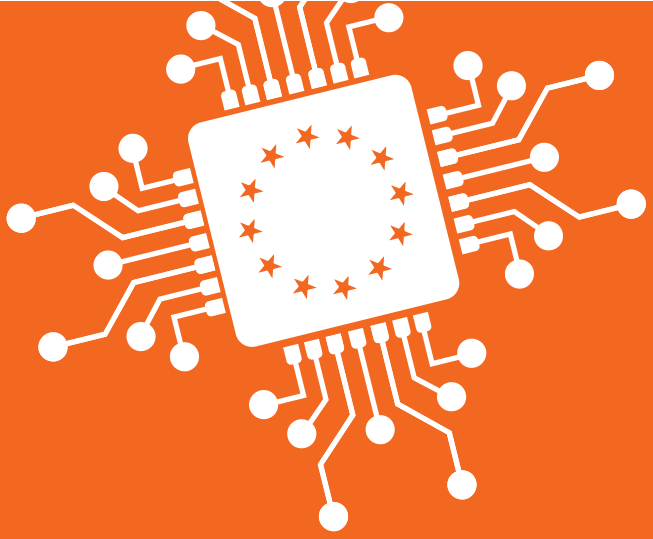

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EXCECUTIVE SUMMARY

Industry Outlook 2030+

Semiconductor Industry

Semiconductors are central to Europe's digital and green transformation and therefore its future competitiveness. The semiconductor industry is a driver for cutting-edge products and an enabler for innovations in other sectors. Powerful semiconductors are key for innovative future applications such as artificial intelligence (AI) and the Internet of Things, but even energy-efficient household appliances and electric cars are inconceivable without semiconductors. Every third innovation in the manufacturing sector in Germany is based on solutions from the electronics industry. Microelectronics is already the basis for a large share of innovations in the automotive industry.

The Industry Outlook 2030+ The Semiconductor Industry examines the status quo and future development of the semiconductor industry in Europe and Germany, the most important European semiconductor location. Central questions are:

- How is the European semiconductor industry positioned? What role does Germany play?
- How does the European semiconductor industry contribute to digitalisation, climate change, and securing skilled labour? What influence does globalisation have on the industry?
- Which conditions and policies influence the future development of the industry?
- What are the strengths and weaknesses, risks, and opportunities for the European and German semiconductor industry?

The research suggests that European semiconductor manufacturers design and produce highly innovative products. In the automotive and power semiconductors markets, European semiconductor companies are already among the global leaders. Furthermore, European companies are also successful suppliers to the global semiconductor industry. They provide chemicals and equipment essential for the semiconductor production worldwide. European companies are seen as technological leaders in the extreme ultraviolet lithography (EUV) lithography technology. Europe has top research facilities on semiconductors and has continuously expanded its strong position in the research into innovative semiconductor solutions in recent years. Research institutions and companies already cooperate successfully in several regional innovation ecosystems.

However, Europe also has weaknesses. While other regions, especially Taiwan, South Korea, and China, have significantly expanded their semiconductor production capacities in recent years, **fewer and fewer chips are being produced in Europe**. Currently, Europe has only 6-8 per cent of the world's semiconductor production capacity. When it comes to designing chips, there is a lack of companies specialising in chip design (so-called fabless companies) in Europe—also due to the lack of customer industries in the field of communication electronics. Overall, only about one in 11 chips is designed in Europe. At the same time, competencies in designing the latest generation of microprocessors are strategically important, as they are needed for many security-relevant future applications such as AI as well as critical infrastructures.

European companies in the semiconductor industry are intensively integrated into highly specialised global value chains. A chip travels around the world about two and a half times before it is completed. The high degree of specialisation leads to numerous critical bottlenecks where only a few countries and companies have sufficient expertise. This is clearly demonstrated by the current supply bottlenecks. However, the bottlenecks in the value chain include not only the production and design of the latest generation of chips but also chip design software, the construction of production facilities, and the manufacture of certain chemicals. The interdependencies in the semiconductor value chains are often exploited by countries for their own political interests. The greatest risks for the business activities of European semiconductor companies—and thereby also for all downstream industries such as the automotive industry —include political tensions and restrictions in global trade that could worsen access to products and technologies.

Due to its high strategic and economic importance to Europe, the semiconductor industry has received considerable attention from policymakers in recent years. In its Digital Compass 2030 policy, the European Commission has defined an ambitious target for the next 10 years: Europe's share of the world semiconductor market is to increase to 20 per cent by 2030 and the establishment of new, technologically leading chip factories is to be driven forward. The proposal for a European chip law envisages investments of €43 billion for semiconductors as „one of the most important industrial projects for many years". This is because, to achieve this very ambitious goal, European semiconductor production capacity will have to increase many times over the current level—up to a factor of five, depending on the growth of the overall market. This creates opportunities for European manufacturers because large-scale funding programmes create synergies and bring together the relevant players from science and industry. That the EU's ambitions are great is already shown by the Important Project of Common European Interest (IPCEI) Microelectronics, the first European joint project of this kind. In this large-scale funding project, Germany, France, Italy, Austria, and the United Kingdom not only granted aid to semiconductor companies for research and development but also to promote the development of manufacturing capacities—a first in European state aid law. In Germany, for example, the chip factories of Bosch, Infineon, and GlobalFoundries in Dresden were newly established or expanded with this support.

