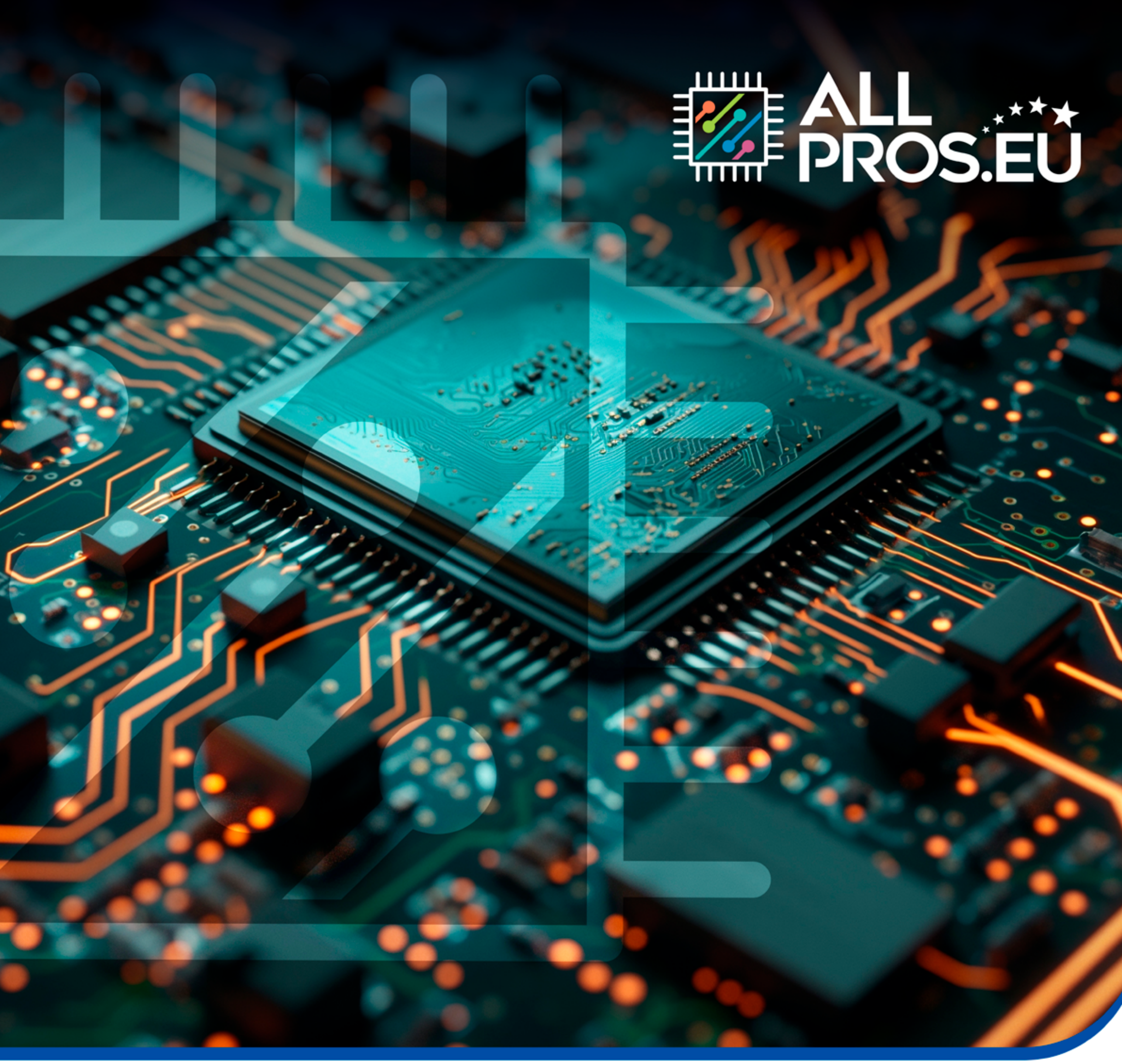

POLICY BRIEF

Chip Design: Challenges and Opportunities for the Chip Design industry in the EU

Funded by the European Union

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The second ALLPROS.eu policy brief zooms in on the current state and the possible future of the EU's chip design sector. The brief covers the main challenges and opportunities facing European players in this space, taking into consideration market, policy, and geopolitical dynamics. It incorporates a review of existing literature, an analysis of industry reports, and insights from semi-structured interviews that altogether support the SWOT analysis and feed into targeted policy recommendations for EU and national decisionmakers.

