May 2024. Technology Snapshot.

Semiconductors in Catalonia



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Semiconductors in Catalonia. Technology Snapshot.

ACCIÓ Government of Catalonia



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Carried out by

Strategy and Competitive Intelligence Unit of ACCIÓ

Barcelona, May 2024



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Executive summary: semiconductors in Catalonia (I)

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Semiconductors are materials that can control electric currents in a very precise manner to provide chips with the ability to process, store and transmit data. New technological advances applicable to semiconductors are vital to facilitate the wave of transformational technologies such as AI, 5G, electric and autonomous vehicles and the IoT.



Executive summary: semiconductors in Catalonia (II)

Catalonia has an industrial, business and research fabric to position itself as a location for microchip design and host a European semiconductor factory. The achievement of proprietary capacities in semiconductors is key to the development of the mobility of the future and local industry 4.0.



Semiconductors in Catalonia

1. Definition and importance of semiconductors



Definition

Semiconductors are materials that can control electric currents in a very precise manner to provide chips with the ability to process, store and transmit data.

A chip contains a set of miniaturized electronic circuits made up of active devices (transistors), passive devices (capacitors, diodes and resistors) and interconnections between them, integrated layer by layer on a thin wafer of semiconductor material, typically silicon.

The increase in the technological capacity of integration in chips has become exponential, and chips currently contain around ten million more components than they did 60 years ago. The most cutting-edge chips measure 3 nanometers (1/20,000 of a human hair) and they're 70% faster than 5 nm chips.

New technological advances applicable to semiconductors are vital to facilitate the wave of transformational technologies in all fields, such as AI, 5G, electric and autonomous vehicles and the IoT.





Importance of semiconductors in industry

Semiconductors impact numerous sectors, including communications, electrical and electronic devices, vehicles, robots, industrial machinery, medicine and medical equipment. **They're facilitators of the evolution of** technologies such as AI, the IoT and robotics.

The complex and global semiconductor value chain has been threatened and strained by different geopolitical balances. Within the context of a lack of international cooperation, creating the value chain and bringing it closer will help strengthen and stabilize a large number of industries that depend on semiconductors to manufacture their products.

Semiconductors lie at the heart of a new technological battle on a global scale. Europe must become an active player and define its own model and strategies to facilitate the digital transformation.

^{rechnologica}

sovereignty

Digitization

Innovation

Cross-Industry

Value Chain

Semiconductors are essential for the digital transformation. The digitization process affecting the economy and society is necessary to incorporate control and efficiency measures into procedures and it's developed rapidly in recent years, while it's also increased the need for all the ranges of semiconductors worldwide.

The semiconductor manufacturing process is extremely complex. Research is being done on innovation to identify new materials and processes to improve capabilities, services and procedures. This has high growth potential and covers different areas of knowledge.

Source: the authors CataloniaConnects

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2. Value Chain



Value Chain

The value chain is characterized by major divisions of labor, highly concentrated market niches and pressure to constantly innovate and invest, and no country brings together the entire production process in its territory

Design (fabless)

This is based on design software and intellectual **property (IP blocs). It's** intensive in terms of knowledge, research and development. Fabless companies typically spend 25% of their income on R&D.

Manufacturing (foundries, fabs)

The process relies on manufacturing equipment, chemicals and silicon wafers to produce chips. It requires large amounts of capital due to the cost of the facilities and equipment. Building a state-of-the-art semiconductor factory costs well over 15,000 million dollars.

Assembly and testing (IDM or OSAT)

This requires equipment and chemicals. Although it's labor-intensive with lower profit margins, companies are increasingly focusing on this phase of the process to improve semiconductor performance.



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Phases of the value chain



Characteristics of the value chain

Major division of labor

There's a major division of labor, not only in the three main stages of the process, but also between equipment and material suppliers, as a result of the economic pressure to constantly innovate.

High capital intensity

Over the next ten years, industry will need to invest about 3 billion dollars across the value chain to meet the growing demand for semiconductors. Just building a next-generation factory requires about \$20 B.

