

2. The Rise of AI and Its Crucial Role in Advancing a Sovereign EU Chip Industry

Technological sovereignty[5] and the transition to Industry 4.0[6] in the semiconductor and chip sector are crucial for the future of the EU. One of the main goals of European tech sovereignty is to reduce risks associated with the European chip industry's dependence on non-EU stakeholders. AI-driven chip design leverages technologies like machine learning (ML)[7], which enables machines to learn from data and improve performance over time[8]. Generative AI[9], capable of producing text, images, and other content based on training data, is also used in the design, verification, and testing of semiconductor devices[10].

AI serves a dual purpose[11] in the semiconductor industry: it is both a critical enabler for digitising manufacturing processes and a technological tool that enhances semiconductor production. AI can significantly improve supply chain management by enhancing production planning, inventory control, and product distribution. For example, by processing real-time data, AI can deliver more accurate demand forecasts, enabling companies to optimise production and inventory management across multiple locations. It can also identify the most cost-effective logistics solutions, contributing to substantial cost savings.[12] Additionally, supply chain managers can track their inventory, thus making internal operations more efficient.[13] This allows companies to quickly respond to disruptions, like labour strikes or transportation issues, thus minimising delays and streamlining operations.

Furthermore, AI applications can support health and environmental sustainability[14]. Examples include the use of AI to assist in calculating the most optimal water and energy consumption during chip manufacturing. AI can also unlock materials optimisation to help avoid concerns such as the potential carcinogenic effects of certain substances, or their role in catalysing reactions that may lead to cancer. For example, AI can accelerate the search for alternatives to perfluoroalkyl and polyfluoroalkyl substances (PFAS), which are persistent "forever chemicals" used throughout the supply chain.[15] By optimising material selection and properties, AI helps reduce these risks and improves public health and environmental safety[16]. For example, AI algorithms can analyse emissions data and suggest modifications to lower pollution levels,

5 Statement on Technological Sovereignty. In the context of growing geopolitical rivalries and the pandemic, the concept of technological sovereignty has emerged to become a key political theme.

6 Industry 4.0 This new, digital industrial revolution holds the promise of increased flexibility in manufacturing, mass customisation, increased speed, better quality and improved productivity.

7 The Impact of AI and GenAI on the Semiconductor Industry

8 ML-IBM

9 The Role of AI in Developing Resilient Supply Chains

10 GenAI-IBM

11 All Eyes on AI: How Artificial Intelligence Could Be the Solution to Semiconductor Industry Challenges

12 Scaling AI in the sector that enables it. Companies could identify cost savings for predictive maintenance and provide resources for the appropriate AI/ML use case. The resulting savings would help the function that sponsored the use case and provided the appropriate resources, allowing it to achieve its business targets.

13 All Eyes on AI: How Artificial Intelligence Could Be the Solution to Semiconductor Industry Challenges.AI can develop predictions surrounding critical events from labor strikes to transportation issues to manage potential shipping bottlenecks.

14 Fraunhofer expert

15 SEMI "PFAS Explainer" https://www.semi.org/en/ehs_PFAS/PFAS_in_Semiconductor_Mfg

16 Fraunhofer expert

such as adopting more eco-friendly materials and energy sources or optimising production processes to minimise waste and emissions[17].

Lastly, AI is utilised by some chip designers looking to streamline the chip design process. This can be achieved by handling repetitive tasks helping with e.g. documentation of software development, thus allowing experts to focus more on creative and high-value work that enhances the design and quality of chips[18]. Also, ML and reinforcement learning can optimise parameters like power, performance, and area (PPA)[19] for chips, reducing time and effort in achieving optimal results. With an almost infinite number of design choices in massive design spaces, it is humanly impossible to find the right choices within a project's timeframe. AI can enhance PPA by taking on an exploration of these large design spaces to identify areas for optimisation.

17 Artificial intelligence in environmental monitoring: Advancements, challenges, and future directions

18 Bosch experts

19 What is AI Chip Design?. In every chip design, there are opportunities to deliver the optimal PPA for its target application.

3. AI across the semiconductor chain: an overview of key use cases

Given AI's transformative potential across the semiconductor supply chain, policymakers should prioritise its strategic integration to enhance efficiency, resilience, and competitiveness. AI-driven improvements in design automation (EDA)[20], predictive maintenance, and quality control can significantly reduce costs, speed up production[21], and strengthen Europe's technological sovereignty.