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Introduction

This policy brief aims to shed light on the current state of the chip design market within the EU, identify challenges and opportunities, and propose actionable recommendations to enhance competitiveness and innovation in the sector. This brief is designed for EU policymakers, semiconductor industry stakeholders, and academic scholars interested in the chip design sector and regulation of the chip industry more broadly. The brief does so by providing a background on the functioning and importance of the chip design sector in Europe, followed by a comprehensive overview of the current challenges and opportunities that are matched with targeted policy interventions. The analysis presented in this brief is based on a mixed-methods approach, building on a SWOT analysis that incorporates a review of existing literature, an analysis of industry reports, as well as insights from semi-structured interviews with actors in the semiconductor technology and policy space.[1]

1 In trying to keep this policy brief concise, the analysis will not incorporate aspects related to artificial intelligence (AI). However, it is worth noting that with the rise of AI, the demand for chips is also growing. Here, AI not only plays a role in driving advancements in the performance of integrated circuits, but also significantly increases the demand for chips due to its high computational requirements. AI is also used across the supply chain in general and in chip design in particular; it aids with the design, verification, and testing of devices, and its high computing power enables much faster and more effective processes.

Chip design in context

The chapter sets the scene for the analysis and policy recommendations presented in the policy brief. It explores the intricacies of the chip design process, the key players shaping the market, and the unique characteristics of this competitive and capital-intensive sector. It also examines the European Union's current standing and capabilities within this strategic domain, providing a foundation for understanding the opportunities and challenges that lie ahead for the EU in strengthening its chip design ecosystem.

CHIP DESIGN PROCESS AND ACTORS

The manufacturing of semiconductors encompasses three major stages: chip design, production, and final assembly, testing and packaging (ATP) stage.[2] The semiconductor industry sees a variation of business models across the supply chain, with the resulting web of dependencies making the industry particularly sensitive to butterfly effect-like disruptions. In the chip design process, electronic design automation (EDA)[3] and intellectual property (IP) providers are instrumental. They play an important role in intermediation between the designers and foundries, ensuring that the building blocks used in the design process correspond to the fab's manufacturing specifications. Moreover, due to a high degree of specialisation and costs associated with chip design, specialised design service companies are also present in the market and can act as intermediaries. Finally, original equipment manufacturers (OEMs) are prominent in design, since they integrate the production of a chip from design and manufacturing down to ATP, particularly when it comes to highly specialised chips, e.g. in the automotive and cloud computing space.

While integated device manufacturers (IDMs) combine all three steps (design, manufacturing, ATP) in-house to pool resources and maximise their output, the growing technical complexity of integrated circuits sees more companies specialise in just one of the steps. Thus, some companies follow a "fabless" model, whereby they design their chips and collaborate with foundries to manufacture the products. These are later transferred to outsourced semiconductor assembly and test (OSAT) vendors, who take care of the packaging and testing of the finished products.[4] Free of the large capital expenditures of manufacturing, fabless companies can focus their expertise and resources on innovations in design and partner with dedicated foundries for fabrication.

The global chip design market is characterised by several key features that shape its growth and development. Chip designers rely on a multitude of R&D processes and IP blocks, with the majority of these inputs being highly specific and high-cost, which in turn generates high barriers to entry for newcomers. The more advanced the chip, the higher its production costs, since greater precision is required for the manufacturing of more technically complex models – and, as chips get smaller, challenges related to quantum effects and minor structural variations arise.[5] Moore's law, the observation that the number

2 For a detailed overview of the semiconductor value chain and its segments, see: European Commission "European Chips Act: Staff Working Document" (12 May 2022), p. 7-12 https://digital-strategy.ec.europa.eu/en/library/european-chips-act-staff-working-document.

3 EDA toolkits are software applications used by designers to create, analyse, and verify the functionality and performance of electronic circuits.

4 Variations across the three models apply, see eg. Harald Bauer et al. "Semiconductor design and manufacturing: Achieving leading-edge capabilities" (McKinsey, 20 August 2020) https://www.mckinsey.com/industries/industrials-and-electronics/our-insights/semiconductor-design-and-manufacturing-achieving-leading-edge-capabilities#/

5 Ibid

of transistors in an IC doubles every two years, has reached its limits related to quantum uncertainties. With that, "More-Moore" and "More-than-Moore" devices focus on improving certain components of the circuits and diversifying its functionalities respectively.[6] Thus, chip design remains as the most R&D-intensive segment of the supply chain; according to Commission estimates, it accounts for between 20-65% of total industry R&D.[7]

THE EU'S ROLE IN CONTEXT

Overall, the state of play in the chip design industry is not favourable to Europe. The US holds a dominant position in the market in the first segment of the chip design space, particularly EDAs, thanks to American companies like Cadence, Synopsys and Ansys holding a near-monopoly.[8] Moreover, major players like Intel, Qualcomm and Broadcom, who are leading the charge in designing chips for the newest applications, are also headquartered in the US. Taiwan is another important region and home to companies leading in multimedia, computer peripheral and telecoms chip design (MediaTek, Novatek, Realtek). Trailing behind Taiwan are Chinese fabless companies, which hold a market share of 15% in 2019.[9] South Korea is another important player, excelling particularly in the field of memory chips like DRAM (dynamic random access memory) and NAND ("not-and") flash, even threatening to overtake China's output.[10]

