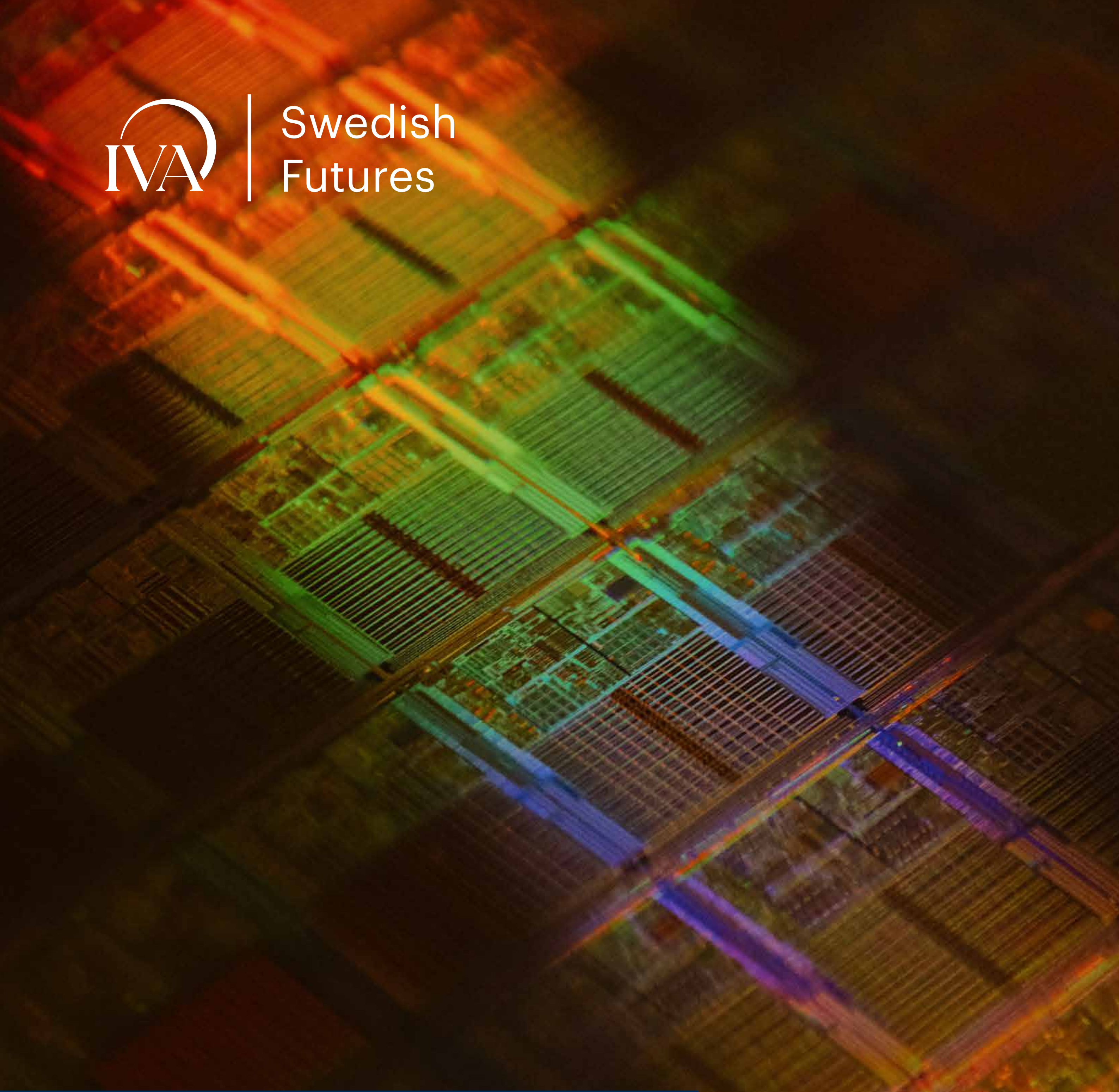

Swedish Futures

Semiconductors

A technical report about semiconductors as part of the *Swedish Futures* series

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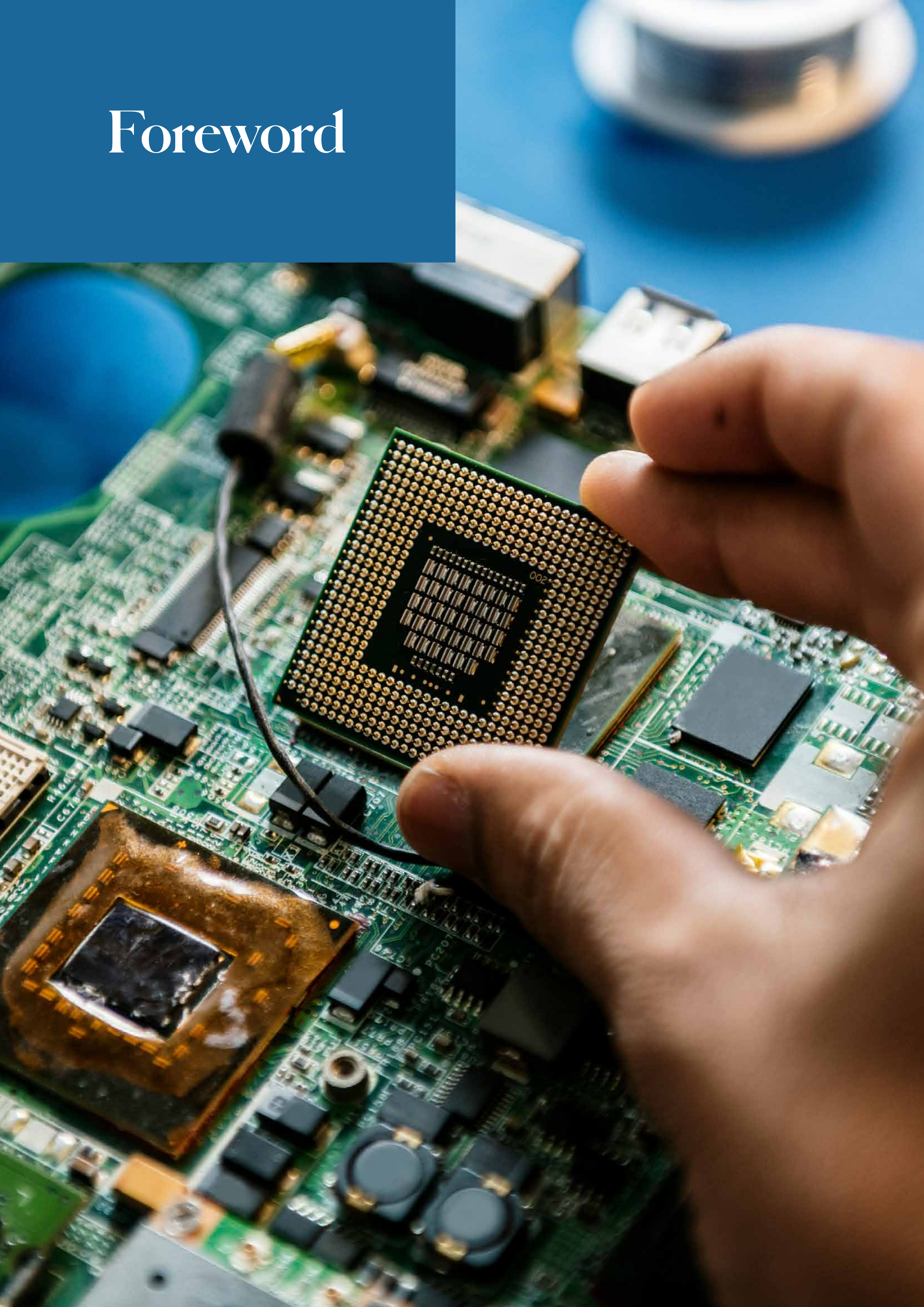
Foreword



IVA is spearheading the *Swedish Futures* initiative to formulate a vision for Sweden as a leader in technology and innovation by 2035. Since autumn 2025, *Swedish Futures* has brought together stakeholders from academia, industry, and the public sector to identify opportunities, challenges and strategic directions for competitiveness and sustainable development.

Among other things, the initiative convenes working groups that quickly and systematically analyse challenges and opportunities in different technology areas and produce highly focused reports. These reports provide an overview of the status quo and outlook for the field under examination and present concrete proposals for action. They also serve as an important foundation for shaping an overarching vision for Sweden in 2035.

This report was written by the working group on semiconductors. The group focused on Sweden's ability to utilise semiconductors and semiconductor technology as a strategic resource for economic and technological development in the broadest sense. The analysis shows that the sector requires investments grounded in strategic governance, the potential for scaling and access to adequate funding.

As is the case with all IVA projects, all participants contributed in their personal capacity and not as representatives of the organisations for which they work. The report's analyses, detailed proposals and to-the-point recommendations are based on the experience and knowledge they contributed and the discussions these inputs engendered. The working group endorses the report as a whole, although this does not mean that all members necessarily endorse every formulation.

The working group on semiconductors was active from December 2025 to April 2026.

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Summary

Sweden holds a strong position in research and certain niche areas of the semiconductor sector, but conditions for industrial scaling and manufacturing capacity are less favourable. In a global landscape where many countries are pursuing extensive and coordinated semiconductor initiatives, Sweden risks losing competitiveness unless it more strategically guides development in semiconductors and backs them with sustained, long-term investment.

This analysis highlights a number of critical challenges. Sweden produces high-quality research, but to maintain and strengthen its position, Sweden needs greater scale, better access to talent, and stronger industry collaboration. There is a clear gap between research and commercialisation, as the lack of testing environments, pilot lines, and manufacturing capacity constrains industrial scaling. Shortages of skilled labour is also a persistent challenge, particularly in technical and manufacturing-oriented occupations.

Funding often lacks a long-term commitment, and access to private capital is insufficient. The semiconductor sector is further constrained by regulatory uncertainty, lengthy administrative procedures, and restrictions in state aid and procurement rules that hinder investment and industrial establishment. At the same time, semiconductors have become an increasingly important strategic issue for defence and security, underscoring the need for resilient and less-vulnerable systems and supply chains.

The working group presents three recommendations for how Sweden should focus its efforts to build industrial competitiveness, advance sustainability, and contribute to both national and global security. These are based on an analysis of Sweden's current position in the semiconductor sector, international trends, and a review of key issues identifying both obstacles and opportunities for Sweden's continued development. They bring together proposals and action points presented in greater detail in the report.

1. Strengthen strategic governance and coordination across the entire semiconductor value chain in the semiconductor sector by building on Sweden's areas of comparative strength and deepening collaboration within the EU to maximise the impact from semiconductor investments.

2. Prioritise industrial scaling through expanded capacity for testing, packaging, and pilot lines, while strengthening conditions for start-ups to grow into internationally competitive scale-ups.

3. Secure long-term funding and a sustainable supply of skilled labour through greater alignment between public and private investment, combined with closer collaboration between academia and industry.

Starting points for work on semiconductors

Background

This report uses the term *semiconductors* in reference to basic research into and the application of semiconductor materials in various electronic, photonic, and sensor-based products. The field includes relevant areas of materials science, component technology, and the design of complex circuits.

The "lower" boundaries of materials science are defined by its potential applications. The "upper" boundaries of systems, design, and software development are defined by their links to hardware. In this report, we use the definition of *semiconductors* outlined above. We have also set the following parameters:

- We take into account the conditions in Sweden for research and development, entrepreneurship, and for companies to establish and develop successful operations. We also seek to include product lines that benefit from the knowledge and tools for component manufacturing, developed as part of advanced processes, specialised architectures, and heterogeneous integration (the term "supertechnology" is sometimes used, encompassing advanced semiconductor processes, heterogeneous integrations and specialised architectures that drive performance and energy efficiency far beyond traditional CMOS technology).
- Some related areas are not covered in this report, due to the limitations of its scope. Our report on semiconductors is closely related to work on systems development, embedded systems, and quantum technology, all of which rely on similar underlying technologies. More generally, knowledge of manufacturing in complex processes is essential.