Besides design, AI can also automate manual manufacturing processes and improve predictive maintenance.[22] It can rapidly analyse extensive datasets from every stage of the chip design process, enabling it to quickly identify the root causes of issues at each phase. For instance, AI enables yield prediction, where models forecast the number of chips that will pass quality control based on early design and production parameters. This allows for more effective planning and adjustments to enhance results[23].

Additionally, in quality control, AI-powered systems can conduct detailed inspections at a microscopic level, detecting defects that might be overlooked by the human eye. This ensures faster, more precise quality control, ultimately improving the overall production process.[24] This proactive approach not only reduces manufacturing costs but also minimises machine downtime by identifying and resolving potential problems before they occur. In other words, picking up on issues in the chain of processes will lead to a cycle-time reduction.[25] In this regard, AI-driven simulations are also utilised to thoroughly test and identify the most effective process configurations. Once the simulations demonstrate a high probability of success, the validated solution is implemented in real industrial processes.[26]

In a wider scope, by analysing and predicting potential supply disruptions, such as labour strikes or transport bottlenecks, and recommending alternative actions, AI can address both shortages and surplus issues effectively. It can also rapidly identify new market targets to acquire chip resources and avoid dependencies on a single supplier. For example, by analysing extensive datasets, including market trends, supply chain dynamics, and geographical factors, AI can forecast emerging markets, pinpoint potential suppliers, and uncover trends that might otherwise go unnoticed. This capability enables more strategic decisions in sourcing and diversifying supply chains, mitigating risks associated with supplier dependency.[27] Finally, AI-driven simulations and training tools can accelerate the learning curve for new hires, while reducing the time and resources spent on training.[28] With a shortage of skilled workers in the semiconductor industry, AI can help fill the gap by improving productivity and enabling faster onboarding of new employees.[29]

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20 What is EDA (Electronic Design Automation)?

21 IMEC expert

22 Need to boost semiconductor fab efficiency? Look to maintenance

23 Yield prediction in semiconductor manufacturing using an AI-based cascading classification system

24 Insight from expert interview. See also: AI Driven quality control

25 IMEC expert

26 Ibid.

27 AI emerging markets: In finance, AI could identify underserved markets.

28 https://allpros.eu/resources/blueprint-report-bridging-skill-gap-semiconductor-sector

29 SME expert "*AI could easily replace it. Whether it's routing for PCBs or package design, the "chip" refers to the package itself. In an ideal situation, I would replace the routing work with AI. Additionally, I would use AI to maintain the system. Currently, there are five computers in the office, and each one runs a different system, making it difficult to understand why something works on one machine but not on another. With AI, we could standardise and maintain one system, potentially with a single OS across all machines.*"

3.1 THE NEED FOR OPEN INNOVATION PRACTICES IN THE INDUSTRY AND SMES

Open innovation (OI) is acknowledged as an important innovation management practice[30]. It refers to the strategic approach where organisations leverage both internal and external ideas, resources, and pathways to drive digital innovation. It also emphasises the importance of knowledge inflows and outflows to accelerate internal innovation and broaden markets for external use of innovations[31]. OI in the Industry 4.0 phase, is relevant to semiconductors and AI in semiconductors because it helps enterprises, no matter their size, to adapt to rapidly changing technologies and markets[32]. In the EU semiconductor industry, this specifically translates into being able to quickly adapt to new manufacturing processes, and improve product designs to stay competitive, and for SMEs, adopt cutting-edge software tools, including AI tools.

However, the capabilities of achieving OI differ between SMEs and larger enterprises[33]. For instance, SMEs often face financial constraints, making them less inclined to adopt and experiment with innovative practices like OI. In contrast, larger enterprises typically have greater financial flexibility, allowing them to explore and experiment more freely. The EU[34] and the Worldbank[35] both recognise SMEs as the backbone of the economy and the heart of innovation and entrepreneurship. This is why empowering SMEs to innovate is crucial, as it supports the advancement of Industry 4.0 and strengthens the EU's digital sovereignty, both of which are closely tied to technological innovation and entrepreneurship.

An enabler for OI, especially for SMEs, is open source software (OSS) tools[36]. OSS refers to software with source code that anyone can access, use, inspect, modify, and enhance[37]. If the paradigm of innovation is turned towards OI, then OSS tools can offer a platform for managing and facilitating it. These tools enable a collaborative environment where SMEs can access and contribute to AI development without facing significant resource barriers. Collaboration through OSS tools is highly cost-efficient, as the software is freely accessible and easy to evaluate. Additionally, co-creation promotes transparency, fostering zero-transaction-cost collaborations while ensuring legal clarity. By leveraging OSS solutions, SMEs can maintain their competitiveness in an increasingly innovation-driven market[38].