Despite many promising steps, the EU's approach to supporting its chip design market is short of achieving the goals set out in its seminal EU Chips Act.[11] Firstly, EU semiconductor players must navigate the same global trends impacting the rest of the industry, such as the need for significant investment in leading-edge manufacturing capabilities and the shift towards applications in AI or wireless technologies. Additionally, the EU is facing a set of challenges particular to its ecosystem, like the so-called "skills gap" and the Union's slow-maturing start-up scene. Finally, the EU has been particularly affected by the fluctuations in access to semiconductors due to its heavy reliance on outsourcing and chip imports.[12] As identified by the Commission, the "lack of autonomous and unrestricted access to semiconductors could have a considerable impact on the competitiveness of different European strategic sectors, the security of EU citizens and the Union's strategic autonomy and economic security."[13]

6 Rosalie Knot "More than Moore: the next steps for the semiconductor industry" (Delmic, 25 May 2023) https://blog.delmic.com/more-than-moore-the-next-steps-for-the-semiconductor-industry

7 European Commission (2022) p. 9

8 Some European companies are gaining steam in the market, particularly Siemens AG. See also:

9 Jan-Pieter Kleinhans "The global semiconductor value chain – primer for policymakers" (Stiftung Neue Verantwortung, 2020) p. 12. https://www.stiftung-nv.de/sites/default/files/the_global_semiconductor_value_chain.pdf

10 Sam Kim "South Korea's Dominance in Chips Poised to Increase as US Squeezes China" (Bloomberg, April 21, 2023) https://www.bloomberg.com/news/articles/2023-04-21/south-korea-s-dominance-in-memory-chips-poised-to-increase-as-us-squeezes-china

11 Regulation (EU) 2023/1781 of the European Parliament and of the Council of 13 September 2023 establishing a framework of measures for strengthening Europe's semiconductor ecosystem and amending Regulation (EU) 2021/694.

12 The EU's trade deficit in the chip sector is significant, as the bloc consumes twice as many chips as it manufactures (about 20% compared to 9%). See also: Jordan Bish et al, "A new dawn for European chips" (Deloitte, 2 November 2022) https://www2.deloitte.com/us/en/insights/industry/technology/semiconductor-chip-shortage-supply-chain.html

13 European Commission, "European Chips Act – Questions and Answers" (30 November 2023) https://ec.europa.eu/commission/presscorner/detail/en/qanda_23_4519

SWOT Analysis

The following SWOT analysis comprehensively outlines the advantages and shortcomings that underlie Europe's chip design ecosystem, and sets the scene for policy recommendations.

STRENGTHS

ESTABLISHED PARTNERSHIPS IN THE EUROPEAN RESEARCH-ACADEMIA ECOSYSTEM

The EU's clear strength lies in its well-developed R&D infrastructure. **The EU is home to some of the world's leading RTOs specialising in semiconductor research and design, with the resulting R&D infrastructure positioning it at the forefront of innovative chip design.**[14] Simultaneously, Europe's universities are continuously innovating their curricula to accommodate for the demand of skilled employees in the chip sector, with a growing number of universities offering summer schools, Master's degrees and specialised courses in the field, combining a strong research focus with practical applications.[15] Furthermore, research institutes that are embedded in local ecosystems help to enhance Europe's R&D capabilities, e.g. MESA+ (the Netherlands)[16] or ICFO (Spain).[17] By collaborating closely with leading semiconductor firms, research institutions can direct their efforts toward solving real-world challenges by responding to industry needs, like in the case of a licensing agreement between X-FAB and IHP Leibniz.[18] On a larger scale, technology parks and innovation hubs, such as Silicon Saxony (Germany)[19] and Sophia Antipolis (France),[20] bring together upcoming and established companies and link them with research expertise.

The EU also plays a role in connecting industry and academia, as exemplified by the latest iteration of its private-public partnership in semiconductors, the Chips Joint Undertaking (Chips JU).[21] Chips JU was set up under the EU Chips Act and is responsible for the implementation of the Pilot Lines, which provide the means for the industry to test, experiment and validate novel prototype system designs in breakthrough technologies.[22] Another way in which the EU supports the research-industry collaboration is through consortia sponsored under Horizon Europe. Funds disbursed under Horizon Europe support a few chip design-specific initiatives that aim at strengthening the EU's capabilities to develop next-generation chips.[23] While Europe excels in creating cutting-edge research, there's a recognised gap in translating these technological advancements into commercially viable products at scale.