The areas of intersection are important, and there is a need for a better understanding of semiconductor technology. For every person who *designs* a chip, ten others need to *understand* the chip in order to carry out their work effectively. Semiconductors and integrated circuits are enablers for existing and future industries.

Why Sweden needs a more strategic approach in the semiconductor field

IVA has conducted a data-driven analysis to map Sweden's global position in 48 strategically important technology areas that are critical to the country's future prosperity, economic resilience, and national security.[1] Among other findings, the analysis showed that Sweden needs to adopt a more strategic approach to secure its international position. Against this backdrop, IVA has chosen to conduct an in-depth analysis of the semiconductor sector and to develop proposals for the best way forward in this area. The selection was based on eight criteria. (See Table 1).

Semiconductors are a strategic resource for the modern economy and a prerequisite for many other technologies such as artificial intelligence, digitalisation, and wireless communication. Semiconductors are also vital for the green transition, fossil-free solutions and the electrification of society. And they play a significant role in systems and technologies linked to the defence sector, as well as in new, emerging technology sectors.

Although Sweden has strong research, leading universities, and an advanced industrial base in semiconductor materials, components, circuit design, and system design, we risk falling behind as other countries make substantial investments in the semiconductor sector.

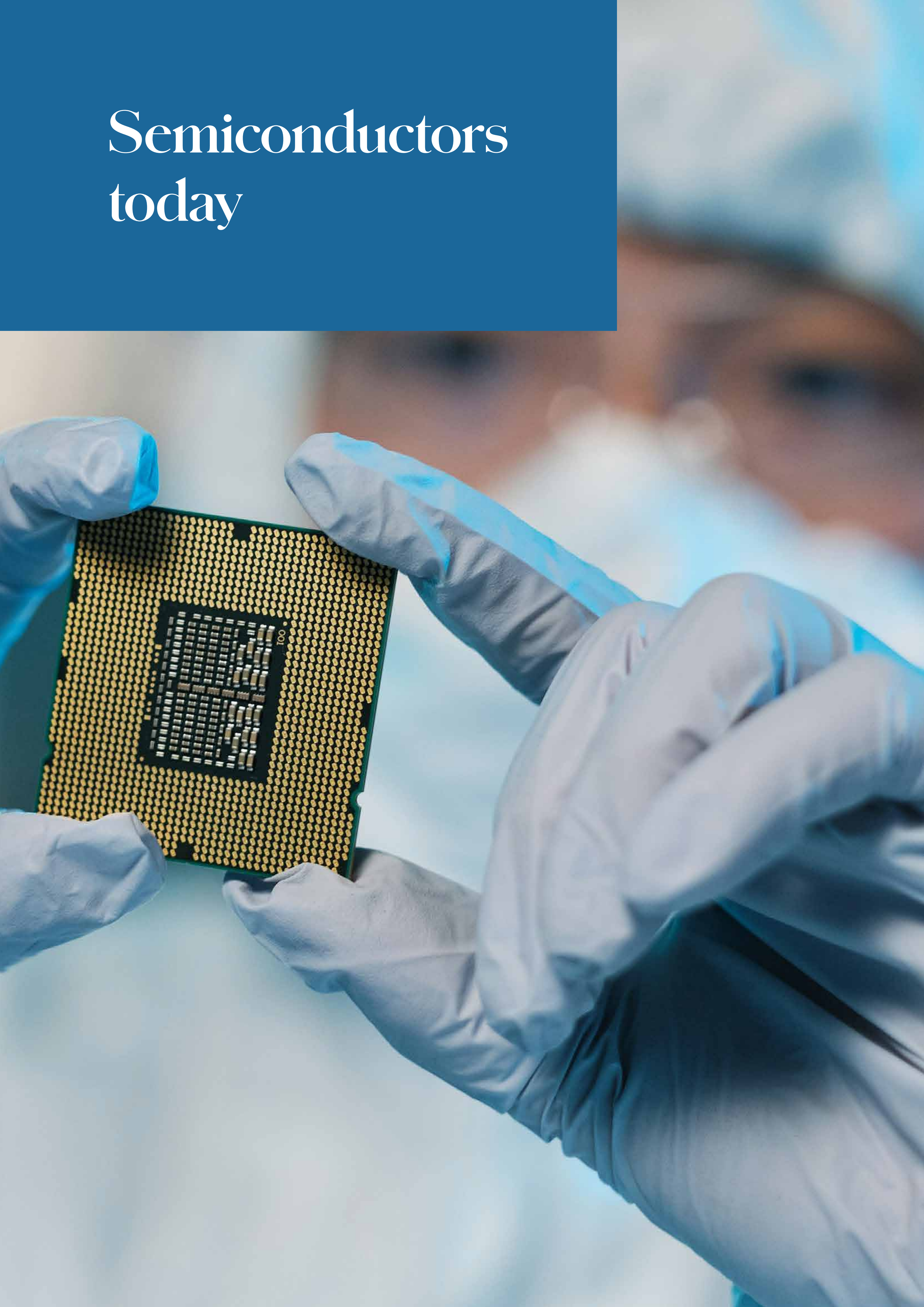
1 IVA (2025). *Sweden's position in strategically important technologies. Investment priorities, strengths and challenges.*

TABLE 1: IVA used eight criteria in focusing on the semiconductor sector.

CRITERION	SWEDISH SEMICONDUCTOR TECHNOLOGY
Global leadership	Sweden is not a leader across the entire semiconductor value chain. However, Swedish semiconductor expertise is strong in certain sub-sectors such as power electronics, sensors, radio frequency (RF) technology, nanotechnology, and systems design.
Turnaround potential (opportunity to reverse current trends)	There is significant potential to build on a strong research base and strengthen industrial competitiveness through better conditions for commercialisation and scaling.
Positioning	Sweden's international position can be bolstered, for example, by focusing on existing areas of strength and by identifying and addressing shortcomings.
Enabling technology	Semiconductors are a foundational enabling technology that supports technological development across a range of other sectors and applications.
International dimension	Swedish semiconductor technology is dependent on global value chains and therefore requires cooperation within the EU and with other international players.
Megatrends	Developments in the semiconductor sector are driven by long-term, structural changes in digitalisation, automation, climate change, and connectivity.
Geopolitics	Semiconductor technology is increasingly important for national security and technological sovereignty. Many countries are making strategic investments in dual-use products.
Hot sector	The semiconductor sector is strategically important and growing rapidly. Extensive investments are being made globally and competition is fierce.

To secure future competitiveness, technological sovereignty, and innovation capacity in an increasingly competitive international landscape, particularly in light of investments currently being made across Europe, Sweden needs to develop and strengthen its semiconductor sector. The work of this group and this report are part of this effort.

Semiconductors today



The technology

A semiconductor is a material with electrical properties between those of conductors and insulators. Its electrical behavior can be precisely controlled by introducing small amounts of selected impurities, a process known as doping. Silicon is the most widely used semiconductor material and is the basis of advanced memory and processor circuits found in computers, mobile phones, and many other electronic devices. Other semiconductor materials, including silicon carbide, gallium nitride, gallium arsenide, and indium phosphide, are used in components and circuits designed for high-power, high-frequency, and high-speed applications. (See an example of semiconductor technology in a radio base station in Figure 3 in the Annex.)

In addition to these materials, the technology involves a wide range of other elements and materials required for manufacturing. Some of these may, for various reasons, be difficult to extract or classified as so-called conflict minerals. The EU regulates conflict minerals with requirements such as traceability and responsible supply chains.

The strong expertise in materials science and material characterisation among semiconductor researchers is a key asset for Swedish industry and research, including in several other materials-related fields.

In Sweden, there are around a hundred companies working with semiconductors in various ways, many of which are so-called *fabless* companies. These firms design and develop semiconductor chips but do not have their own manufacturing facilities. Instead, they collaborate with companies known as *foundries*, which operate factories equipped with advanced machinery for making chips. Sweden also has several companies that supply equipment and research infrastructure within the semiconductor sector.

SEMICONDUCTORS ARE USED IN MANY DIFFERENT APPLICATIONS

The suitability of semiconductor materials for various applications is determined by their fundamental physical properties. These properties enable semiconductors to amplify and switch electrical signals, forming the basis for transistors and other electronic components. Semiconductors can control electrical current, store and process data, emit light, and convert signals. They are used in a range of different components such as microprocessors, memory chips, sensors and light-emitting diodes (LEDs). Semiconductors are a fundamental building block of modern electronics and are essential for technologies such as computers, smartphones, vehicles, energy systems, space technology, and medical equipment.

With a few exceptions, Swedish companies in the semiconductor sector are small or medium-sized. They have a high capacity for innovation but are dependent on other players (such as *foundries*). They also require access to advanced industrial-grade packaging, as well as large-scale testing and validation.[2]

Microelectromechanical systems (MEMS) are one area in which Sweden has a strong industry position globally. Other areas include photonics, nanotechnology, high-frequency electronics, and power electronics.

Swedish players in the semiconductor sector are located in the Stockholm–Mälardalen region, Gothenburg, Linköping–Norrköping and in Lund–Skåne.

Sweden has a strong infrastructure for research and basic prototype development at universities and at the Research Institutes of Sweden AB (RISE), particularly through the semiconductor

2 Svensk Elektronik (2026), *Svensk Elektronik (2026), Sweden's National Semiconductor Strategy 2035*, chapter: The Swedish Semiconductor Ecosystem.

research infrastructure Myfab. However, the country lacks sufficient capacity for industrial transfer and industrial qualification (large-scale testing and validation), as well as advanced packaging. Sweden does not have many packaging providers and testing services for semiconductor chips, making Swedish companies highly dependent on collaboration with external partners, often in Asia. Today, there are several Swedish coordination initiatives, such as Semiconductor Sweden and the SCCC, Sweden's node in the EU network of semiconductor chips competence centres.

A successful Swedish example in silicon design tools

Silicon design tools function as infrastructure within the semiconductor industry by linking architecture, design, and physical manufacturing into a coherent digital development chain. They are used to model, simulate, and verify designs prior to silicon fabrication. These tools encompass a broad spectrum of software for developing and simulating semiconductor chips, ranging from low-level electronic design automation (EDA) tools to more advanced high-level system and architecture simulators.

These tools make it possible to validate functionality, performance, and energy efficiency at an early stage in increasingly complex system-on-chip (SoC) designs.[3] They are essential for managing the technical complexity of the semiconductor industry and for reducing risk and costs in the highly advanced and expensive manufacturing process.

Sweden has significant expertise in this field. One example is Intel's development of the Simics simulator, which is used to model and analyse complex computer systems.[4] Now widely used in silicon design and system development internationally, Simics was born out of research at the Swedish Institute of Computer Science (SICS), an example of Sweden's research contribution to the global semiconductor industry.

The semiconductor sector as a system

The semiconductor sector should be viewed as a long, coherent value chain in which multiple layers – from materials to systems – all contribute to a final product. Innovation often connects activities across different parts of this value chain – commonly referred to as *co-design*. A systems perspective is essential in the semiconductor sector, as the technology is always part of a broader context and does not function in isolation.

By linking materials research with a systems perspective, research, design, manufacturing, and industrial needs, for example, can be coordinated more effectively and efficiently. In this way, research results can be translated into concrete applications and create real value. A systems perspective can help focus investments where they have the greatest impact and manage the complexity and changes typical of the rapidly growing technology sector. This is particularly important in the semiconductor sector, as the technology acts as an enabler for many other sectors and requires close collaboration between multiple stakeholders.

In the semiconductor industry, value is created in several stages, from research and chip design to manufacturing and the integration of chips into various products. The greatest value creation occurs in the early stages (such as advanced design and development) and in the later stages (where chips are integrated into systems and sold to end markets). Manufacturing itself is highly capital-intensive and technically complex but does not

3 Cirstea, M. et al. (2024). *Digital Electronic System-on-Chip Design: Methodologies, Tools, Evolution, and Trends*. Micromachines. 15. 247.