3.2 THE DIVERSITY IN INDUSTRY AND THE CAPABILITY TO INNOVATE

The ability to drive innovation in general, and OI in particular, varies significantly among industrial players[39]. Research indicates that industries with higher levels of human capital[40] are more likely to adopt AI at greater scales[41]. Given the diversity in industry capabilities and human capital across European countries, this disparity presents both challenges and opportunities for innovation in the region. On the other hand,

30 Open Innovation in SMEs; SMEs and open innovation
31 Open innovation as a field of knowledge
32 SMEs and open innovation
33 Ibid.
34 EU and SMEs
35 Worldbank and SMEs
36 OSS in the Automotive Industry- OpenForum Europe
37 What is OSS?
38 OS in the automotive industry- OpenForum Europe
39 Technological readiness in Europe EU policy perspectives on Industry 4.0
40 The European Human Capital Index
41 The role of human capital in AI intelligence adoption In Europe Human capital accounts for about one-third of AI adoption by firms a decade later, driven primarily by human-capital-intensive firms.

there are instances of employees that fear that AI will replace them, leading to a distrust of the new technology and results in a negative attitude of employees toward the usage of AI[42].

Moreover, technological innovation and thus competitiveness[43] in Europe is driven both by the EU and the capacity of the Member States to innovate.[44] This suggests that successful innovation is heavily influenced by the diverse infrastructure, regulatory frameworks, cultural capacities, and economic resources available at the national level within each Member State[45]. Access to funding, a conducive regulatory environment, and, in general innovation-fostering political culture of various domains all play a key role in fostering innovation that can transform the industry[46]. Therefore, Europe must adopt a more collaborative approach to remain competitive in the global innovation arena. This makes OI an even greater necessity, extending its application to a new level, collaboration at the national Member State stage[47].

3.3 THE BUILD-OR-BUY DILEMMA IN AI: VENDOR LOCK-IN RISKS AND OPPORTUNITIES FOR OSS

A recent report on AI usage in organisations suggests that there may be a need for new processes and approaches for deploying, as well as continuously monitoring and maintaining, AI systems[48]. The build-or-buy dilemma presents risks, such as SMEs facing vendor lock-in, while also creating opportunities for OSS development.

3.3.1 RISKS

One of the key drivers of the build-or-buy dilemma in AI is the resource gap between larger companies and SMEs. While larger companies have the flexibility to absorb potential errors in their AI investment decisions, SMEs face significantly higher risks. A poor investment in an AI provider could have severe consequences for their business or result in vendor lock-in, limiting their future options and competitiveness[49]. Moreover, proprietary AI vendors have emerged as the primary employers of top AI talent, creating a situation where companies must increasingly rely on these vendors as they absorb the best talent. This has given rise to the phenomenon of "AI Talent Wars" which intensifies competition for skilled professionals across industries[50]. For example, AI vendors dry up the talent pool, leaving few AI experts in the chip industry, and use software as a service (SaaS) models to create dependencies on their services and thus vendor lock-in[51].

Consequently, organisations face a range of other challenges when choosing their preferred tools. Firstly, they must determine how to select and collaborate with AI vendors in a way that is both efficient and does not compromise their competitiveness. For example, if a smaller-sized company lacks access to

42 The evolution of artificial intelligence adoption in industry
43 Strengthening the European competitiveness
44 Innovation policy. Article 173 of the Treaty on the Functioning of the European Union (TFEU), which states that 'the Union and the Member States shall ensure that the conditions necessary for the competitiveness of the Union's industry exist'.
45 Desi
46 Dynamic Capabilities and Strategic Management. Dynamic capabilities are higher-level processes that help organisations adapt to emerging demands, develop new abilities, and efficiently coordinate resources. To enhance innovation, firms must transform processes, structures, and leadership, and adopt open innovation, networking, and new governance. For instance, combining external and internal practices and decentralising management are key to fostering innovation
47 Competition, open innovation, and growth challenges in the semiconductor industry: the case of Europe's clusters.The analysis indicates that the challenges facing the industry stem from the structure of the industry in Europe and the structure of the wider European technology industry.
48 How organisations can choose between buying and building AI systems
49 SMEs & Large Companies- Build or Buy Dilemma
50 AI Talent Wars
51 AI vendor lock-in SAP

the necessary capabilities and datasets to develop competitive models, it may fall behind competitors who have access to more advanced AI tools, all while operating at the same price point in the market[52]. Additionally, companies need a strategy for developing their internal AI capabilities in an environment that is dynamically evolving and of short-term talent scarcity. In other words, the main dilemma lies in the fact that there is a security and a vendor lock-in risk when it comes to externally provided AI models to manage aspects of an SME's supply chains.