14 See e.g. CEA-Leti https://www.leti-cea.com/cea-tech/leti/english/Pages/Welcome.aspx

15 For more, see: Silvana Muscella et al. "Blueprint Report: Bridging the Skills Gap in the Semiconductor Sector. A coordinated approach and Call to Action for the semiconductor community" (ALLPROS.eu, 2 July 2024) p. 16-18 https://allpros.eu/resources/blueprint-report-bridging-skill-gap-semiconductor-sector

16 ALLLPROS.eu "Best Practice: MESA+ Institute" (20 August 2024) https://allpros.eu/resources/best-practice-mesa

17 ICFO – The Institute of Photonic Sciences https://www.icfo.eu

18 X-FAB, "Licensing agreement between X-FAB and IHP Leibniz Institute leads to innovative 130 nm SiGe BiCMOS platform" (12 September 2022) https://www.xfab.com/automotive/news-detail-page/article/licensing-agreement-between-x-fab-and-ihp-leibniz-institute-leads-to-innovative-130-nm-sige-bicmos-platform

19 For more, see: https://silicon-saxony.de/en/

20 For more, see: https://www.sophia-antipolis.fr/en/

21 Chips JU https://www.chips-ju.europa.eu

22 Chips JU – Pilot Lines https://www.chips-ju.europa.eu/Pilot-lines/

23 E.g. Infrachip, which unites ten partners who are developing the first integrated, distributed research infrastructure in Europe that enables Lab-to-Fab solutions for the sustainable development of future chips. For more, see: https://infrachip.eu

STRONG SPECIALISED MARKETS

European dominance in specialised semiconductor markets like automotive, industrial, and IoT is supported by a combination of historical expertise and focused industry leadership. STMicroelectronics (France), a European semiconductor leader, excels in producing chips for smart driving and smart industry applications. Similarly, Infineon (Germany) is renowned for its power semiconductors used in automotive electronics, energy-efficient solutions, and IoT devices. European chip firms benefit from a closely integrated ecosystem that includes leading automotive manufacturers like Volkswagen and BMW (Germany), which are pioneering the integration of advanced electronics for electric and autonomous vehicles.

Europe's specialised markets have carved out a niche that is less susceptible to the intense competition seen in more commoditised semiconductor markets, like leading-edge and cutting-edge applications of AI and ML. This trait also introduces more stability to the supply chain, since company-specific custom solutions are less affected by fluctuations in demand, although *force majeure* disruptions (like the Covid-19 pandemic) are an exception.[24] The prevalence of analogue semiconductors and sensors means that Europe's chip industry is also less affected by the node shrinkage competition. Instead, innovation in more traditional semiconductors, such as power supply chips or radio frequency applications, is driven by innovations in chemistry and utilising new materials, e.g. silicon-carbide (SiC) or gallium-nitride (GaN).[25]

By concentrating on high-value, application-specific chips for automotive, industrial, and IoT uses, European companies are able to command higher margins and establish long-term partnerships with key industry players.

WORLD-LEADING MATERIALS AND EQUIPMENT PROVIDERS

Europe's strength in semiconductor materials and equipment is critical to its overall competitiveness in the global market. ASML (the Netherlands) stands out as a world leader in the production of advanced photolithography machines essential for advanced chip manufacturing. Their extreme ultraviolet (EUV) lithography machines are fundamental to producing smaller, more efficient chips and are utilised by the biggest foundries and IDMs in the world, including Intel, TSMC and Samsung. The region also hosts significant players in the semiconductor materials sector, with companies such as Merck KGaA, Linde, BASF (Germany) and Air Liquide (France) leading the charge in specialty gas and chemical markets, supplying front-end manufacturers with crucial materials. Europe's leadership in this sector embeds it deeply into the global supply chain, and furthers the competitive position of local businesses by embedding them in the global market.

24 Fraunhofer IIS "Bright minds wanted for chip design in Europe" (27 March 2024) https://www.iis.fraunhofer.de/en/magazin/series/chipdesign_in_europe/bright_minds_chip_design_europe.html

25 Kleinhans (2021) p. 12

WEAKNESSES

MISDIRECTED FOCUS ON STRENGTHENING CHIP MANUFACTURING

Europe is lagging behind other regions in manufacturing capacities (declining from 24% of global production capacity in 2000 to 8% in 2022).[26] Currently, chip production in Europe encompasses primarily mature technology, with only a small fraction of production focusing on advanced technologies.[27] So far, Europe has no capacity to produce cutting-edge chips and plays a minor role in computer chip design, accounting for only 2% of the market for chip design outside of companies that both design and produce chips.[28] Indeed, the top 10 IC designers do not include a single European company, with the field dominated by the US, Taiwan, and China.[29] Thus, **Europe faces a significant gap in the design and manufacturing of both cutting-edge and trailing-edge computing chips, largely due to the lack of demand from the local customer base, which focuses on industrial and automotive uses.**[30] While notable exceptions exist, the prevailing lack of European industrial end-users stands in the way of increasing the EU's manufacturing capacities. Thus, the EU Chips Act-led efforts to on-shore production on a large scale might be misguided, as "the expense and level of technological sophistication required mean that it will be years before Europe can develop cutting-edge manufacturing capabilities."[31]