4 Information retrieved from the company's website on 21 April 2026. Link: www.intel.com/content/www/us/en/developer/articles/tool/simics-simulator.html

FIGURE 1: Simplified model for semiconductor development.

Research	Universities and research institutes develop new materials, processes, and architectures. Focus on physics, materials science, and electronic design.
Design and prototyping	Design of circuits and system-on-chip using advanced CAD tools. Simulation and testing of prototypes prior to manufacturing.
Pilot production/ Foundry	Small-scale manufacturing in cleanrooms to validate design and production processes. Processes, yield, and functionality are tested before large-scale manufacturing.
Commercial manufacturing	Full-scale factories (fabs) produce chips in larger volumes. Standardisation, quality assurance, and cost efficiency are examples of key aspects.
Integration and application	Chips are integrated into end products such as consumer electronics, vehicles, and industrial systems. Feedback from the market can drive improvements in design and processes.
Feedback to research and innovation	Results and experiences from industry and the market are fed back into research and development for next-generation technology.

always yield equally high margins. This means that different parts of the chain have varying economic significance, even though all are necessary for the final product to function.[5] Sweden's strength as an industrial nation lies in its ability to build and understand complex systems.

European perspective and internationalisation

Swedish companies can strengthen their position in the semiconductor sector by collaborating with others. Developing industry-specific requirements and specifications, for example, could create economies of scale for both Sweden and Europe. EU-wide semiconductor specifications could be based on industry needs for robustness, longevity, and safety. This would strengthen the European market and benefit Sweden through better-adapted components and greater opportunities to influence standards and participate in EU initiatives.

European standardisation, such as common requirements for components, can also drive down prices and increase production volumes. Europe can serve as a platform for projects with longer lead times and strategic significance, for example in the defence sector. For Swedish players, it is becoming increasingly important to engage in effective lobbying at the EU level to influence future frameworks and investment priorities.

For innovations to reach the market, the right initiatives must be undertaken at the right time, alongside collaboration through relevant partnerships. Swedish players also need to operate within a European context, taking into account technical

5 See, for example, the European Commission's visualisations of the semiconductor value chain in connection with the EU's European Chips Act, where the sector is presented as a multi-stage structure from design to commercialisation (European Commission, 2023).

competitiveness, security, and the EU's attractiveness.

Internationalisation should take place at three levels, with European cooperation as a key starting point. In addition, collaboration is needed with associated countries such as Canada, Japan, and South Korea, as well as broad global cooperation.

Investments in the semiconductor sector

Swedish investments have been concentrated on research, development, and pilot production in the early stages of the semiconductor value chain. The greatest share consists of research infrastructure for micro- and nanotechnology, particularly clean-room environments and pilot facilities at the Myfab nodes at Chalmers, KTH, Lund, and Uppsala. These investments have been built up gradually through government research funding and infrastructure grants.[6] A second share consists of initiatives in electronics and semiconductor technology, where funds have been directed towards centres of excellence, pilot lines, and industry-oriented development.[7] In addition, Swedish actors participate in the EU's semiconductor programme, which has strengthened Swedish research and innovation environments.[8]

The industry's own investments in hardware-related activities in Sweden have primarily focused on systems and testing, as well as on research and development, rather than on large-scale chip manufacturing.

EUROPE INVESTS IN SEMICONDUCTORS

The EU's Chips Act came into force in 2023. The Act aims to strengthen Europe's semiconductor industry through investment in research, innovation, and improved manufacturing capacity in Europe. The objective is to reduce dependence on external suppliers and ensure a stable supply of semiconductors, even during crises and supply disruptions.

The EU aims to mobilise over EUR 43 billion in public and private investment to strengthen Europe's technological sovereignty and increase its share of global semiconductor manufacturing to 20 percent by 2030.

Source: 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 (Chips Act).

Further information is available via this link: digital-strategy.ec.europa.eu/en/policies/european-chips-act

A summary of funding levels in the semiconductor sector across some twenty countries is presented in a recently published report from Svensk Elektronik.[9] See also the key issue on funding later in the report.

6 The Swedish Research Council. (2023). *The Swedish Research Council's Guide to Research Infrastructure 2023 and Myfab. The Swedish research infrastructure for micro- and nano fabrication*. Link: myfab.se.

7 A search of all projects funded by Vinnova can be carried out via the following link: www.vinnova.se/sok-finansiering/projekt/. Similarly, projects funded by the Foundation for Strategic Research can be searched via the link: strategiska.se/forskning/genomford-forskning/

8 Internationally, Swedish actors have received support within the EU's semiconductor programme (Chips JU), EuroHPC JU, DIGITAL and Eureka clusters. The extent of Swedish participation is described in Vinnova's Annual Report 2025, page 29.

9 Svensk Elektronik (2026), *Sweden's National Semiconductor Strategy 2035*, Appendix A.

Developments in semiconductors

Current trends

Global trends in the semiconductor sector

The global semiconductor industry is shaped by several strong trends.[10] AI, increased digitalisation, electrification, fifth- and sixth-generation mobile networks for high-speed wireless communication (5G/6G), a growing number of connected devices communicating via the internet (IoT), and defence applications are driving rapidly growing demand for high-performance, energy-efficient electronics. At the same time, the threat of pandemics, geopolitics, and trade restrictions have highlighted vulnerabilities in global supply chains and the need for greater resilience and strategic autonomy. Access to high-quality semiconductors is crucial to a country's competitiveness and security, as well as for enabling the climate transition.

Even individual components contribute to the development of entire innovative systems. Quality and expertise in integration, architecture, and the co-design of hardware and software are key competitive factors. Innovation is no longer driven solely by miniaturisation, but by material integration and how different chips and technologies are combined through heterogeneous integration. Examples of such combinations include chiplet-based solutions and advanced packaging. Specialised hardware for AI and other applications is also becoming increasingly important for achieving better performance and energy efficiency. Technology areas such as photonics, quantum technology, power electronics, and MEMS are gaining in importance, as is hardware-based security.

There is a need for investment in emerging technologies where Europe can take a leading role internationally. At the same time, the demand for skills is growing rapidly, creating a shortage of qualified labour. The industry is also characterised by high costs, long development cycles, and uncertainties linked to energy, materials, and trade. This increases the need for long-term investment, collaboration, and effective development environments.

Trends in the European semiconductor industry

The European semiconductor industry is a central part of the economy and a prerequisite for digitalisation, electrification, and innovation in industry. The chip shortage in 2021–2023 demonstrated how dependent Europe is on secure semiconductor supply chains. The shortage led to significant economic losses while also reshaping global market relations. One case is the Chinese-owned semiconductor company Nexperia, which was forced to sell its UK factory after the UK government raised concerns about national security and control over critical technology.[11]

Semiconductors are crucial to Europe's technological sovereignty. European countries are strong in design, power components, microcontrollers, and sensors. But there are also certain gaps in design, advanced packaging, AI, and high-performance computing (HPC) expertise, as well as in printed circuit board (PCB) and electronic manufacturing services (EMS) manufacturing. According to a German analysis, targeted investment, skills development, and close cooperation across the entire semiconductor value chain are needed to strengthen European competitiveness and independence. Furthermore, European countries must ensure that there is sustainable manufacturing and energy infrastructure in Europe.[12]

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10 The text under this heading is based on a report from Svensk Elektronik (2026), *Sweden's National Semiconductor Strategy 2035*, chapter 'Global Trends Shaping the Semiconductor Industry' and chapter 'Semiconductor Technology Trends with High Impact'.

11 UK Parliament Post (2024). *Supply of semiconductor chips*. Post note 721..

12 German Electro and Digital Industry Association (ZVEI e.v.) (2025). *From chips to chances. The importance of and the economic case for supporting microelectronics*.

Swedish analysis shows good potential in the semiconductor sector

The Swedish Agency for Economic and Regional Growth has analysed how the EU's Semiconductor Act can be applied in Sweden and what consequences it may have for Swedish industry and innovation capacity.[13] The analysis shows that Sweden is strong in research, innovation, and certain specialised parts of the value chain, such as materials, equipment, and design. However, Sweden lacks large-scale manufacturing capacity compared with leading semiconductor nations.

The agency believes that the EU's Semiconductor Act opens up several opportunities for Sweden, such as greater access to EU funding, deeper international cooperation, and the potential to develop niche areas of strength. It also highlights challenges, including global competition for investment and talent, a shortage of skilled labour, and the need for a clearer national strategy and better coordination between stakeholders.

The agency assesses that Sweden stands to benefit from the EU's semiconductor initiative. However, this will require measures such as a national semiconductor strategy, investments in attracting skilled labour and in education and training, along with strengthened collaboration between industry, science, and the public sector.

The working group's reflections on developments in the semiconductor sector

Semiconductors are not an isolated technology, but a part of a system of products in which hardware and software are developed symbiotically. The trend is towards more specialised and complex solutions, rather than general-purpose, cloud-based systems. At the same time, the software ecosystems are becoming more complex, placing greater demands on coordination and a holistic approach. When hardware is optimised, for example for energy efficiency, it is important not to overlook the increasingly complex software layer. The reverse is also true: If software is not adapted to the underlying hardware architecture, energy consumption may soar.

For Sweden, the ability to scale up businesses is a challenge, particularly in an increasingly specialised industry where large companies play a key role.

The world will look very different in five years. Rapid technological development in semiconductors means the sector is evolving rapidly, which requires Sweden to both build on established strengths and, at the same time, invest in new, still-maturing areas. One example is the increasing use of AI, which in turn is driving energy consumption across society. The development of AI-generated code means that software can increasingly be optimised for hardware, enabling more specialised and efficient system solutions.

The working group sees a trend towards greater geographical fragmentation within the semiconductor sector. Europe is striving for greater autonomy, which creates new opportunities for Swedish players. To keep pace with technological developments in the semiconductor sector, Sweden needs to combine investment in established areas (such as advanced electronics and system integration) with initiatives in new areas (such as AI-optimised chip design, heterogeneous architectures and new materials).

Historically, experts in the semiconductor sector have been ready to act as technological developments have progressed. Sweden needs to continue working in the same forward-looking manner in the future.

13 Swedish Agency for Economic and Regional Growth (2024). *Halvledaraktens tillämpning i Sverige*. Report prepared by Langbeck B., Rosenlund J., Jansson L. Ref. No. Ä 2023–279.

Key issues

Key issue 1: Research

Funding and the ability to attract the right people determine quality

Sweden has strong research and access to key infrastructure, such as Myfab. At the same time, there are challenges in scaling up operations and translating research results into profitable industry. Today, much of the value of Swedish research is realised by players abroad, rather than contributing to Swedish industrial development.

The strength of Swedish academia in semiconductor research depends on stable funding, without which quality risks deteriorating rapidly. At the same time, scale is a crucial prerequisite for success, as business models in the semiconductor sector are based on volume and the ability to scale up to achieve competitiveness.

A generational shift is underway in the semiconductor sector. Many people in leading positions are approaching retirement and there are limited opportunities for re-recruitment. One reason for the difficulty in recruiting is that funding in the semiconductor sector is perceived as being too short-term and limited. Nevertheless, universities need to work strategically on recruitment going forward.

Success requires scale and the ability to scale up

Success requires that research and infrastructure can be translated into industrial applications. Industrialisation requires tools other than academic excellence, such as better access to Swedish and European pilot lines.

International examples show how strong institutes and close links between research and industry can drive technological development. For example, Imec in Belgium, SEMATECH in the US and the Industrial Technology Research Institute in Taiwan have contributed to rapid innovation through joint research platforms, risk-sharing and effective knowledge transfer between academia and industry.

Sweden needs to find its own model, tailored to our country's unique conditions, which can combine academic excellence with industrial relevance and long-term skills provision.

Collaboration between academia and industry must be strengthened

Sweden needs to bolster the link between investment in research and education and their benefits to industry. Just how research investments contribute to industrial development and competitiveness requires better monitoring.

Collaboration between academia and industry must be strengthened. One observation within the working group is that it is difficult to move between academia and industry in Sweden.