3.3.2 OSS OPPORTUNITIES

On the other hand, if the AI is "in-house", it will be more limited in the available data[53]. While there is no one-fit solution to the build-or-buy dilemma, existing literature[54] suggests the key factors influencing the decision are operational costs, data acquisition, and the suitability of the approach for each case. To be more specific, business leaders need to consider what fits better with their existing operating model. For AI, the make-or-buy decision has important factors, including the extent to which the buyer trains the acquired learning module and the degree to which their data is used, as opposed to publicly available or supplied data, for training. Implementation and the operational cost comparison are key factors in swaying organisations' decisions one way or the other.[55]

Furthermore, larger companies with substantial computing and resource power can opt for a balance of building some AI capacities in-house and using external providers[56]. However, as was mentioned above the same cannot be said about SMEs as they do not have the same resources to balance the dilemma. Research suggests that OSS tools, which can facilitate OI, may help address this issue. For example, companies require a balanced approach that combines proprietary systems (buy) with OSS (build). OSS enables low cost in-house development and deployment while leveraging externally developed software, fostering innovation and reducing dependence on proprietary vendors. More specifically, OSS foundations can provide open platforms, a safe space for companies and competitors to collaborate on shared standards and building blocks, overcoming conservative culture (for example the mentioned fear of AI through co-creation, transparency and risk aversion that might otherwise inhibit open collaboration[57].

52 How organisations can choose between buying and building AI systems

53 Fraunhofer expert *"some companies don't have enough data or they just choose to rely on someone who has a better model and then I think maybe the issue of security will come up."*

54 Make or Buy Strategy for AI in Automotive: How Much "Make-AI" is Necessary to Succeed?

55 SME expert

56 Bosch experts

57 OSS in the automotive industry- OpenForum Europe

4. Challenges to the implementation of AI in the EU chip industry

The successful implementation of AI largely depends on an organisation's current practices and its ability to plan for future technologies[58]. Based on the interviews conducted and the limited literature on AI implementation challenges specific to the EU chip industry, it is evident that integrating AI across the semiconductor value chain presents interrelated challenges that affect every stage of the process. These challenges are technical, financial, and legal in nature.

4.1 TECHNICAL AND FINANCIAL CHALLENGES

The industry faces a severe talent shortage, and the lack of specialised expertise further complicates AI adoption in both chip design and manufacturing. Moreover, deploying AI in EDA demands professionals skilled in both AI and semiconductor design, adding another layer of complexity. Today, the semiconductor industry is also facing growing challenges due to complex production processes and limitations stemming from Moore's law[59]. As transistors continue to shrink, it becomes more difficult to sustain cost efficiency, maintain high quality, and achieve performance improvements. This escalating complexity amplifies the need for advanced AI solutions, while simultaneously making their integration more challenging across design, manufacturing, and testing phases

Another crucial challenge revolves around the lack of resources from SMEs to use AI. This constraint intensifies the build-or-buy dilemma, making it a critical decision that can shape their long-term viability. While AI can lead to cost savings, the initial investment in AI-powered tools and technology can be significant and thus SMEs might face financial challenges to its integration[60]. As a result, SMEs may face financial challenges in integrating AI, which could lead to their exclusion from utilising it or force them to opt for cheaper, less effective alternatives. Moreover, due to limited budgets, many SMEs cannot afford consultancy services for EU funding proposals, resulting in missed opportunities[61]. In addition to that there is a prevailing culture where SMEs feel discouraged from challenging competition outcomes, as raising concerns may lead to exclusion[62].

4.2 REGULATORY AND LEGAL CHALLENGES

One other known issue with applying AI in the industry is the domain of data management and legal complexity,[63] which also impacts all AI-related processes. An AI solution is as good as the data it processes. Unwillingness or legal challenges to the provision of data or inaccuracy and incompleteness thereof can lead to poor-quality analytics, and thus poor decisions and designs. Moreover, much of the data required to train AI systems is proprietary and limited in quantity. Companies without the necessary resources to generate this data themselves may struggle to develop AI systems capable of effectively generalising across different chip designs and manufacturing processes.