Indeed, **the EU Chips Act funding has already gone a long way to ensuring more European and non-European investment in manufacturing**. In 2023, a slew of new manufacturing, R&D and chip design centres across the EU was announced by the American giant Intel,[32] although these investments have since been put on hold due to the company's reshoring efforts.[33] Intel's pivot stands as a clear example of the risks associated with overreliance on manufacturing. Additionally, experts warn that the focus should shift from building up a "mega fab" capacity to shoring up industrial strongholds (e.g. automotive) to play into the existing strengths of the local chip market.[34]

FINANCING AND REGULATORY CHALLENGES FACING EUROPEAN START-UPS

Start-ups continue to play a leading role in the semiconductor design space, with the majority of chip start-ups being active in this market segment.[35] Entering the chip design space is often more feasible for start-

26 European Semiconductor Industry Association, Strengthening the Global Semiconductor Supply Chain in an Uncertain Era, p. 5.
27 ASML, Position Paper on the Chips Act (4 February 2022) p. 4 https://edge.sitecorecloud.io/asmlnetherlaaea-asmlcom-prd-5369/media/project/asmlcom/asmlcom/asml/files/news/2022/asml-position-paper-on-eu-chips-act.pdf
28 Alicia García-Herrero and Niclas Poitiers,"Europe's promised semiconductor subsidies need to be better targeted" Bruegel (17 October 2022) https://www.bruegel.org/blog-post/europes-promised-semiconductor-subsidies-need-be-better-targeted
29 Trendforce, "Top Ten IC Design Houses Ride Wave of Seasonal Consumer Demand and Continued AI Boom to See 17.8% Increase in Quarterly Revenue in 3Q23, Says TrendForce" (20 December 2023) https://www.trendforce.com/presscenter/news/20231220-11965.html
30 Kleinhans (2021) p. 12-15
31 Frederico Mollet, "Chips on our shoulder: Is Europe neglecting design in its semiconductor strategy?" (European Policy Centre, 4 March 2021) https://www.epc.eu/en/Publications/Chips-on-our-shoulder-Is-Europe-neglecting-design-in-its-semiconducto~3c341c
32 The total cost went up significantly since the announcement, with the German fab in Magdeburg alone costing €30 billion. See also: Deutsche Welle "Germany, Intel sign deal for chip factory in Magdeburg" (19 June 2023) https://www.dw.com/en/germany-intel-sign-deal-for-chip-factory-in-magdeburg/a-65962310
33 Intel "A message from Intel CEO Pat Gelsinger to employees regarding the next phase of Intel's transformation" (16 September 2024) https://www.intc.com/news-events/press-releases/detail/1710/a-message-from-intel-ceo-pat-gelsinger-to-employees
34 Niclas Poitiers "Europe Doesn't Need a Mega-Fab" (Bruegel, 22 September 2021) https://www.bruegel.org/comment/europe-doesnt-need-mega-fab
35 Julia Christina Hess et al "Who is funding the chips of the future?" (Stiftung Neue Verantwortung, April 2023) https://www.

ups than venturing into manufacturing due to the lower (albeit still significant) initial capital requirements. While chip manufacturing requires extensive capital for hardware, like equipment and facilities, chip design can be initiated with much smaller teams and less physical infrastructure, with the majority of the costs concentrated in IP block and software purchases. Moreover, the agility and high degree of specialisation of start-ups allows them to chart new frontiers in specific applications more easily (e.g. in AI).

Challenges for fabless start-ups:
1. Long-term investment horizon
2. Dependent relationship between designers, chip fabs and end users.

However, all fabless start-ups face **two major obstacles that are particular to the semiconductor ecosystem, namely the long-term investment horizon and the dependent relationship between designers, chip fabs and end users.** On the first point, chip design projects exhibit a capital-expenditure heavy development cycle, meaning that capital has to be "patient" and grapple with spending large sums on a project before knowing the venture will turn into a viable business. Secondly, chip designers do not exist in a vacuum – the designs have to be integrated into the supply chain early on, as they need to both match the specifications of fabs that will manufacture the chips, as well as meet the specific needs of the end customers. Worker shortages also pose an additional hurdle that persists across the EU semiconductor landscape.[36] This shortage is largely attributed to the **skills gap, which is credited at about 22% in the EU design sector** and whose roots can be traced to a number of labour market and higher education trends.[37]