The number of adjunct professors has fallen, and both universities and companies must take greater responsibility for facilitating mobility, shared appointments, and long-term collaborations. Today, the semiconductor sector is far too academic, and the merit systems are poorly aligned with industry's needs.

Academia must make an effort to identify individuals who would be suitable as adjunct professors and to support them effectively when they join universities. However, industry must also support selected employees in setting aside time to work as adjunct professors.

Increased mobility between academia and industry is of great importance for knowledge exchange and innovation capacity.[14] While recruitment from industry to academia (for example, through adjunct professorships) is relatively well-established, the corresponding movement in the opposite direction does not occur as frequently. Having university professors also work in industry for a period can strengthen collaboration, increase the practical relevance of research and contribute to a more integrated innovation system.

Within the semiconductor sector, there is a growing need for both short-term staff exchanges between academia and industry and a stronger link to undergraduate education. Shorter exchanges contribute to the rapid dissemination of up-to-date knowledge and a greater understanding of each sector's needs, while closer integration with undergraduate education is important for building relevant skills at an early stage. This can, for example, be achieved through industry-related course modules, work placements and degree in collaboration with companies.

Place greater value on applied research

Academic excellence is the foundation of research success, but high-quality basic research needs to be complemented by excellence in application, industrialisation and integration between research and industry. Only when the entire ecosystem is characterised by high quality is true innovative power created.

Excellence needs to be complemented by clear incentives that encourage researchers to work to a greater extent and strengthen collaboration with industry. Examples of incentives that could be developed include career paths, promotion and competitive remuneration models.

It is important to highlight the value of linking industrial challenges to academic research. In Sweden, we should develop how this work is carried out, drawing inspiration from models in other European countries.

Applied research must also be given sufficient funding and attention. Scientific publications are not sufficient as a measure of quality and success. Excellence, particularly at higher levels of technological maturity, must be measured more broadly and in a more complex manner. Clearer methods are needed to demonstrate how initiatives contribute to increased competitiveness, new businesses and more jobs.

14 Wai, S. (2023). *Inventor mobility and spillovers in the early semiconductor industry.* Technology in Society, 75, 102331.

Key issue 2: Industry, manufacturing, and innovation

There is a need for closer links between academia and industry (see also the key issue on research).

Addressing demand, particularly for dual-use applications

Sweden needs to strengthen demand in the semiconductor sector. By creating incentives for industry to use European components, investments in Swedish and European semiconductor manufacturing can become commercially viable even without extensive state support. This may be particularly relevant in sectors such as the automotive and defence industries. China can be seen as an example of how a country works strategically with demand-driven demand. This is achieved, among other things, through government initiatives to stimulate the electric car market, which in turn strengthens the domestic semiconductor industry.

To strengthen the business case for Swedish (and European) manufacturing, Sweden should review the possibility of applying similar standards and requirements for components and circuits across more sectors. This is particularly important for technologies with both civilian and military applications (see the key issue on defence and security).

Manufacturing links to innovation

Locating manufacturing in Sweden also strengthens innovation and related activities, as development and innovation often benefit from proximity to manufacturing.

Swedish semiconductor manufacturing could be stimulated through increased investment in start-ups, where small companies are given the conditions to grow into medium-sized enterprises (see the chapter on proposals). Such a strategy would be well-suited to Swedish conditions, rather than investments in large semiconductor factories producing billions of chips per year or very large quantities of silicon wafers (so-called giga-fabs).

Discussions on manufacturing need to take into account the needs of potential customers, for example within the defence industry. Technical and commercial perspectives need to be weighed up, and depending on the area of application, higher manufacturing costs or other compromises may be justified.

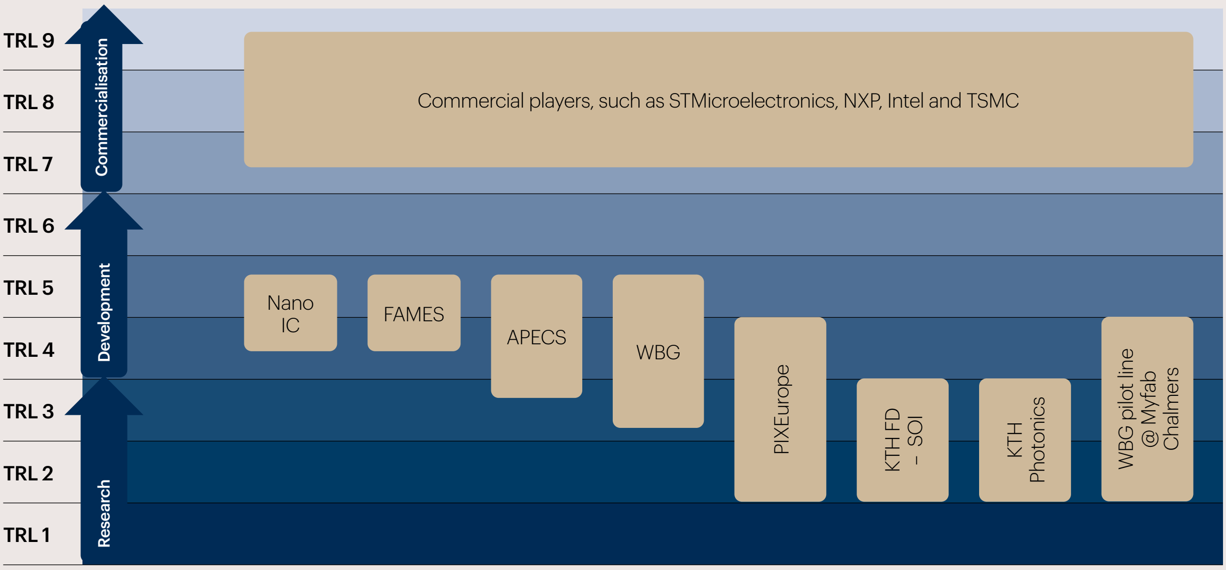
Swedish start-ups must be able to grow

Sweden has start-ups and large companies but lacks a clear middle tier of medium-sized technology companies in the semiconductor sector. More growing companies would strengthen the ecosystem's resilience and increase access to people with adequate expertise in the semiconductor sector. To promote the emergence of more medium-sized companies, a better business climate, more long-term financing and a more needs-driven strategy are required, in which the state acts to a greater extent as a customer and a driving force for innovation. The medium-sized companies currently operating in Sweden are usually not active in the electronics sector, but rather in mechanics and other industries.

Pilot lines are a vital link between research and industrial manufacturing

A pilot line is a small-scale, experimental manufacturing environment where new chip technolo-

FIGURE 2: The figure shows approximately where five pilot lines identified and launched within Chips JU stand in terms of research, development and commercialisation (the so-called TRL scale). The pilot lines within Chips JU are NanoIC (beyond 2nm leading-edge system-on-chip), FAMES (fully depleted silicon-on-insulator applications), APECS (advanced packaging), WBG (wide band gap materials) and PIXEurope (advanced photonic integrated circuits). For comparison, the figure also shows examples of research pilot lines operated at KTH and Chalmers, respectively, as well as examples of commercial players.



gies can be developed, tested, and improved. Pilot lines are a vital link between research and commercialisation in the semiconductor sector. At the same time, virtually all of today's pilot lines lack an industrial track and cannot be used for scaling or commercial manufacturing. There is therefore a gap in the European innovation system between pre-industrial research and development and large-scale commercial manufacturing, which is a cause for concern.

The EU is investing approximately EUR 3.3 billion in the first five pilot lines under the semiconductor public-private partnership *Chips Joint Undertaking*. The funding is shared between the EU, member states, and industry, with the EU contributing approximately EUR 1.7 billion and the remainder matched by members states and private actors under a co-financing model.[15]

The five European pilot lines are intended to support research, development, testing, design, and

15 European Commission. (2023). *Commission launches Chips Joint Undertaking under the European Chips Act*. Brussels, 30 November 2023. Link: ec.europa.eu/commission/presscorner/api/files/document/print/en/ip_23_6167/IP_23_6167_EN.pdf. Information retrieved 11 May 2026.

experimental manufacturing of next-generation semiconductors (see Figure 2). The EU pilot lines are accessible to academia, research institutes, small- and medium-sized enterprises, and larger industrial partners. At the same time, access is often contingent upon participation in larger EU projects and is further restricted by state aid rules, creating barriers to use.

A key question is how the Swedish pilot lines relate to those at EU level. Sweden has already established infrastructure with strong links to research. The EU pilot lines are aimed to a greater extent at building bridges between research and industrial application on a larger scale. This creates both synergies and tensions. Sweden has a strong foundation through existing pilot lines, which provides good conditions for participation in European initiatives. At the same time, just how national resources should be integrated with EU initiatives without overlapping and an unclear division of responsibilities remains a challenge.

At the EU level, there are specific tools to support investment in strategic areas and bridge the gap between research and the market, such as the Important Projects of Common European Interest (IPCEI)), an initiative designed to boost growth, jobs, and competitiveness through joint efforts on innovation and transition. Sweden's key challenge is to become better at using these tools and positioning itself within European initiatives. This could, for example, involve systematically monitoring how Swedish actors use the EU's pilot lines, in order to identify obstacles and increase utilisation rates in the long term.

Key issue 3: Education and training

There is a growing skills gap across the entire European semiconductor sector. Overall, the labour shortage in the semiconductor industry in EU member states is expected to be around 75,000 positions during the period 2024 –2030. The need for skills is expected to continue growing, partly due to large-scale retirements and rising demand driven by digitalisation, electrification, and increased use of advanced technology.[16]

Sweden needs to address this gap by training more engineers, strengthening research and industry collaboration, and improving the supply of skills linked to the entire semiconductor value chain.

Broad semiconductor expertise requires training people in many different fields

Sweden must strengthen general expertise and understanding of semiconductor technology, as the technology is crucial for many industrial sectors and for the development of new business areas. At the same time, it must attract enough specialists in both hardware and software.

There is a broad need for expertise ranging from advanced materials and physics expertise to knowledge of design, manufacturing, and procurement. Visualisation and verification are two key

16 Beaujeu R., Sain-Martin L., Lebon C. (2024). *Adressing the talent gap in the EU semiconductor ecosystem*. Skills strategy 2024. European Chips Skills Academy.

areas where highly skilled individuals are needed. From a broader perspective, strategic procurement and client expertise are just as important as cutting-edge technical skills. To attract people with the right skills, much closer collaboration is needed through long-term dialogue between academia and industry, in both education and research.

More hands-on experience is needed during training

There is a growing need to strengthen the practical and laboratory-based elements of existing engineering programmes related to the semiconductor sector. Students need to spend more time working directly in advanced laboratory environments with equipment for micro- and nanofabrication, such as lithography, material deposition, and characterisation. Greater focus on such elements is important to bridge the gap between education and industrial application.

This would provide them with a better understanding of the entire chain from design to manufacturing, which in turn would enable newly qualified engineers to contribute more quickly in development and manufacturing-related roles in the semiconductor industry.

Better planning is needed to draw more engineers

The shortage of engineers is a general problem in Sweden, even though applications for civil engineering programmes are on the rise. Universities can train more engineers with the right resources, but the number of study places has not been correctly allocated, and completion rates vary between institutions.

The major universities, particularly KTH, Chalmers, and Lund, draw high numbers of applications. Smaller institutions, however, find it harder to fill their courses and in many cases, the graduation rate is low. Sweden, with a population of 10.7 million, currently has around fifteen institutions offering five-year engineering programmes. By comparison, the Netherlands, with a population of 18 million, has four to five institutions with equivalent engineering programmes.

To draw more engineers, educational resources must be concentrated to a greater extent in the strongest technical environments. These offer relevant laboratory facilities that link theory and practice and create the conditions for high-quality education in the field of semiconductors. A general STEM strategy is not sufficient; more people must be trained in engineering.