58 Blueprint Report: Bridging the Skill Gap in the Semiconductor Sector
59 Moore's law
60 SME expert
61 SME expert
62 Ibid.
63 Fraunhofer expert

When acquiring data, a company must exercise appropriate due diligence to comply with data protection and privacy issues. In the background interviews, industry representatives complained about regulatory complexity, which made it difficult to determine the extent to which industrial data is covered by appropriate legislation, e.g. the AI Act[64]. This uncertainty has created excessive barriers to implementation, slowing down the uptake of AI and stoking fears of legal transgressions among employees[65]. Simultaneously, the interviewees underlined that regulations should ensure to assist companies to their due diligence in data usage, but without becoming overly complex, as excessive complexity can create barriers to trust in using AI for the different processes.

64 Bosch experts
65 Bosch experts

5. Policy recommendations

Based on an analysis of AI usage across the semiconductor value chain, the capabilities needed for innovation and specifically OI, the challenges faced by implementers, and the barriers to applying AI within this sector, this section will present policy recommendations aimed at positively shaping the future of the chip design industry in the EU. These recommendations focus on the benefits of providing more targeted support for SMEs, enhancing STEM education, enabling OI and establishing clearer rules and procedures for governing AI applications. They are derived from a thorough literature review and cross-referenced through interviews with experts from industry, research, and SMEs.

5.1 PROMOTE STEM EDUCATION, TRAINING, AND FOSTERING OF AI TALENT

A key challenge identified in the ongoing development of AI is the decreasing interest in STEM (Science, Technology, Engineering, and Mathematics) fields in the EU and thus the lack of expert human resources. This trend limits the talent pool and undermines the growth of a workforce capable of leveraging AI technologies. The challenge was also highlighted in the ALLPROS.eu "Impact of AI and GenAI on the Semiconductor Industry"[66] webinar.

- **More investments from Member States in STEM education at all levels with an emphasis on AI and digital skills to ensure the future workforce is prepared to meet the demands of an AI-driven economy:** Based on the recommendations from the Commission's research service and the current Commission's political guidelines, educational policies of Member States should stimulate interest and access to STEM. The Commission prioritises increasing student interest, participation, and achievement in STEM fields, expanding student access to qualified STEM teachers and leaders, reducing disparities in STEM talent and skills, and building community awareness and support for STEM education. It is crucial to avoid ambiguities in defining STEM concepts, identify the specific outcomes that need to be measured, develop or adapt tools to assess these outcomes, and evaluate the effectiveness and feasibility of educational practices and programmes. The same considerations should apply for the education of employees as well, to build a strong talent pool across the EU.

- **The EU should facilitate the flow of international AI talent to the EU by reevaluating immigration pathways for technical professionals to address the skills challenge**: The "Impact of AI and GenAI on the Semiconductor Industry" white paper report[67] proposed that this should be paired with strengthening talent competitiveness in Southern and Eastern Europe by focusing on reskilling, upskilling, improving economic conditions, and strategically investing in innovation and research for sustainable growth. While undertaking reforms of national and EU labour and migration laws is necessary to accommodate the personnel shortages and demographic changes across the EU, this process is politically sensitive and gradual. Thus, it is recommended that in the short-term the EU amplifies the existing initiatives and funds projects that help fill critical gaps in the AI workforce and support innovation across the region. Here, EU-funded initiatives such as the Digital Explorers[68], a Baltic-based consortium connecting ICT specialists from Nigeria, Kenya, Armenia, and Iraq with opportunities in the Baltic region, should be further supported and replicated across other geographies. Similarly, the GreenChips-EDU project[69] is spearheading efforts to enhance vocational education, training, and student mobility in microelectronics.

66 The Impact of AI and GenAI on the Semiconductor Industry
67 Blueprint Report: Bridging the Skill Gap in the Semiconductor Sector
68 Digital Explorers
69 Greenchips-edu

By bringing together schools and businesses from across the EU, including underrepresented countries like Italy, Portugal, and Croatia, alongside an international partner from Burkina Faso, the initiative fosters collaboration and broadens opportunities in the field.

- **Facilitate cross-border knowledge transfer for business to address the skills challenge**: Policies should remove barriers to either knowledge sharing between EU-based and international companies or cross-border mergers and acquisitions (M&A), which can enable EU companies to access global knowledge and technology, thus reaffirming the idea of OI. This will support the growth of AI capabilities within SMEs and foster international collaboration. One example of economic policy areas for Member States to follow to ameliorate M&A on can be Cyprus[70]. It boasts an attractive cross-border merger regime, with benefits like VAT-exempt mergers, reduced administrative costs, and a favourable business environment. Another example is Estonia's eResidency program[71], which provides a digital identity for opening and registering businesses in Estonia with minimal digital administrative effort and no need for a fixed location. With that, "eResidents" gain access to the EU business ecosystem and Estonian public e-services.