In terms of public funding, European start-ups have relied on funds from the Digital Europe Programme, Horizon Europe – which includes the JU funding,[38] as well as the specialised startup funds under the European Innovation Council (EIC)[39] – and the European Institute of Innovation & Technology (EIT). However, clear gaps in funding have persisted over the years. Since 2019, only 27 out of 901 start-ups funded through the EIC Accelerator programme have operated in the semiconductor space.[40] The EIC Accelerator foresees more investments into chip start-ups under the STEP Scale Up programme in 2025, although the programme operates with a modest budget of 300 million EUR and looks to finance a broad spectrum of deep tech companies.[41]

When it comes to semiconductor start-ups that receive funding through Horizon Europe more broadly, chip start-ups comprise only 6% of the total funded companies.[42] As a whole, EU projects and grants require companies to have non-negligible resources and know-how of the landscape to participate, while a big share of the EU Chips Act funds focuses on funding large manufacturing sites and empowering partnerships among the biggest RTOs and manufacturers.[43] Given these circumstances, **chip design start-ups often lack the necessary resources or longstanding partnerships or reap the benefits of EU funding.**

interface-eu.org/publications/semiconductor-startup-funding-activities p. 17

36 Raphaël Beaujeu et al. "Skills Strategy 2024" (European Chip Skills Academy, November 2024) https://chipsacademy.eu/wp-content/uploads/2024/11/ECSA-Skills-Strategy-2024.pdf p. 3

37 Silvana Muscella et al. (2024) p. 6-10

38 Electronic Components and Systems for European Leadership (ECSEL) received up to €1.2 billion in EU funding and has fostered collaboration between industry and academia to drive innovation in microelectronics. Its successor, Key Digital Technologies Joint Undertaking (KDT JU), had an even larger budget of up to €1.8 billion, aiming to bolster Europe's technological sovereignty in key digital technologies.

39 See: EIC Fund https://eic.ec.europa.eu/eic-fund/about-eic-fund_en

40 Data taken from a keyword search ("semiconductors") of the EIC Accelerator Portfolio on Dealflow.EU, excluding non-EU-based companies from the search, see: https://discover.dealflow.eu/companies/f/all_slug_locations/not_switzerland_israel_~united_kingdom~_norway_iceland_~united_states~_georgia_serbia_kosovo_china_russia/patents_categories/anyof_Semiconductors/tags/allof_horizon%20europe_not_eicfund. Last updated in October 2024.

41 STEP Scale Up https://eic.ec.europa.eu/eic-funding-opportunities/step-scale_en

42 Data taken from a keyword search ("semiconductors") of the EIC Accelerator Portfolio on Dealflow.EU, excluding non-EU-based companies and companies funded under the EIC Fund from the search, see https://discover.dealflow.eu/companies/f/all_slug_locations/not_switzerland_israel_~united_kingdom~_norway_iceland_~united_states~_georgia_serbia_kosovo_china_russia/patents_categories/anyof_Semiconductors/tags/allof_horizon%20europe_not_eicfund.

43 Insights from interviews. See also: Zosia Wanat "Is the EU's response to the chips race leaving its start-ups behind?" (Sifted, 28 April 2023) https://sifted.eu/articles/europe-semiconductor-chip-regulation

OPPORTUNITIES

MORE INDEPENDENT AND EQUITABLE SOLUTIONS WITH OPEN SOURCE

Open silicon, which refers to an open source approach to designing and developing chips, can significantly bolster Europe's chip design industry by bolstering its R&D ecosystem and helping to address the skills challenge.[44] One of the key advantages of open silicon is the ability to leverage community-driven designs and improvements, which accelerates the development process and encourages the sharing of best practices. Utilising the open standard RISC-V instruction set architecture (ISA) has allowed European designers to access a robust and customisable foundation for their chip designs without the high licensing fees associated with proprietary architectures.[45] The licensing costs, which can reach up to 2 million EUR per year, as well as the long negotiating processes constitute two major obstacles to chip design firms' ambitions. **By adopting open silicon and open ISA frameworks, European companies can benefit from a global pool of expertise and innovations**, thus enhancing their competitive edge and accelerating time-to market (TTM) for new products.

Even more significantly, open silicon can help European chip design companies **reduce their dependence on external IP and proprietary technologies**, thereby increasing the EU's technological sovereignty and overall resilience. There is already strong precedence for embracing openness among European chip leaders, with companies like NXP Semiconductors and STMicroelectronics utilising open source to develop tailored solutions for specialised markets like automotive, industrial, and IoT applications.[46] **By embracing open silicon, Europe can stimulate homegrown talent, support start-ups, and foster a more dynamic and integrated semiconductor ecosystem**, ultimately strengthening its position in the global semiconductor market.