PhD students are central to research and future industrial expertise. They account for a large share of practical research, and many who have completed their doctorates go on to key roles in industry, academia, and research institutes. Among those who have completed their doctorates in Sweden, more than half are established in sectors outside higher education (for example, in industry) three years after graduation, while the remainder stay in academia.[17]

Investments in postgraduate education are long-term, and the benefits can sometimes be realised in other sectors or countries. There is a risk that talent will leave Sweden, although international mobility also creates valuable networks.

Manufacturing and industrialisation expertise are neglected areas

Expertise in manufacturing and industrialisation has been neglected and requires integration into

17 Swedish Higher Education Authority (2024). *Doktorsexaminerades etablering på arbetsmarknaden Examinerade 2013–2020*. Report number: 2024:31.

education programmes – along with better skills training.

Manufacturing expertise involves the practical, efficient manufacture of a product, while industrialisation expertise involves developing and adapting the product and processes for its large-scale, efficient production. Knowledge of both aspects is required. One problem is that teaching and research focusing on practical and applied manufacturing do not always count towards academic qualifications.

Universities of applied science play a vital role in meeting practical skills needs in the manufacturing chain. To build a strong semiconductor industry, we need not only researchers and engineers, but also skilled technical staff. Organisations that train operators and other skilled staff would benefit from collaborating with the major universities.

Position the semiconductor sector as an attractive and future-proof career choice

To secure future skills, there is a need for better-scaled training programmes, more PhDs, and closer collaboration between universities and companies. Students need a better understanding of the realities of the industry, covering everything from design and yield to procurement and supply chain management.

Sweden has good opportunities to attract international students and must create better conditions for them to remain in the country after graduation. At the same time, academia needs to strengthen opportunities for international students. The trend is positive, with rising demand and strong European students. Over the last ten years, the number of international students graduating in Sweden has increased.[18]

Looking ahead, it will be important to clearly signal that the semiconductor sector offers attractive and future-proof career opportunities. A stronger industrial ecosystem with greater production volumes and more attractive employers could help recruit more newly qualified engineers and PhD graduates.

Key issue 4: Funding

Sweden is building on a long tradition of investment in the semiconductor sector, which has created a stable foundation with high-quality research and good access to infrastructure. Sweden is an international leader in some niche areas, while in others it is not as strong.

Funding in the semiconductor sector is an investment, not a subsidy

Funding in the semiconductor sector should not be viewed as a subsidy, but as a necessary investment in building a foundation for future profitable

18 SCB (2025). *International student mobility in higher education 2024/25*. Statistical reports. UF 20 SM 2502.

companies and for innovation. Investments in the semiconductor sector increase industrial capacity (which creates profitable companies), contribute to Swedish exports and create jobs; see Table 2. Successful Swedish exports, such as vehicles, aircraft, robots, and telecoms, are entirely dependent on a high level of Swedish expertise in the semiconductor sector.

The global semiconductor market is growing rapidly and is expected to increase from around SEK 6 trillion in 2024 to over SEK 9.3 trillion in 2030 (which corresponds to just under one percent of global GDP).[19] Investments in the global semiconductor market are estimated to generate ten times greater value within the global electronics market, which in turn generates ten times greater value within markets encompassing industry and services.[20]

Swedish academic research infrastructure, such as Myfab, is generally of a high standard and provides a solid foundation for research and education. At the same time, its infrastructure is costly to maintain and requires continuous investment to remain internationally competitive. It also requires expansion to encompass initial scaling and industrialisation. It is crucial that these facilities are utilised to their full potential and benefit a wider range of stakeholders. State-of-the-art equipment at higher education institutions requires expertise and resources to broaden its use and attract a wider variety of users. This requires investment and a clearer conviction among public authorities regarding the strategic importance of the semiconductor sector.

Investments in Swedish semiconductor technology come from public and private research and innovation funders, European programmes, private venture capital firms, large industrial groups and international collaborations. These initiatives benefit a wide range of stakeholders in the semiconductor industry and semiconductor research environments who benefit directly from the investments. Indirectly, these initiatives contribute to the entire Swedish innovation system through enhanced competitiveness, more jobs and greater technological capacity. See Table 2.

Lack of industrialisation and ability to scale up operations

There is relatively strong commercialisation in the early stages, but the transition from start-up to larger, well-established companies is difficult. This is largely due to a lack of industrialisation and difficulties in scaling up operations. Sweden needs become better at translating innovations into large-scale manufacturing and moving from the innovation stage to competitive firms.

The investment culture in high-tech applications is a limiting factor. Start-ups in the semiconductor sector can take up to five years or more before they become profitable and require significant capital investment. By comparison, investments in, for example, cloud services or apps, where returns can be realised more quickly, are often seen as more attractive and less risky.

Long-term financing is required

There is a shortage of private capital to drive new business creation and expansion. Public funding has historically been important in the start-up phase when the state can contribute to share risk.

19 German Electro and Digital Industry Association (ZVEI e.v.) (2025). *From chips to chances. The importance of and the economic case for supporting microelectronics*. See Figure 1.4, page 13.

20 German Electro and Digital Industry Association (ZVEI e.v.) (2025). *From chips to chances. The importance of and the economic case for supporting microelectronics*. See Figure 3.8, page 40. Source: DECISION Etudes & Conseil, Deutscher Bundestag, Infineon, S&P Global, WSTS, ZVEI, Omdia Q3 2024.

TABLE 2: Current overview of investments in Swedish semiconductor technology and where they are put to use.

INVESTORS	EXAMPLES	DIRECT BENEFITS	INDIRECT BENEFITS
Public sector	Vinnova, the Swedish Research Council, regional innovation programmes	Universities, research institutes, start-ups	Swedish industry, labour market
Private research funders	The Knut and Alice Wallenberg Foundation (KAW), Foundation for Strategic Research (SSF)	Centres of excellence, research programmes, infrastructure	Long-term skills supply, international appeal, strong research environments
EU and European initiatives	Chips JU, Horizon Europe, pilot lines	Swedish researchers, companies, R&D collaborations	EU partnerships, profiling Sweden as a technology nation, exports
Major Swedish industrial companies	Companies in the automotive, telecoms, automation, and defence sectors	Companies themselves, subcontractors	Swedish innovation clusters, workforce, partners
Private investors (venture capital)	Venture capital firms (VC firms), industrial funds	Start-ups, scale-ups	Economic growth, new products
International semiconductor companies	Infineon, STMicroelectronics, GlobalFoundries	Swedish R&D labs, partnerships	Swedish industry, global networks, knowledge transfer
Universities	KTH, Chalmers, LiU, LU, UU	Innovation and start-ups, students, researchers, users of testing environments	Swedish innovation climate, technological expertise, start-ups
Research institutes	RISE	Pilot projects, prototype development	Industrial collaboration, innovation environment
Society at large	-	-	Technological sovereignty, jobs, exports

But long-term private financing is crucial for building scalable and profitable companies and for their sustainable growth. A key factor is that private capital often also brings expertise, for example through active ownership and board representation *(smart money)*.

The semiconductor industry requires a long-term perspective. To enable industrialisation, innovation, and scaling, stable financing over time is needed, not just short-term support. The protracted time horizon for scaling and the long payback period for investments are a challenge for Swedish investment culture.

Existing infrastructure in the semiconductor sector should be utilised more effectively. In fact, upgrading existing facilities may be a more appropriate alternative due to the long payback period for investments in new infrastructure.

Universities need both investments in excellence and stronger core funding, but the long-term nature of the funding is crucial. At the same time, higher education institutions have a responsibility to clarify how these resources translate into higher quality, not merely greater volume. So far, additional resources have often merely led to more faculty appointments rather than strengthening excellence, top-tier recruitment, and research impact.

International collaboration is important, and EU co-funding must be strategic

Resources are limited, and Sweden cannot match China or the US in their scale of state support. This means Sweden must prioritise strategically and use existing funds wisely. It must also become much more adept at making use of its position within the EU.

International cooperation is important, and Sweden therefore needs co-funding for EU projects. At the same time, however, co-funding must be strategic and carefully considered, so that Sweden can recoup, in the long run, the resources it invests in European collaborative projects. Sweden therefore needs an analysis of how to link national resources to European initiatives. It also requires a plan for leveraging Swedish resources through EU funding, with a clear strategy across the entire value chain from research to manufacturing.

International examples show that major industrial initiatives are possible, but they require significantly greater and more long-term resources than Swedish authorities currently provide. Such initiatives also require faster regulatory processes, particularly for permits. The time lag between decision and market launch (often more than five years) creates further challenges, particularly for companies driven by quarterly results. In many countries, the state funds critical infrastructure, as such costs are difficult for individual companies to bear.

There should be greater opportunities to increase the flow of EU funds to Sweden, which is a prerequisite for access to national co-funding. Larger companies need to engage more in EU projects, as this creates valuable collaborative structures and strengthens Sweden's position in the European ecosystem.

Continued funding is needed to enable Swedish companies and researchers to participate in European initiatives. The EU funding mechanism for collaboration, Important Projects of *Common European Interest* (IPCEI), can serve as a key tool for large-scale, cross-border projects aimed at strengthening Europe's technological sovereignty, research, and semiconductor manufacturing. In addition to IPCEI, there are several other instruments that strengthen Europe's and Sweden's expertise in semiconductors and provide Swedish stakeholders with opportunities to collaborate on research and industrial development.

Chips Joint Undertaking (Chips JU) funds research, design, and pilot production of advanced chips. Other examples include *Horizon Europe* and programmes such as *Digital Europe* and *EIC Accelerator*, which support innovation, testing, and commercialisation.

The lack of private market-based funding poses a challenge

Although private capital is often lacking for later phases of technology investment, it is important to note that many successful companies would not have emerged without public funding as a foundation in their early stages. The most effective model therefore seems to be a combination of public and private funding, where the state can take the initial risk and provide guarantees, but the market provides the bulk of the capital during the industrialisation phase.

In the development of advanced technology, it is common for public funds to dominate the financing initially.[21] There have been positive experiences with the state taking on initial risk followed by private investors contributing capital, expertise and networks. International examples include US programmes for early-stage technology development in small businesses and programmes that created a market for private venture capital funds.[22] Other examples include the US non-profit accelerator IQT, which has strong ties to government intelligence agencies and often invests alongside private venture capitalists, as well as Canada's programme for co-investment between the state and private investors, which has built up many growing companies.[23] Historical Swedish examples illustrate the importance of early government initiatives alongside private investment for technological and industrial success, as seen in companies such as Ericsson and ABB.[24]

Government funding in the semiconductor sector is still insufficient and must be supplemented by private capital. Companies also need to contribute more. This is particularly important because universities and the public sector cannot bear the entire cost of the skills development required at the manufacturing stage.

It must also be clarified which companies should be expected to make a larger contribution and how this can be linked to industrialisation. One example is the automotive industry, where rules requiring the use of European components can create tensions between European industrial policy and the option of relying instead on global supply chains.

21 Lerner, J. (2010). *The future of public efforts to boost entrepreneurship and venture capital*. Small Business Economics, 35(3), 255–264.

22 SBIR. *History and impact of the SBIR program*. U.S. Small Business Administration. Link: www.sbir.gov. Small Business Administration. *Small Business Investment Company (SBIC) program overview*. Link: www.sba.gov.

23 IQT. Link: www.iqt.org. BDC, Business Development Bank of Canada. Link: www.bdc.ca..

24 Carlsson, B., & Stankiewicz, R. (1991). *On the nature, function, and composition of technological systems*. Journal of Evolutionary Economics, 1(2), 93–118.

Key issue 5:
Regulation

For the semiconductor sector to function, support in the form of funding and investment is not enough. To create business activity, relevant and effective regulatory frameworks are also required, for example regarding permit processes, land allocation and other practical conditions.

A fragmented system with a lack of technical expertise

Semiconductor sector issues are currently handled by several ministries, including the Ministry of Climate and Business, the Ministry of Education, the Ministry of Defence, and the Ministry of Finance. Coordination between these ministries needs strengthening. In some cases, government agencies may also apply conflicting interpretations of policy decisions without anyone taking notice. Overall, this poses the risk of a fragmented system that cannot fully capitalise on Sweden's opportunities.