High knowledge intensity

Industry spent more than 14% of its income on R&D in 2020. Moreover, companies need to work closely with each other and with research and technology bodies to develop the semiconductors of the future.

Long manufacturing cycles

The industry is characterized by long-term planning, and customers have to place orders well in advance. In total, the production of a semiconductor can last up to a year.

Trans-nationality

The United States, Japan, South Korea, Taiwan-China, the EU, China and several Southeast Asian countries play a critical role in the value chain. No region can complete all the phases of the process internally.

Extreme inter-dependences

Having close connections within the ecosystem is crucial when it comes to developing competitive products. However, the above creates significant inter-dependences between companies and countries, making it difficult to change suppliers and manufacturers.

Sources: Stiftung Neue Verantwortung (2021) "Understanding the global chip shortages" and BCG & SIA (2021) "Strengthening the global semiconductor supply chain in an uncertain era" CataloniaConnects



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3. Sectors of application





The final application impacts the technological evolution of semiconductors; while supercomputers and smartphones require ever more powerful and smaller chips (<10 nm), industries such as automotive make do with larger chips (between 28 and 65 nm).



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Demand by sectors

Demand for semiconductors by end use in 2023 and variation with respect to 2022





2023 has been characterized by increased sales in the automotive and industrial sectors, as well as a growing demand for semiconductors key to artificial intelligence systems. The demand for semiconductors continues to be focused on products geared towards final consumers, such as laptops and smartphones.

Source: SIA Factbook 2023
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4. World Market



The world semiconductor market

The turnover of the global semiconductor industry will reach \$588.36 B in 2024, constituting a 13.1% increase compared to 2023. With estimated year-on-year growth amounting to 6.3%, the turnover will reach \$736.4 B in 2027.

- Growth will be driven by the technological convergence of connectivity and artificial intelligence, which will become the core of product development activities across all the verticals.
- The deployment of 5G, the increase in smart phone use worldwide, the migration to electric and connected vehicles, factory automation and the proliferation of IoT devices are key trends set to drive growth in the mid and long-term markets.







Global semiconductor turnover and variation with respect to the previous year billions of dollars and %, 2019-2024

Sources: Statista and McKinsey CataloniaConnects

Semiconductor value chain, by geographical areas

The semiconductor value chain is highly complex and each stage of the production process is interdependent with the others.

The United States leads in R&D intensive activities, with Europe in second place, while the Far East (Taiwan-China, China, Japan and South Korea) excel in the other links in the value chain.



Distribution of the specialization of the semiconductor value chain, by geographical areas



Note 1: OSAT: assembly and testing.

Note 2: "Others" includes countries such as Malaysia and Israel.



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Segmentation of the semiconductor market by regions



Source: the authors, based on Statista and SIA Factbook 2023

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*Except China

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Source: the authors, based on Statista, Stiftung Neue Verantwortung (2020), "The global semiconductor value chain", and the Generalitat de Catalunya Government of Catalonia



7 of the top 10 semiconductor supplier companies are from the US, with Intel in the lead by a long way.

Main companies supplying semiconductors by turnover in billions of dollars, 2023







Source: Statista CataloniaConnects

Leading companies in the semiconductor market around the world: demand

Chinese companies lead the ranking of companies with the highest demand for semiconductors, with 5 in the top 10. The United States also features prominently with 3 companies, particularly Apple.

Global technology companies by spending on semiconductors in billions of dollars, 2022







Source: Statista CataloniaConnects

European capabilities in the semiconductor value chain

Despite the presence of niche companies, it will take a major effort for Europe to catch up with large-scale nextgeneration semiconductor manufacturing in the mid term

Europe has companies (European and foreign ones) at some stages of the semiconductor value chain:

- Manufacturers and IDM of semiconductors with applications for automotive equipment, industrial automation and sensors. The main ones are the Franco-Italian ST Microelectronics firm, NXP from the Netherlands and companies based in Germany (GlobalFoundries, Bosch, Infineon, X-FAB and UMS).
 Europe doesn't have any companies that manufacture next-generation semiconductors at the moment, although Intel, which already has a 20 nm plant in Ireland, will set up another one in Germany.
- Fabless, such as ARM, based in the United Kingdom. It has developed its own architectural standard, and its chips are used in almost every smart phone in the world.
- Providers of key technology for industry. ASML from The Netherlands is a niche leader, having developed the most advanced method for miniaturizing chip structures with its extreme ultraviolet (EUV) lithography system. The production of high-end chips around the world wouldn't be possible without this technology. The French SOITEC firm also excels as a producer of special wafers.