MORE RISK-TOLERANT FUNDING FROM PRIVATE AND PUBLIC INVESTORS

The European chip design industry is witnessing a significant uptick in risk-tolerant funding, fueled by both private venture capital (VC) and public investment initiatives. A growing number of specialist VC funds are emerging on the continent, with many specialising exclusively in deep tech and computing technologies. These funds, often characterised by deep domain expertise and an appetite for long-term returns, are filling a critical gap in early- and growth-stage financing for innovative chip design start-ups.[47] This specialisation creates bidirectional benefits: companies can save time by approaching the funds that have the necessary background knowledge to assess their viability, and fund managers have an easier time tapping into their sector expertise.

As of 2023, about 72% of European semiconductor start-ups were supported by individual investments originating from the continent.[48]

On the public funding front, the EU and Member States are prioritising chip design in various initiatives, aligning with broader strategies to bolster Europe's technological sovereignty. Pillar I of the Chips Act allocates considerable resources to R&D and design ventures, while funding offered under the EIC and EIT programmes goes a long way to fund lab-driven research. Public funds are increasingly structured to de-risk private investments, offering co-financing schemes, grants, and equity participation to support start-ups and scale-ups. These public-private synergies are creating a virtuous cycle for the European chip design sector.

44 Paula Grzegorzewska and Helena Winiger "The European Chip Ecosystem and Open Source Silicon" (ALLPROS.eu, 2023) p. 19

45 RISC-V is already utilised by a number of companies in Europe, which include leading innovators on the market, see e.g. Semidynamics, which offers the world's only fully customisable 64-bit RISC-V processor IP: https://semidynamics.com/en

46 See repositories on GitHub: NXP (https://github.com/nxp-imx) and STMicroelectronics (https://github.com/stmicroelectronics).

47 Examples include VC funds like Runa Capital and UVC Partners (Luxembourg), Verve Ventures (Switzerland), and CDP Venture Capital (Italy).

48 Hess et al (2023) p. 16

THREATS

DWINDLING TALENT POOL

Across the board, the European semiconductor industry is facing a critical skills shortage, with low numbers of young people entering the profession. This is particularly visible in the design sector where, unlike in other regions (the US, Asia), Europe lags in offering specialised and attractive educational pathways for future designers. This lack of visibility reduces the appeal to prospective students who might otherwise be interested in the high-tech aspect of the industry. Moreover, there is a notable deficiency in professorships dedicated to chip design, which impacts the ability to offer specialised courses and research opportunities.49

EXTERNAL DYNAMICS AFFECTING THE SUPPLY CHAIN

As the semiconductor value chain is part of a deeply interdependent market, factors like local trends in supply, trade regulations, and legislative decisions in foreign countries have a material impact on the availability of materials and market dynamics.50 In chip design, the overreliance on foreign-made software and IP blocks leaves EU chip designers particularly vulnerable to these external conditions. Moreover, the global nature of the semiconductor industry means that changes in export controls and trade regulations in other regions, particularly in the US and Asia, can have immediate and profound impacts on European companies. These controls can limit access to essential technology and components, complicating the production and development processes within Europe.

49 Supra no 15 for a detailed discussion of the skills gap causes and solutions.

50 Toby Sterling "Dutch curb chip equipment exports, drawing Chinese ire" (30 June 2023, Reuters) https://www.reuters.com/technology/amid-us-pressure-dutch-announce-new-chip-equipment-export-rules-2023-06-30/

Policy recommendations

Having considered the strengths, weaknesses, opportunities and threats facing the chip design industry in the EU, this section will present policy recommendations that can positively impact its future directions. They emphasise the benefits of more targeted support for R&D, wider adoption of open source solutions, as well as a development of better support schemes and more investments in European chip start-ups and scale-ups. **These recommendations are pertinent given the first Chips Act review, scheduled to take place by September 2026.**

1. MORE TARGETED SUPPORT FOR R&D TO INCREASE ITS GEOGRAPHICAL SPREAD AND COMMERCIAL APPLICATIONS

The transition from research to fab production is crucial, as it can significantly influence Europe's ability to attract and retain investments in the semiconductor sector. Thus, while the EU's strong research backbone is a significant asset, there is a pressing need to enhance the utilisation of this research by connecting it more effectively with the industry's existing manufacturing and commercial practices, all across the bloc.

» **The EU should continue to pool resources for novel research**: The Chips JU Pilot Lines are a step in the right direction when it comes to translating laboratory research into industrial fabrication through a truly collaborative and European approach. The EU should continue this trajectory by unveiling more pilot lines focused on strategic areas such as low-power chip designs, next-generation computing (like quantum computing or neuromorphic computing), and secure hardware.

» **The EU should promote funding of RTOs all across the Union**: Institutions like imec, CEA-Leti and MESA+ are the great success stories of European R&D, but they tend to be geographically concentrated in Western and Southern Europe. Considering their role in stimulating local entrepreneurship and supporting EU-level research, existing RTOs in underrepresented Member States could receive targeted EU funding via a "leveling-up" strategy. Similarly, the EU could develop guidelines to aid Member States in determining the up-and-coming semiconductor clusters that could benefit from the establishment of a new RTO.[51] Moreover, projects stemming from Horizon Europe and the EU Chips Act could promote a more geographically balanced approach by favouring consortia with a more diverse partner makeup.