In-depth technical expertise is also lacking among both officials and decision-makers within the political system and at government agencies. Greater participation of engineers in politics, policy-making, and public administration is also desirable. In addition to general technical expertise, it would be beneficial for those who handle cases, make decisions, and formulate strategies to have a specific understanding of the complex value chains and ecosystems in the semiconductor sector.

Regulatory processes are slow

Current licensing and approval processes are time-consuming and have long lead times, which risks delaying investments and business establishment. Administration is cumbersome and complex, and systemic barriers can slow development, while a lack of trust risks reducing efficiency.

Authorities who make decisions affecting the semiconductor sector must be able to process cases more quickly and strengthen their ability to adapt to new conditions and changes.

Procurement laws and EU regulations affect incentives for the industry

Policy incentives and instruments, such as public support or demand-side management, can play an important role in creating markets and attracting investment. Public procurement laws and EU regulations influence incentives for the industry. How such incentives are applied varies between countries.

In Sweden, public sector procurement is primarily governed by the Public Procurement Act. The Swedish rules are based on transparency, equal treatment, proportionality, and non-discrimination, and are intended to ensure competition and cost-effectiveness. On the one hand, the rules provide stable and predictable conditions; on the other, they can add administrative burdens and slow development and innovation processes.

Decisions on public procurement for semiconductor projects are taken at various levels in European countries. In Sweden, this usually takes place within government agencies, where decisions may be delegated to the responsible manager or project manager depending on the size of the project. In Finland, decisions are primarily taken by national research and development bodies and within ministries, often in consultation with the responsible project coordinator. In Belgium, this is done within federal and regional authorities and research institutes, where the decision itself is taken by boards or committees comprising representatives from government bodies and industry. In Germany, decisions are taken within ministries and state research funding bodies, in practice often at ministerial level with delegation to a programme office. In the Netherlands, responsibility lies with authorities and institutes that make decisions via programme offices in which industrial partners participate.

EU countries use state aid differently, both in volume and format. They do not apply it uniformly, and some use aid more aggressively than others.[25]

Sweden provides less state aid than many other EU countries; for example, Denmark and Germany provide 40–60 percent more state aid relative to GDP than Sweden.[26] Generally speaking, Sweden has strong institutions and regulatory governance, which is often linked to cautious and legally secure policy implementation.[27] However, there are indications that Sweden is moving towards a more active and systematic application of EU state aid rules. Swedish courts have begun to play a greater role, including by requesting preliminary rulings from the Court of Justice of the European Union for the first time.[28]

In a number of member states, EU state aid rules are actively used to finance strategic projects in semiconductors and microelectronics. Most support goes to physical chip production, followed by power electronics, research and development in microelectronics, and advanced packaging. Support is also provided for research and development infrastructure and pilot lines. Countries with a large industrial base (such as Germany) often provide direct support, while Sweden instead frequently participates in EU-coordinated initiatives. In Sweden, state aid is primarily used for research and development and for pilot projects.

PROCUREMENT IS GOVERNED BY SEVERAL LAWS

The Public Procurement Act (2016:1145) implements the EU Public Procurement Directives. Provisions supplementing the Act on Procurement in the Utilities Sectors (2016:1146) and the Act on the Award of Concessions (2016:1147).

STATE AID MUST COMPLY WITH RULES

EU state aid rules affect Swedish research and innovation by determining how public funds may be used. Aid to companies must be proportionate and transparent and must not distort competition in the EU. Under the EU rules, targeted support for research, development, and innovation is possible provided it takes place within approved state aid frameworks. Strategic EU instruments such as IPCEI, which allow certain exemptions from state aid rules, are important in the semiconductor sector.

25 Ambroziak A. (2025). *The New EU Industrial Policy: A paradigm shift in need of coordination and funding*. SIEPS 2025:2.

26 Karl Lundvall K., Karttinen E., Karlsson Jamous C. (2020). *State aid in Sweden vs. the EU. Is Sweden lagging behind?* Svenskt Näringsliv.

27 OECD (2025), *OECD Economic Surveys: Sweden 2025*, OECD Publishing, Paris.

28 Delphi (2025). "State aid update for Sweden: the two first State aid preliminary references to the ECJ – and new responsibilities for the Swedish Competition Authority in State aid."

The EU has approved extensive state aid by member states to strengthen Europe's semiconductor industry and increase Europe's self-sufficiency in chip manufacturing.[29] In Germany, the semiconductor venture ESMC plans to build a new chip factory in Dresden (with ca. EUR 5 billion in state aid), and support is also being provided for the expansion of Infineon. In Italy, around EUR 2 – EUR 3 billion is being allocated to STMicroelectronics for the manufacturing of power electronics, and Austria is supporting ams OSRAM's new semiconductor factory. The support is part of the IPCEI initiative and the Open European Foundry (OEF).[30]

Key issue 6: Defence and security

Through the funding of research in early development stages, which helped bear high initial costs, investments in defence equipment have been important for semiconductor technology development. During the Cold War, US military needs drove the development of integrated circuits and laid the foundations for the microelectronics industry, with support from the Defense Advanced Research Agency (DARPA).

In Sweden, investment in defence equipment has contributed to the development of semiconductor technology, particularly in niche areas. The development of radar and sensor systems, for example, has stoked demand for high-frequency components based on materials (such as gallium arsenide and gallium nitride). And defence-related development in secure and reliable communications has contributed to advanced circuit solutions in telecommunications.

Collaboration between industry, academia and public authorities (such as the Swedish Defence Materiel Administration) has helped build up Swedish cutting-edge expertise in electronics, sensors, and system integration, which has been used in both military and civilian applications.

The dual-use perspective has become essential

Critical semiconductor manufacturing requires preparedness and is capital-intensive, particularly for components with applications in defence and military-civilian dual-use. Changes in the geopolitical environment and stricter security requirements have made a dual-use perspective increasingly important. At the same time, investor interest in these solutions is growing, not least in semiconductor sensors (sensing).

Dual-use refers to a mutual relationship between civilian and military technology. Innovations developed in the civilian sector can help reduce costs and enable technical breakthroughs for military

29 EU (2025). *Milestone in strengthening Europe's semiconductor manufacturing capacity under Chips Act reached*. Digibyte, published 13 October 2025.

30 The European Chips Act, Article 11: Open EU Foundries.

applications, while advanced military development can drive cutting-edge expertise and innovations transferrable to civilian applications, enabling cost-efficiency and scaling.

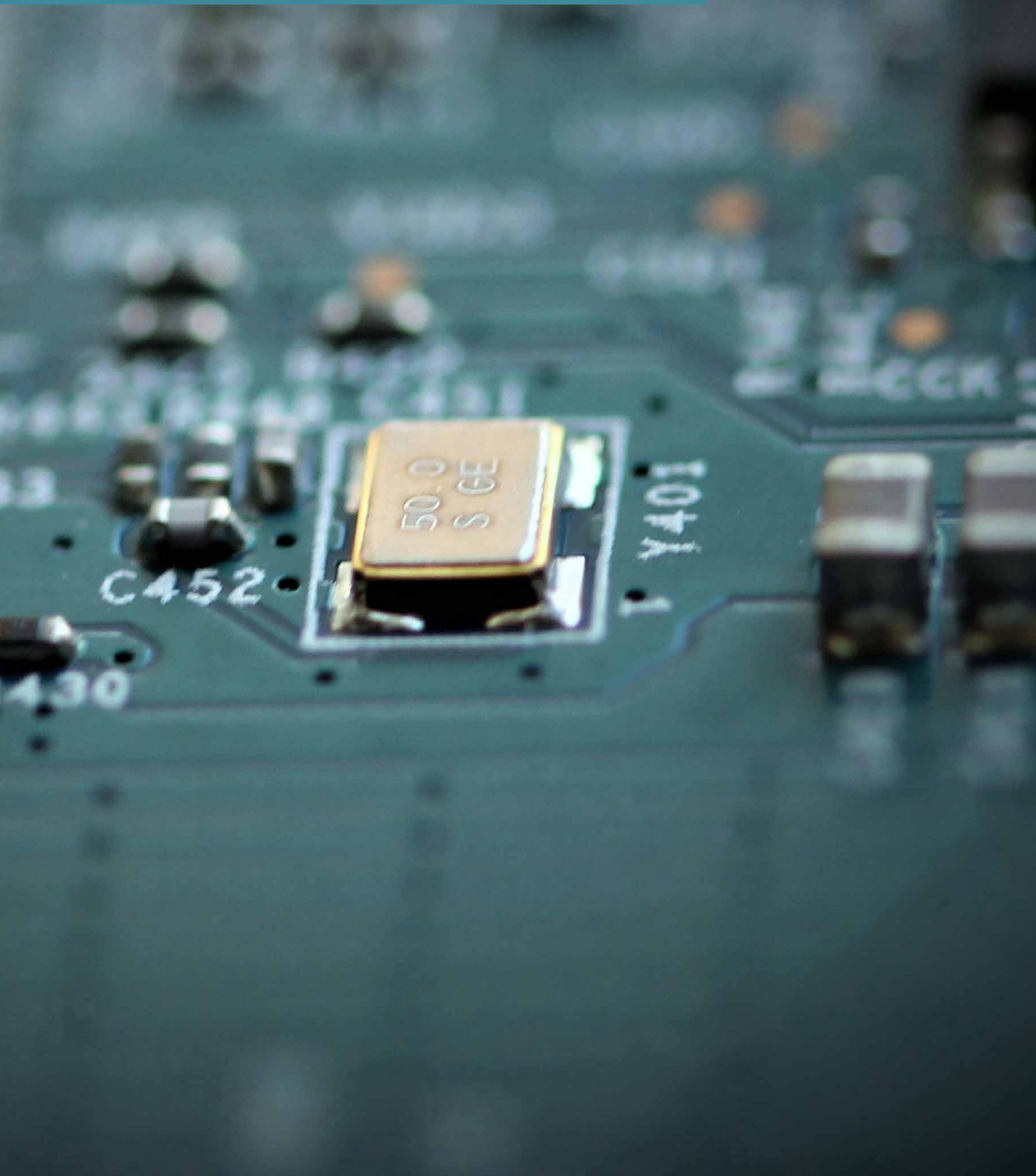
Defence-related issues could be more clearly integrated into technical education programmes. For example, education in electronics (particularly regarding semiconductor expertise) could to a greater extent be delivered through collaboration between technical faculties and the Swedish Defence University.

Reducing dependence to strengthen defence and security

Several countries are developing their own alternatives in the semiconductor sector to reduce dependence on the US and China. A stronger application of the principle of European preference could strengthen European defence. In the defence industry, it may be justified to accept higher costs for European components, but the long-term development of the semiconductor industry simultaneously requires genuine market-driven demand.

Defence and security issues should be viewed as a common European challenge rather than a national concern. European space and defence initiatives, such as those at the European Space Agency and the EU's space programme, can be used strategically to create demand for advanced semiconductor technology. At the same time, deeper cooperation in the Nordic region and Europe can contribute to greater volumes and increased competitiveness.

The way forward



Vision

By 2035, Sweden will have a clear and coordinated agenda for the semiconductor sector. Academia, industry, and the public sector will be working towards common goals. Sweden will be an active and strategic player in Europe. There will be significant and well-coordinated participation in EU programmes. International collaborations will run smoothly without administrative red tape.

Sweden has strengthened its ability to take innovations from research to market. There is access to pilot lines, testing environments, and scaling capacity both nationally and through European collaborations. More companies have grown from start-ups to medium-sized firms, which strengthens the entire ecosystem. Sweden has a clear position in selected areas of strength, such as power electronics, high-frequency electronics, photonics, new materials, and heterogeneous integration. Development is characterised by a systems perspective, where the entire value chain functions effectively.

There is good access to funding at all stages, from research to industrialisation. Public and private actors collaborate effectively. National co-funding makes it possible to participate in European projects and take leading roles. There are incentives that support collaboration between academia and industry, which has led to more researchers engaging in innovation projects. There are effective models that make it possible to scale up companies and translate innovations into business value.