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5. International initiatives



Timeline of public policies of the main players in the semiconductor value chain



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Semiconductor initiatives in Europe

European Chips Act

A European regulation that has recently entered into force to promote the semiconductor sector in the EU, **reinforcing and increasing the continent's chip** production, innovation, research and attraction of investment, with a desire to coordinate unity between states to cope with the volatility of supply in the market.

Chips for Europe

An initiative established by the European Chip Act to promote technological capacity and innovation in semiconductors in the EU in relation to five main objectives: design, pilot lines, quantum chips, competition and chip funds.

IPCEI

The EU approved two IPCEIs (Important Projects of Common European Interest) in 2018 and 2023 in the fields of microelectronics and telecommunications to provide different European companies with state aid. The aid of the two IPCEIs provided by the member states totals 10 billion euros.

European Region Semiconductor alliance

An initiative that seeks to foster the growth and competitiveness of the semiconductor industry in Europe, based on knowledge exchange, best practices and cooperation between regions.

Sources: European Commission, Silicon Saxony and ACCIÓ





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Structure of the PERTE of semiconductors



Develop the design and production capabilities of the microelectronics and semiconductor industry in Spain.

in stages



1. Long-term 2. Prioritization 3. Progress

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7 principles

vocation

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6. Technological trends and opportunities and challenges



Technological trends in semiconductors



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Opportunities and challenges in the semiconductor industry



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7. Semiconductors in Catalonia



The semiconductor ecosystem in Catalonia





Source: ACCIÓ (latest data available: 2022)

Mapping of the semiconductor business ecosystem in Catalonia



By segments^{**}, 41.5% of the companies are devoted to the PCB and electronics, 25% operate with the auxiliary industry and engineering, 23% are design and IP companies, 7.4% are firms working in distribution and 6.9% produce equipment. Other less important segments are quantum and photonic chips (5.1%), materials (4.6%), fabs (1.8%) and assembly and testing (1.4%).

* Increases with respect to the 2022 mapping. More companies have been quantified thanks to the Semiconductor Alliance, the commitment to the reindustrialization of Catalonia and the extension of the scope of the value chain.

** Companies may be classified in more than one segment of the semiconductor value chain.



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Source: ACCIO (latest data available: 2022) CataloniaConnects



Segmentation of the semiconductor value chain in Catalonia

Illustrative partial image. The companies that are part of "Demand" are not quantified in the business mapping.

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Source: ACCIÓ CataloniaConnects

Agents of the semiconductor ecosystem in Catalonia



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Impact of semiconductors on the Catalan manufacturing industry

44.1% of the Catalan manufacturing industry uses semiconductors in its processes and products.

The sectors that use the most semiconductors are:

HIGH EXPOSURE

- Computer and electronic products
- **Transport** materials
- Electrical materials and equipment
- Machinery and equipment

MEDIUM EXPOSURE

- **Food and drinks**
- Pharmaceutical products
- Chemical products
- Textile, clothing, leather and footwear

Semiconductors are key to the development of the mobility of the future and industry 4.0 in Catalonia.

Note: estimate based on IDESCAT's data on the GVA of Catalonia in 2021



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Source: ACCIÓ **Catalonia**Connects

Related industrial systems

Demand

Support



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Semiconductor initiatives in Catalonia

Semiconductor alliance in Catalonia

A tool that facilitates and promotes the participation of the different players involved in advice, promotion and reinforcing the ecosystem and industrialization of chips and semiconductors in Catalonia.

Semiconductor strategy

An action plan that facilitates industrial policies with added value and support for initiatives which, within the framework of the alliance, have a decisive impact on improving the competitiveness of the semiconductor industry in Catalonia.