- **Collaborate with OS consortia to develop curricula that incorporate real-world projects and promote collaborative learning for cross-border knowledge transfer:** Establishing cross-border educational initiatives can foster international collaboration and knowledge sharing in AI and semiconductor technologies, strengthening the talent pipeline and enhancing innovation across industries. Collaboration can take various forms, including interdisciplinary education, cross-border learning programs, shared methodologies, OS initiatives, and joint research. These efforts foster OI and thus knowledge exchange, and skill development on a global scale.

- **Strengthen and expand policies like the European Open Science Cloud[72] across Europe:** This platform supports multidisciplinary and multinational research by promoting the use of FAIR (Findable, Accessible, Interoperable, Reusable) data and supplementary services. Expanding its scope to include collaborations with industry players could help define standardised interfaces and architectures while developing modular, flexible, co-created, and cost-effective open-source AI tools for every enterprise to use[73].

5.2 ENHANCE INDUSTRY COMPETITIVENESS THROUGH AI TRANSPARENCY, EXPLAINABILITY, AND TRUST

As AI systems become more integrated into business operations, these systems must remain transparent and understandable[74]. To ensure the adoption of AI is grounded in trust, the EU should support businesses to establish clear rules around ownership, management, and traceability of AI applications to prevent misuse and ensure accountability. Additionally, policymakers must make sure to mandate explainable AI systems, where the processes and outcomes of AI solutions are transparent, understandable, and verifiable. This will help businesses and consumers trust AI-driven decisions and optimise machine learning algorithms with reliable data.

- **Policymakers should promote the successful integration of the AI Act that, from February 2025 onwards, requires AI systems to be explainable, so users can transparently understand how solutions are derived**[75]: This recommendation can minimise the risk of errors like AI hallucinations. However, they should strive to strike a balance between implementing regulations and preserving the competitive

70 Eu cross border mergers for business restructuring and optimisation
71 eResidency
72 EOSC EU Node
73 OSS in the automotive industry- OpenForum Europe
74 Bosch experts, IMEC expert
75 Guidelines on AI system definition to facilitate the first AI Act's rules application

potential that AI can unlock for the European industrial ecosystem[76]. Additionally, regulations should avoid excessive complexity to prevent creating barriers that hinder public trust in AI. Overly complicated rules can lead to delays in implementation, which runs counter to the government's goal of fostering AI adoption and progress.[77]

- **Member States should prioritise Article 57[78] of the AI Act, which promotes the establishment of national regulatory sandboxes until August 2026**: These sandboxes offer a controlled environment for companies to test AI technologies under regulatory supervision. This process can further be enhanced by the collaboration of businesses, startups, and research institutions with regulators, creating a structured framework that reduces compliance uncertainty, empowers competitiveness and enhances trust in the regulation.

- **Integrate OS and OI practices into the national regulatory sandboxes**: A more specific proposal to advance collaboration for transparency, explainability, and trust is to elaborate on OI practices for the regulatory sandboxes. Actions could include promoting OS created AI tools and frameworks that emphasise these values, encouraging participation from OS communities to drive innovation and accountability (e.g., through code reviews, audits, and possibly hackathons). For example, OS platforms provide a clear framework for data sharing and collaboration, reducing legal uncertainties and facilitating compliance with regulations like the AI Act.[79] These endeavours will overall support regulatory sandboxes to test and validate OS AI solutions and will provide a collaborative environment for experimenting with new approaches under close monitoring that can also be overseen by the respective Member State AI regulatory bodies, thus leading to the amelioration of regulatory complexity.

5.3 FOCUS ON SMES AND CREATE A SUPPORTIVE OS AI ECOSYSTEM FOR THEM

As mentioned before SMEs are fundamental for the European economy[80]. However, these enterprises often face significant challenges in adopting and integrating AI technologies due to financial constraints, limited resources, and inadequate support structures. To ensure that SMEs can leverage the full potential of AI, the following policy actions are recommended.

- **The EU should ensure sustainable funding for SMEs and encourage a more democratic feedback system:** While the EU supports various aspects of SMEs and acknowledges the challenges they face in competition[81], there is still room for improvement, particularly in ensuring sustainable funding. This issue can affect various aspects of SMEs, including their ability to secure financial resources. For example, as mentioned before due to limited budgets, many SMEs cannot afford consultancy services for EU funding proposals, resulting in missed opportunities[82]. Additionally, there is a prevailing culture where SMEs feel discouraged from challenging competition outcomes, as raising concerns may lead to exclusion[83]. This highlights another area for improvement: creating a fairer and more transparent funding competition process. would help SMEs improve their proposals and compete on equal footing with larger corporations.