The supply of skills is strong and sustainable. More students are being trained in relevant fields, and Sweden attracts and retains international talent. The link between education and the labour market is clear, and more people are moving between academia and industry. The semiconductor sector is perceived as an attractive, future-proof industry that contributes to innovation, growth and the climate transition.

Industrial companies' increased knowledge of semiconductors has strengthened their ability to make more informed purchasing decisions. This has led to better technical understanding, more strategic requirements and more long-term and robust supplier choices. This, in turn, has contributed to more stable and predictable demand in the semiconductor sector.

Four proposals for strengthening Swedish competitiveness in the semiconductor sector

This section presents four overarching proposals to strengthen Sweden's competitiveness in the semiconductor sector, with each proposal set out in concrete action points. The proposals are based on the premise that semiconductors are a strategic enabling technology of crucial importance for digitalisation, AI, electrification, and defence. At the same time, the sector is characterised by fierce global competition, high investment requirements, and rapid technological development.

Sweden currently has strong research environments and positions in a number of areas that are significant for the development and manufacturing of semiconductors. However, there are several challenges when it comes to translating these strengths into industrial-scale operations and creating long-term value. One clear challenge is the need to strengthen Sweden's ability to scale up companies and to bridge the gap between research and manufacturing.

Against this background, we offer four proposals for action:

- Develop a Swedish strategy and governance framework for the semiconductor sector
- Create the conditions for industrial scaling and manufacturing in Sweden

- Secure funding and incentives for collaboration and investment
- Ensure that employees are highly skilled and that research is of high quality

Our proposals are in line with the analysis and proposals from the Swedish Agency for Economic and Regional Growth in 2024, which argued that Sweden needs a national semiconductor strategy along with initiatives to secure the supply of skilled labour and training and strengthened collaboration between industry, academia, and the public sector.[31] According to the agency's analysis, this requires additional funding. For the period 2024–2029, the agency said an investment of approximately SEK 1.2 billion would be needed for national co-financing to match EU funds, while more funds (around SEK 3 million per year) would be required for public administration to expand work on investment support and administrative coordination, among other things. They also argued that changes to national regulations are needed to enable greater support for, for example, pilot lines.

For each of our proposals, we present several concrete action points, describing the measures required and the actors who should be responsible for implementing them. In addition, we outline various options for implementing the proposals over a ten-year period. There is no relative prioritisation among the proposals; all need to be implemented and work should begin immediately.

Our proposals demonstrate how a more coordinated, long-term, and system-oriented approach can help strengthen Sweden's position in the European and global semiconductor ecosystem.

In implementing the four proposals, stronger collaboration between several ministries would be beneficial. This would strengthen Sweden's position by enabling the country to act in a more coordinated manner. It would also facilitate matters for other actors in the system by helping to send more consistent signals to government agencies.

Proposal: Develop a Swedish strategy and governance framework

For Sweden to hold its own in the semiconductor sector, a clear direction and better coordination are required. As the system is fragmented and lacks a common agenda, there is a risk that efforts will prove ineffective. International collaboration, particularly in the EU, is needed to build high-quality national capacity.

Sweden needs a clear and unified direction for the entire value chain, from research to manufacturing and market. It currently lacks such a holistic perspective. Existing Swedish initiatives are valuable, but they focus on different parts of the ecosystem, and a lack of coordination means they do not form a coherent whole. Sweden has strong research expertise and many innovative projects, but the connection between research, industrial manufacturing, and commercialisation remains limited.

31 Swedish Agency for Economic and Regional Growth (2024). *Halvledaraktens tillämpning i Sverige*. Report prepared by Langbeck B., Rosenlund J., Jansson L. Ref. No. Ä 2023–279..

Sweden can draw inspiration from several international initiatives. Europe wants to create a balanced European ecosystem through the EU's regulation on semiconductors, the European Chips Act.[32] The US is investing in local production and research through the CHIPS Act.[33] China has long-term, state-led initiatives aimed at self-sufficiency in the semiconductor sector.[34]

Sweden's role in the EU's semiconductor act should be viewed in the light of the country's size, research strength, and industrial base. Sweden should strive to secure a share of EU semiconductor initiatives that is proportionate to the country's size and population. This requires a coherent national agenda that clarifies how Swedish actors should be positioned and how the links between research, innovation, and industrial application can be strengthened.

Concrete action points for developing a Swedish strategy and governance:

- **Develop and implement a national agenda for semiconductors** covering the entire semiconductor value chain. The main actor is the Swedish government, which needs to work closely with industry, higher education institutions, and relevant Swedish authorities.
- **Ensure strategic EU collaboration** by increasing Swedish participation in EU programmes and securing national co-funding. The state (government and responsible authorities) needs to collaborate with universities and industry.

A Swedish strategy and governance framework could be developed through various courses of action. If the injection of new resources is limited, one option could be to coordinate existing initiatives. A more active option is to set clear priorities, in order to identify and prioritise certain selected areas of strength for targeted initiatives. A proactive option is to identify, fund, and drive strategic initiatives that can strengthen Sweden's position.

Implementation can be structured in three phases over a ten-year period. In the first two years, the agenda and priorities are defined. Over the next three to five years, Sweden actively positions itself within the EU and strengthens its international role. In the longer term (years 6–10), Sweden will have secured a clear and enduring position in the European semiconductor ecosystem.

See also the Swedish Agency for Economic and Regional Growth's 2024 proposal for concrete measures and a feasibility plan.[35]

32 European Commission. (2023). *European Chips Act*. Brussels: European Commission.

33 U.S. Congress. (2022). *CHIPS and Science Act of 2022*. Washington, DC: U.S. Government.

34 State Council of the People's Republic of China (2020). *New Policies to Promote the Development of the Integrated Circuit Industry and Software Industry*. Beijing: State Council.

35 Swedish Agency for Economic and Regional Growth (2024). *Halvledaraktens tillämpning i Sverige*. Report prepared by Langbeck B., Rosenlund J., Jansson L. Ref. No. Ä 2023–279.

Proposal: Create the conditions for industrial scaling and manufacturing in Sweden

Sweden's greatest challenge in the semiconductor sector is to move from strong research and small start-ups to industrial scale. Sweden and Europe need a type of semiconductor manufacturing whose scale is adapted to the European industrial structure. Targeted efforts are required to build capacity, reduce dependencies, and create an ecosystem where Swedish knowledge and innovations can become competitive companies, products, and services. Concrete action points to create the conditions for industrial scaling and manufacturing in Sweden:

- **Create a national scale-up programme** by securing funding, business support, and partnerships for organisations that are in a growth phase and require various types of support to scale up. Government research and innovation funders are key (for example, Vinnova and Industrifonden), but other funders such as foundations and private investors are also important. Swedish scale-ups need not only capital but also the expertise, experience, and business guidance that private investors can provide.

- **Create national capacity for testing and packaging** by building infrastructure for testing, validation, and advanced packaging. The state (the government and relevant authorities) needs to collaborate with universities and industry. Infrastructure should be built in collaboration between universities, industry, institutes (particularly RISE) and government authorities. Collaboration is required between all these actors and with relevant actors in the EU.

- **Expand access to pilot lines** by investing in more and more accessible pilot lines linked to scaling. Relevant universities, industry, institutes (particularly RISE) and public authorities must work together to increase access to Swedish and European pilot lines.

The options for building Sweden's semiconductor capacity can be summarised in three models. The market-driven model is based on initiatives by private actors and investments with limited government control. The partnership model involves close collaboration between companies, universities, and the state to share risks and expertise. A third option is for state actors to take primary responsibility for capacity building by establishing nationally important resources and infrastructure to ensure strategic national control over critical parts of the value chain.There are several strategic considerations. In deciding whether to focus on scale or specialisation, Sweden should avoid direct competition with major global manufacturers and instead focus on specialisation in well-chosen niches where we can benefit from high levels of research and innovation expertise. One question is whether Swedish players need to own their own resources or whether it is sufficient to have access to capacity. We believe that not all manufacturing has to take place in Sweden, but that it is necessary to possess knowledge and expertise across the entire semiconductor sector, particularly regarding critical steps in the process (such as testing and packaging). Getting to market quickly (speed to market) is another key factor, where the ability to move quickly from prototypes to products can determine Sweden's competitiveness.

To achieve success, a well-functioning Swedish ecosystem is needed. It is not enough for individual companies to be doing well or for a particular university to be able to publish in leading scientific journals. The entire chain from research to industrial manufacturing needs to function seamlessly and efficiently.

Proposal: Secure funding and incentives for collaboration and investment

The semiconductor sector is capital-intensive and requires a long-term perspective. Current funding models are often too short-term and insufficient in later phases. To enable industrialisation, both more capital and better incentives for collaboration and investment are needed.

Public procurement can (under the right conditions) serve as a tool to strengthen demand and thereby accelerate technological development in the semiconductor sector. Experience from defence-related procurement shows that the state can act as a demanding and long-term customer.[36] This creates incentives for companies to invest in advanced manufacturing, design capacity, and research and development. Applied to semiconductors, this means that public demand could help build domestic expertise in chip design, manufacturing, and materials technology. At the same time, the risks are significant. The semiconductor sector is characterised by high fixed costs, rapid technological change, and fierce international competition. Misguided procurement risks inefficient investments or technological lock-in. This requires a high level of procurement expertise and a focus on functional requirements, rather than on specific technical solutions.

The semiconductor sector requires clear and well-functioning regulations to enable business and investment to function effectively. The current system is fragmented and processes are often slow, which hinders both business establishment and innovation. To strengthen the sector, Sweden needs greater technical expertise among officials and decision-makers, better coordination between authorities, and regulations that create clear incentives for private and public investment.

Concrete action points to secure funding and incentives for collaboration and investment:

- **Ensure long-term funding** by prioritising larger and more long-term initiatives, rather than an over-reliance on short-term, project-based funding. There is a need for stable and sustainably secured core funding. Government research and innovation funders are key, but so are other funders such as foundations and activities within research institutes.

- **Create demand through public procurement** by introducing incentives (or even requirements) for European components, particularly in strategic sectors. The main actors here are the Swedish government and the relevant Swedish authorities, who need to collaborate with standardisation bodies and stakeholders in the EU.

- **Ensure that regulations are clear, coordinated, and faster to apply** by strengthening cooperation between ministries and authorities, and by involving individuals with technical and semiconductor-specific expertise in the development and implementation of laws, regulations and other rules.

36 Eliasson, G. (2010). *Advanced Public Procurement as Industrial Policy*. Springer. Eliasson, G. (1985). *The Firm and Financial Markets in the Swedish Micro–to–Macro – Model, Theory and Verification*. Stockholm: IUI and Almqvist & Wiksell.

- **Adapt the application of EU state aid rules** to support strategic initiatives, while facilitating investment from private actors. The main actor is the Swedish government, which should collaborate with relevant authorities and EU bodies to create effective processes and incentives.

Funding can be arranged in various ways. In early development phases, public research and innovation funders play a key role. Co-investment between public and private actors can be used to spread and share financial risks (often later on the technology readiness level (TRL) scale). Public funds can, to some extent, be used to stimulate private investment, for example through procurement, guarantees, or partnerships with industry.

It is important to strike an appropriate balance between public and private funding. The state can take early risks, but long-term scaling and effective governance require private engagement. Semiconductor projects have long payback periods, which means that funders must consider both short- and long-term perspectives. Selective initiatives can yield rapid results but require careful analysis to avoid misplaced priorities in the long run. Models where the state stimulates demand, for example through procurement, can often be more effective than direct support.

Proposal: Ensure highly skilled labour and high-quality research

Skills are a fundamental prerequisite for the entire semiconductor ecosystem. Sweden needs both more specialists and a broader understanding of societal aspects. Research must be of the highest academic quality and also strongly linked to industrial benefits through closer collaboration and revised incentives.