The efforts of the European Commission and the member states to invest massively in the expansion of the European semiconductor industry are meeting a **growing future demand for semiconductors**. Driven by the trends of digitalisation and sustainability, the demand for semiconductor solutions will increase significantly in the future. The demand for automotive semiconductors, in which European manufacturers are world leaders, will grow the strongest of all semiconductor submarkets—driven by electromobility and automated driving. Electronics and software will play a central role in the cars of the future and are already responsible for most innovations in the automotive sector. European semiconductor manufacturers can thus actively contribute to Europe's transformation into a digital and green economy.

Higher production volumes on the one hand and increasing use of resources in new manufacturing technologies on the other, make it necessary to develop **more resource-efficient semiconductors**. The design phase of semiconductor products is crucial for this endeavour. In future, the environmental impact of products must be optimised at an early stage of development. The ecological footprint of semiconductor products will be become an increasingly important objective alongside the performance, cost, and system properties of the product.

As an industry of cutting-edge technology, **the semiconductor industry is particularly dependent on access to skilled workers for ensuring its innovation and competitiveness**. Specialists for mathematics, information technology, natural sciences, and technology (MINT), which also includes electrical engineers, are particularly important. Additionally, digital skills and especially software skills will becoming increasingly important. This trend is already evident in semiconductors for the automotive industry. Meeting this demand is one of the important future challenges for the European semiconductor industry. Table 1 summarises the strengths, weaknesses, opportunities, and threats of the European semiconductor industry.

Although this industry outlook focuses on the European semiconductor industry, the German perspective is of particular interest as **Germany is a strong European semiconductor player**. Two of the leading semiconductor manufacturers in Europe, Infineon, and Bosch, and one of the three top European research institutions on semiconductors, the Forschungsfabrik Mikroelektronik, are located in Germany. A high level of patent activity in the semiconductor sector illustrates that Germany is leading

Europe's innovation activities in in industrial application of semiconductors. Germany, and more specifically Dresden, also has the largest semiconductor cluster in Europe and can boast the highest proportion of STEM professionals in Europe. Thus, supporting the international competitiveness of Germany is essential to meet the European Union's ambitious goals.

If Germany wants to strengthen and expand its role as major location for the European semiconductor industry, **several measures should be considered by policymakers**.

- **Strengthening semiconductor research and chip design:** Firstly, the Federal Government should strengthen Germany's existing strengths as a location for analogue semiconductors, power semiconductors, and chips for automobiles and industry applications, as existing ecosystems can be built on them. Secondly, existing gaps in the design of strategically important technologies such as high-performance processors should be closed.

- **Build production capacities for key customer industries:** The German government should not focus unilaterally on building production capacities in the area of structure sizes below 10 nanometres. It should also financially support the production of innovative chips with larger structure sizes, for example, power semiconductors made of new materials, and the large-scale application of cutting-edge technologies, for example in plant engineering. The most important instrument is the IPCEI, for which companies in Germany have already submitted funding applications in a second round, which still have to be approved by the Bundestag.

- **Cooperation with domestic and non-European partners:** Here, Germany can draw on existing initiatives such as the Semiconductor Alliance, the Alliance for Processors and Semiconductor Technologies, and the joint undertakings within the framework of EU Horizon 2020 to leverage synergies across Europe and jointly coordinate the orientation of funding programmes.

- The semiconductor industry **benefits from an unrestricted international trade** because cooperation and knowledge transfer play a decisive role in the highly labour-divided semiconductor value chains.

- The **promotion of STEM specialists** through the advancement of women and improved access to the labour market for foreign specialists, as well as education and training in the newly defined occupational profiles for the semiconductor industry, is essential to prevent a lack of skilled workers from becoming the bottleneck for the future development of Germany as a semiconductor location.

- **Environmental and climate regulations**, such as the directives on the use of chemicals, **must allow the production of semiconductors** in Europe in the future.

- **Access to renewable energy — especially green, affordable electricity —** must be secured for semiconductor companies in Germany.

SWOT-Analysis of the European Semiconductor Industry

Strengths

- ☺ Strong competitiveness of European manufacturers in automotive, power, and analogue semiconductors
- ☺ Close ties to strong customer industries (automotive and industrial)
- ☺ Market-leading position of a European company in EUV lithography
- ☺ Strong European research institutions and increasing share of global research output
- ☺ Well-trained engineers and skilled workers

Weaknesses

- ☹ Decreasing European share of global semiconductor manufacturing capacity
- ☹ No European advanced manufacturing capacity
- ☹ Low European design competence for advanced chips
- ☹ Hardly any companies in the fabless sector, lack of European customers for advanced semiconductors
- ☹ Need for improvement in the transfer of know-ledge from cutting-edge research to local industry (example Belgium)

Opportunities

- ☺ Energy transformation as a driver for European semiconductor demand
- ☺ Electrification and automation strengthen demand for automotive semiconductors
- ☺ Digitalisation and Industry 4.0 create growth opportunities
- ☺ Large-scale European funding programmes to build production capacities and strengthen chip design
- ☺ Improved transfer from cutting-edge research to application
- ☺ Alliances with international partners

Threats

- ☹ Highly fragmented semiconductor value chains with critical bottlenecks at a few companies and countries
- ☹ Political tensions and trade conflicts
- ☹ Disruptive potential of digitalisation for automotive value chains
- ☹ Software development competencies as bottleneck
- ☹ Large-scale semiconductor development programmes in other regions of the world (USA, China)
- ☹ Increasing resource consumption of modern semiconductor manufacturing

Source: Oxford Economics

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