- **The EU and the Member States should support SMEs in developing similar capabilities with larger companies and provide them with strong advocacy and guidance for AI adoption:** Larger companies

76 Bosch experts, IMEC expert
77 Ibid.
78 AI Act Article 57
79 OS in the automotive industry-OpenForume Europe
80 The Council-European SMEs
81 Ibid.
82 SME expert
83 Ibid.

have the resources to establish dedicated departments focused on AI implementation and related areas such as cybersecurity[84]. Current EU policies should aim to support SMEs in developing similar capabilities or, at the very least, provide strong advocacy and guidance for AI adoption. By educating employees and fostering proficiency with AI tools in the workplace, these measures can help SMEs strengthen their operations and encourage widespread adoption of AI technologies. Member States should also encourage SMEs to participate in the aforementioned regulatory sandboxes to bridge communication gaps and promote open innovation through collaboration.

- **Facilitate open source tools for private sector contributions to public data trusts:** SMEs should also embrace open innovation by sharing knowledge externally and receiving internally. This recommendation would enable them to cooperate, exchange expertise, tools, data, and solutions, ultimately enhancing their skills and enabling them to compete more effectively with larger companies. The facilitation of open source tools for private sector contributions to public data trusts will be under the auspices of the Data Governance Act (DGA)[85] under the chapter of data altruism. This would give SMEs access to more data to share and incorporate into their processes.

- **The EU should provide financial and regulatory incentives for the OS community to develop and maintain tools specifically designed for SME operations and data exchange**. Research[86] shows that while the private sector is willing to engage in data altruism, this is often hindered by a lack of data-sharing tools. Also, SMEs struggle to acquire and utilise AI-enabling software due to financial constraints[87]. The cost-effective, transparent, customisable, and collaborative development of OS solutions can help build trust and encourage their adoption by SMEs. The nature of OS can help SMEs overcome financial barriers while maintaining control over their systems.

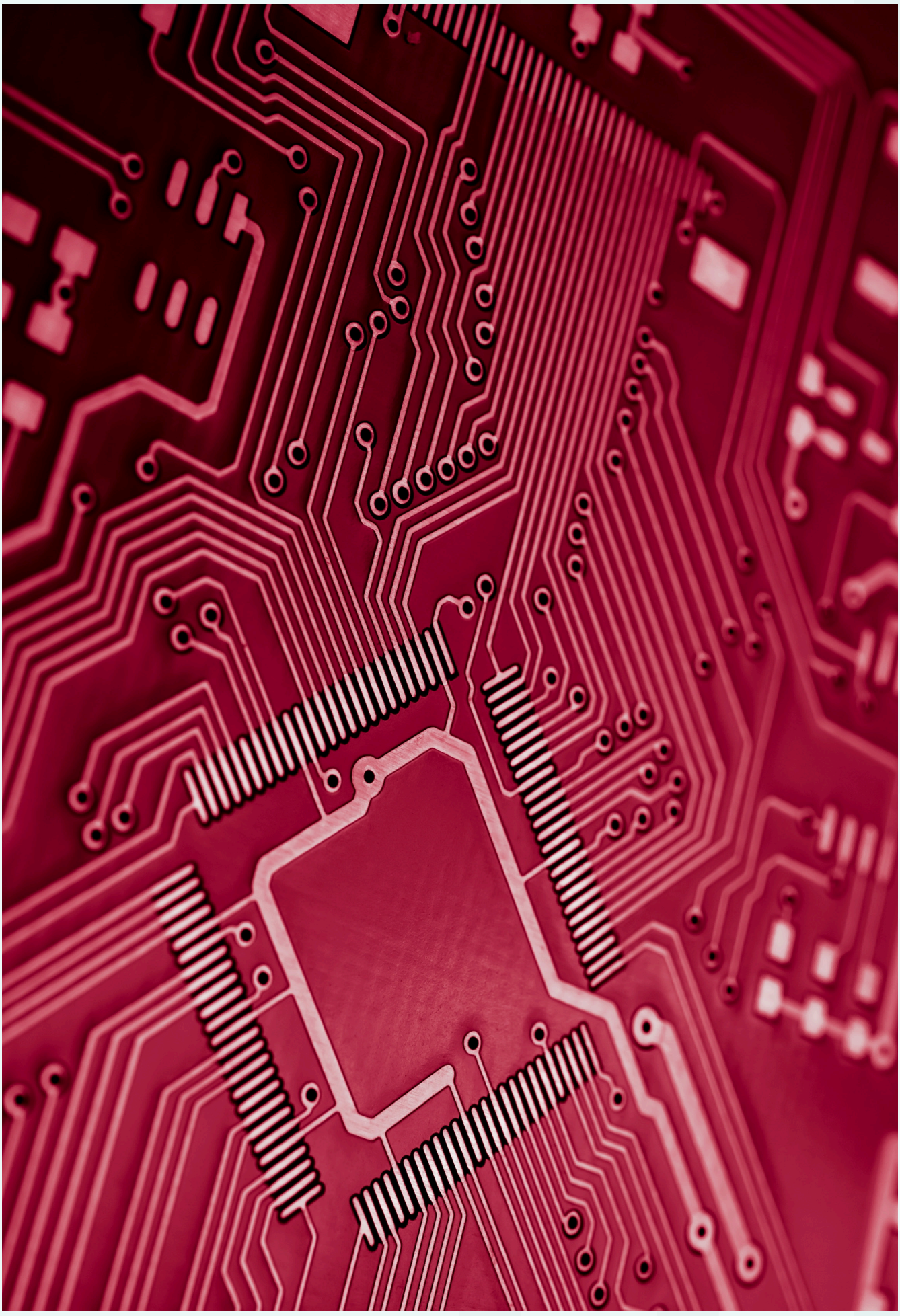
- **Policymakers and SME leaders should encourage the adoption of open standards to foster competition and support the use of OSS:** OS tools are typically challenging to use by SMEs due to a lack of proper documentation of the software[88]. Policies, for example, boosting the governance of OS projects or the creation of open harmonised technology standards[89] should support the development of user-friendly, well-documented, and regularly updated interoperable open source solutions. These tools should balance security, usability, transparency, and flexibility, enabling SMEs to leverage AI and manage other processes without the high costs of proprietary solutions. To avoid potential vendor lock-in, policymakers and SME leaders should encourage the adoption of open standards. These standards must be designed to ensure full implementability within OSS frameworks[90].