Specific action points to secure highly skilled labour and high-quality research:

- **Secure the supply of skilled labour** by increasing the number of study places, PhD students, and vocational courses. Universities and applied sciences universities that offer engineering programmes are vital, and they need to collaborate with industry to ensure that their course of study is genuinely useful in the sector.

- **Strengthen the practical and laboratory-based elements** of the programmes. Students in existing engineering programmes need to do much more work in advanced laboratory environments with equipment for micro- and nanofabrication, such as lithography, material deposition, and characterisation. University-level engineering programmes must take responsibility for this.

- **Strengthen the link between academia and industry** by introducing incentives for collaboration. Mobility is a key prerequisite in the semiconductor sector. For mobility between academia and industry (and between academia and research institutes) to function effectively, funding is required that also covers costs beyond salaries. Exchanges and rotations should cover the entire career span, not only for professors but also for PhD students and postdocs. Some funding opportunities currently exist, for example via the Foundation for Strategic Research, but they are not sufficient. It is generally easier to move from academia to industry than vice versa, and stronger incentives are needed for companies to give employees the opportunity to spend part of their working hours in academia.

- **Reform incentives in academia** so institutions of higher education can build capacity for commercialisation in close proximity to academic research environments. The aim is to stimulate development that strengthens links with industry, within or directly connected to the existing academic structure. Responsibility lies with higher education institutions and research funders.

Skills provision for Sweden's semiconductor sector can be achieved in various ways. A swift, practical, and feasible approach is to strengthen and expand existing education programmes and research environments. Another is to foster greater integration between universities, research institutes, and industry to ensure that knowledge is translated into practical benefits.

The balance between cutting-edge research and breadth of expertise is crucial. Sweden needs both world-leading research and a broad skills base across the entire system. Academic freedom must coexist with industrial relevance. Attracting and retaining international expertise is crucial, as is matching educational capacity with the labour market's actual needs.

It is possible to strengthen the skills base over a ten-year period. During the first two years, decisions could made regarding educational programmes and incentives. Over the following two years, the skills base could be strengthened through increased collaboration between academia and industry. Over a ten-year horizon, Sweden could establish a stable education and research environment that attracts top talent to the semiconductor industry.

Recommendations

The working group has three recommendations for how Sweden should focus its efforts to build industrial competitiveness, advance sustainability, and contribute to both national and global security.

The recommendations are based on an analysis of Sweden's current position in the semiconductor sector, global trends in semiconductor development, and a review of key issues identifying both obstacles and opportunities for Sweden's continued development. They bring together the proposals and action points set out in more detail above.

1. Strengthen strategic governance and coordination across the entire semiconductor value chain in the semiconductor sector by building on Sweden's areas of comparative strength and deepening collaboration within the EU to maximise the impact from semiconductor investments.

2. Prioritise industrial scaling through expanded capacity for testing, packaging, and pilot lines, while strengthening conditions for start-ups to grow into internationally competitive scale-ups.

3. Secure long-term funding and a sustainable supply of skilled labour through greater alignment between public and private investment, combined with closer collaboration between academia and industry.

Appendix

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Glossary

AI
Artificial intelligence.

Chiplet
Small, specialised chips combined into a larger system, rather than building a single large chip.

Co-design (US.)
Refers to the parallel development of hardware and software to achieve better performance and efficiency.

CMOS (US: complementary metal oxide semiconductor)
A semiconductor technology in which two types of transistors are combined to create fast and power-efficient integrated circuits.

DARPA (Defense Advanced Research Projects Agency)
A US government agency that funds and conducts advanced research and innovation in technology to strengthen US defence capabilities.

Dual-use
Refers to technology or products that can be used for both civilian and military purposes.

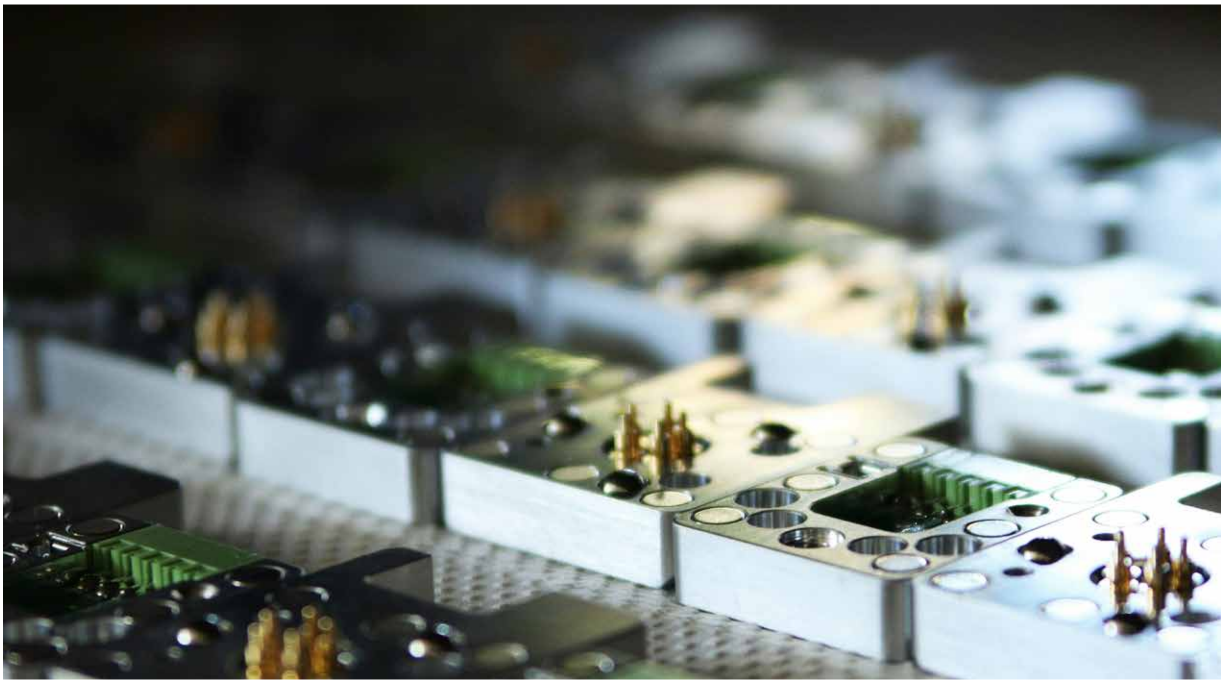
EMS (electronic manufacturing services)
Refers to services for the manufacture, assembly and testing of electronic products. EMS production involves the design, manufacture and assembly of electronic circuit boards and finished electronic systems for industry, vehicles, telecoms and other applications.

HPC (high-performance computing)
Refers to powerful computing solutions designed to handle large-scale calculations quickly. HPC expertise involves specialist knowledge in advanced data processing, algorithm development, parallel programming and the optimisation of large-scale systems to power AI and other computationally intensive applications.

IPCEI (Important Projects of Common European Interest)
An initiative aimed at boosting growth, jobs, and competitiveness through EU-wide efforts in innovation and transition.

IoT
Internet of Things.

Packaging
Refers to techniques for connecting multiple chips within a single package so that they function as a single unit with high performance and energy efficiency.



MEMS (Micro-Electro-Mechanical Systems)
Small microsystems that combine mechanical and electronic components on a chip. Sensors may also be included as components.

Miniaturisation
The number of transistors on a chip roughly doubles every two years, leading to faster and cheaper computers over time. This is commonly referred to as Moore's Law. As the number increases, the size of each transistor decreases.

Myfab
A Swedish semiconductor research infrastructure offering cleanrooms and advanced prototype development.

PCB (printed circuit board)
A circuit board that connects electronic components.

RF technology (radio frequency technology)
Technology that uses electromagnetic waves in the frequency range 3 kHz to 300 GHz for wireless communication, signal processing, and power transmission.

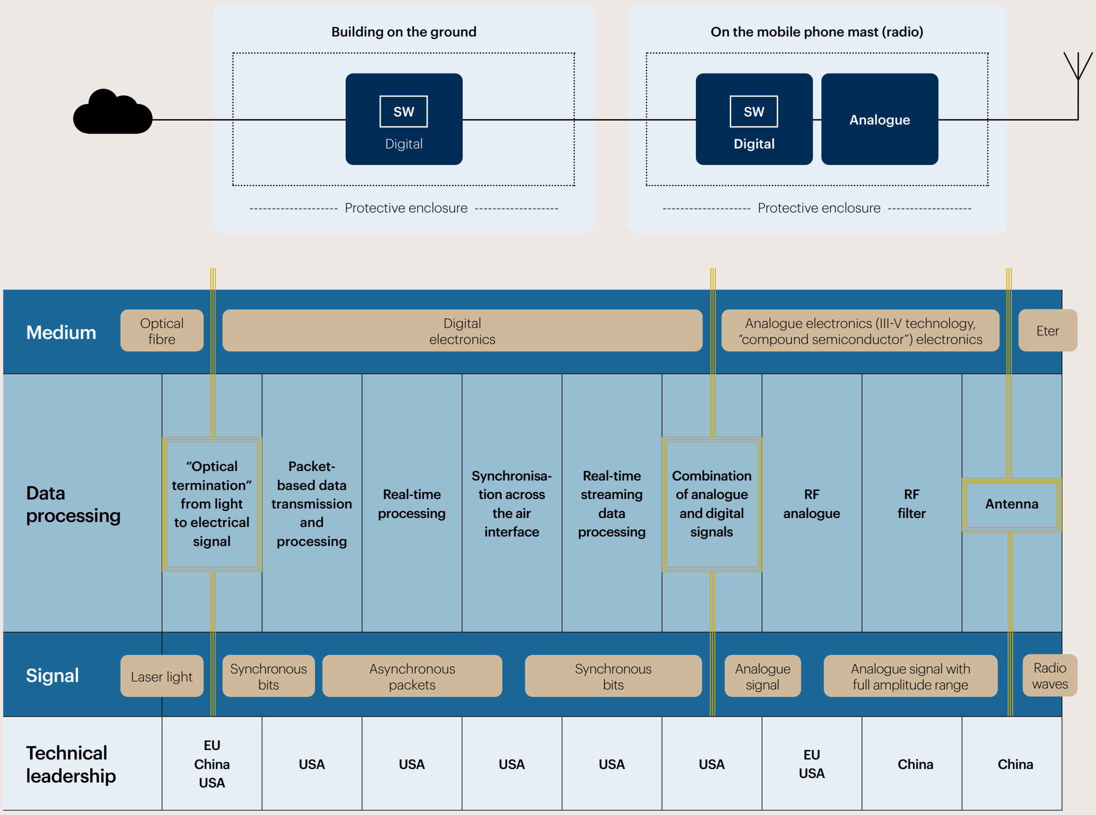
STEM
Stands for science, technology, engineering, and mathematics and is used as an umbrella term for education and fields in the natural sciences, technology, engineering, and mathematics.

TRL level (technology readiness level)
A scale from 1 to 9 that indicates how mature a technology is. The scale ranges from early-stage research (TRL 1) to fully developed and commercially used technology (TRL 9).

Yield
The proportion of all chips manufactured on a wafer that function correctly and pass the tests. A wafer is the production surface for semiconductor chips, i.e., the surface where all chips are manufactured before they are cut out and used individually.

FIGUR 3: The figure illustrates the need for infrastructure and semiconductor technology to convert data packets transmitted via an optical fibre into radio waves emitted by an antenna in a radio base station (RBS). RBS antennas are critical components for wireless network infrastructure, enabling mobile devices to connect to the network via technologies such as passive antennas and multiple-input multiple-output systems, which increase radio link capacity by using multiple transmitting and receiving antennas.

The figure illustrates which region (Europe, the US, and China, respectively) holds technical leadership in a particular type of semiconductor technology. Comment: in the analogue electronics stage (outlined in the description of the medium in the figure), Ericsson uses LdMOS (Laterally Diffused Metal Oxide Semiconductors) and GaN (gallium nitride) as semiconductor materials in its amplifiers. Source: Ericsson



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