2. PROMOTING WIDER ADOPTION OF OPEN SOURCE TOOLS TO SPEED UP INNOVATION AND DEMOCRATISE ACCESS

Open source tools in EDA, as well as open ISA standards offer several advantages that can significantly impact the pace of design and development process in the EU's semiconductor industry. Therefore:

» **The EU should invest in the maintenance and development of open EDA tools**: Open source-based design tools enable designers to adapt the software to their specific design needs. While certain open source solutions are not mature enough for wide-scale industrial adoption due to a lack of people, lack

51 Determining the location of the new RTOs by embedding them into an existing ecosystem could help to avoid the establishment of "cathedrals in the desert", see: David Charles and Katerina Ciampi Stancova "Research and Technology Organisations and Smart Specialisations" (Joint Research Centre, 2015) p. 12 https://joint-research-centre.ec.europa.eu/document/download/538dbf62-ad12-4607-9d0a-08acff97547a_en?filename=JRC97781.pdf

of capital, or weak connection with design, users in the startup and education space already report major benefits can only be amplified with greater financial support from the EU.[52]

- **The EU should promote fair and transparent IP use in open ecosystems**: The European Commission should work with industry and research communities to ensure that licencing terms for open ISAs like RISC-V remain fair, non-discriminatory, and transparent, benefiting European start-ups and scale-ups. Moreover, the EU should back initiatives that aim to define open standards for IP and data sharing, thus ensuring interoperability across European design tools and ecosystems (such as the Design Platform proposed under the Chips Act).

3. CONTINUED INVESTMENT IN EDUCATION AND TRAINING OF FUTURE CHIP DESIGNERS

As per the Chips Act, which emphasises building up skills and attracting talent as key to enhancing the EU's semiconductor ecosystem, investments in education and training should be aligned to market needs and current demographic trends. Thus:

- **The EU and Member States should consolidate their skills efforts**: Drawing on best practices from EU-funded projects like the ECoVEM and Edu4Chips, and harnessing the potential of the EU Chips Skills Academy, the EU should support the development of a multi-pronged chip skills strategy that comprehensively addresses design-specific needs. The EU and Member States should take into account industry needs as to not undermine the market expectations and needs, as detailed in the ALLPROS.eu Blueprint Report on Skills.[53]
- **The EU should support targeted educational initiatives**: Overall, the strategy should support the development of targeted educational programmes at the university level focusing on semiconductor design (including specialised courses on advanced design techniques, software, and emerging technologies), the introduction of chip design apprenticeships under Erasmus+, as well as encourage public-private partnerships to fund scholarships, research grants, and faculty positions in chip design.

4. TAILORED SUPPORT FOR CHIP START-UPS AND SCALE-UPS

Supporting homegrown start-ups will translate into strengthening the EU's chip ecosystem as a whole. Access to financing is a critical component for enabling start-ups and scaleups, particularly in such a capital-intensive industry like semiconductor design. To accelerate the development of European chip start-ups:

- **The EU should improve access to Chips Act funds for start-ups**: The EU should consider introducing safeguards that prioritise the inclusion of start-ups in the Chips Act-funded activities, particularly around design. Thus, mechanisms like ring-fenced funds designed specifically for design start-ups could ensure that a substantial portion of resources bookmarked for Pillar I does not get absorbed by established players.
- **Member States and the EU should prioritise the strengthening of the capital exit market**: While the work on the Capital Markets Union is ongoing, Member States should seize the moment and help to create exit opportunities for start-ups. National governments could expand and promote tech-specific listing venues within existing stock exchanges (e.g., Euronext Tech) to provide tailored IPO options for chip design start-ups. In the meantime, the EU could reduce the regulatory complexity and listing costs for tech IPOs to encourage smaller and mid-sized firms to go public in Europe rather than seeking US markets.

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- **The EU should simplify the IP protection and strengthen the negotiating position of chip start-ups**: Next to promoting the use of open standards and open source design software, the EU should also ensure that start-ups receive adequate support in negotiating with providers of proprietary software and IP blocks. By streamlining the patenting processes, lowering fees, and providing access to EU-funded IP advisory services, European start-ups would be better placed to secure their IP quickly and affordably.

Summary

With strategic use of existing policy instruments, enhanced legal frameworks, collaborative initiatives like Joint Undertakings, and focused efforts on the commercialisation of research, the EU is well-positioned to strengthen its competitiveness and innovation capacity in the chip design industry. By capitalising on these opportunities, the EU can ensure a resilient and forward-looking semiconductor sector.

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