- **OS tools and methodologies should be designed and used to foster international collaboration, benefiting not only SMEs but also enterprises involved in chip design**: This approach strengthens open innovation and enhances the competitive advantage of the European industry in total. That is because at the silicon level, the introduction of new chip concepts, through standards such as the UCIE[91], plays a crucial role. These standards enable the creation of modular chip designs by allowing different chips to be seamlessly combined. While not an OS in the traditional sense, UCIE represents an open standard that fosters collaboration and innovation. This approach is vital for advancing the field, as it accommodates the growing diversity of applications. By adopting modular chip systems, the ecosystem becomes more inclusive, enabling specialised players to contribute niche chips that, when integrated, form more comprehensive and advanced systems.[92]

84 Bosch experts
85 Data Governance Act
86 Data Altruism
87 SME Expert
88 SME Expert
89 Harmonised standards
90 OSS in the automotive industry- OpenForum Europe
91 UCIE standards
92 IMEC Expert

- **Learn from the governance and open innovation systems of Mittelstand and Sematech**: Lessons from the *Mittelstand*[93], a network of SMEs in Germany, Austria, and Switzerland that has successfully navigated economic shifts since the 1960s and penetrated into solid markets such as the Japanese, offer valuable insights into SME collaboration. To thrive, SMEs need support and cooperative frameworks, much like the Mittelstand model, where SMEs specialise in niche markets and leverage shared platforms to integrate their solutions and expand globally. These platforms help address key challenges, such as legal uncertainties, that often hinder collaboration and create new industry standards. A similar approach was taken in the United States with Sematech in the 1980s, a nonprofit consortium uniting public and private partnerships among chip manufacturers, aimed at closing the competitive gap with Warsaw Pact countries through flexible governance and open collaboration[94]. These approaches underline the importance of open collaboration and thus OI in keeping SMEs competitive in an increasingly dynamic global economy.

93 Lessons from the Mittelstand
94 Sematech



6. Summary

AI technologies can offer significant benefits to the EU's chip production and pave the way for the EU's digital and technological sovereignty. However, successfully implementing AI for these purposes comes with significant challenges These challenges can be solved with specific points of focus for European policymakers both on the EU and on the national level. This policy brief presents key recommendations to advance STEM education and training for AI talent development, strengthen industry competitiveness through AI transparency, explainability, and trust, and foster a collaborative and supportive AI ecosystem for SMEs. A unifying principle that connects these recommendations is open innovation, which facilitates collaboration, transparency, and the exchange of skills and knowledge to drive AI-driven growth and success.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