InnoFab

Pre-production infrastructure for manufacturing prototypes and short runs of microchips for testing before sending them to the mass production foundries.

Master's degree in Semiconductor Engineering and Microelectronic Design

A new inter-university degree that will train professionals to reinforce the sector and address the challenges of the future. Coordinated by the UPC, with the participation of the UB, the UAB and the URV and the collaboration of the **CSIC's Barcelona Microelectronics Institute.**



European Region Semiconductor alliance

A European initiative that brings together 27 regions, including Catalonia, to promote the growth and competitiveness of the semiconductor industry in Europe, based on knowledge exchanges, best practices and inter-regional cooperation.



Semiconductor Alliance in Catalonia

The **Alliance** aims to become the tool of the Government of Catalonia to facilitate and actively promote the participation of the different players involved in advice, promotion and reinforcing the ecosystem and industrialization of chips and semiconductors in Catalonia.

Functions of the Alliance

- To develop the strategy to promote the semiconductor industry
- Monitoring, coordination, validation, evaluation and accountability
- To propose and support strategic projects capable of expanding the productive capacity (Industry NP 2022-2025) and training (Society of Knowledge NP)
- To promote the participation of Catalonia in European initiatives to develop the ecosystem



The aim of the Alliance is to promote the growth and consolidation of the semiconductor, electronics, photonics and quantum ecosystem to secure a competitive, innovative and sustainable economy.



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Semiconductor strategy in Catalonia

An action plan that facilitates industrial policies with added value and support for initiatives which, within the framework of the alliance, have a decisive impact on improving the competitiveness of the semiconductor industry in Catalonia.







Master's degree in Semiconductor Engineering and Microelectronic Design

The master's degree, fully adapted to the business reality

of the industry, is designed to be completed with 60 credits chosen from one of its two branches: Semiconductor Engineering and Microelectronic Design, in one academic year and with the option of studying both branches, completing the 90 credits in a year and a half with a dual end-of-year project.

- Semiconductor Engineering, in which the students will be trained in the different aspects of the use of microelectronic chip technologies, such as clean room manufacture, encapsulation, characterization and reliability analysis, as well as understanding of the physical phenomena that occur in current and emerging semiconductor devices.
- Microelectronic design, which seeks to train the students in the design of digital and analog integrated circuits and systems using advanced technologies.

The master's degree in Semiconductor Engineering and Microelectronic Design is an inter-university qualification coordinated by the Barcelona Higher Technical School of Telecommunication Engineering (ETSETB), attached to the Polytechnic University of Catalonia (UPC), with the participation of the University of Barcelona (UB), the Autonomous University of Barcelona (UAB) and the Rovira i Virgili University (URV) and the strategic collaboration of the Barcelona Microelectronics Institute (IMB-CNM) of the Spanish National Research Council (CSIC).





Catalonia's participation in the semiconductor PERTE

Catalonia is taking full advantage of the semiconductor PERTE, attracting new investments and the participation of companies in flagship projects.



Emblematic projects announced in Catalonia within the framework of the PERTE

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- Intel and the BSC are joining forces to set up a pioneering microchip design laboratory in Barcelona with 200 million euros of investment from the PERTE and another 200 million euros from Intel
- Cerdanyola del Vallès will host the Innofab, a chip preproduction center entailing an investment totaling 360
- million euros and the creation of 200 jobs
- Cisco has set up its first microchip design center in the FU in Barcelona

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ACCIÓ's Next Generation EU office is a service Next Generation that encourages the participation of Catalan companies in strategic projects.

- In the grants granted by the CDTI to the "PERTE Chip Mission" program so far, 14 Catalan companies have obtained 16.8 million euros, 36% of the State total
- Two of the 56 European companies participating in the microelectronics IPCEI approved in 2023 (financed by the PERTE) are Catalan: Openchip (granted with 111 M€) and Semidynamics (granted with 38.58 M€)

Companies and institutions taking part in the PERTE:



Foreign investment in semiconductors in Catalonia



Catalonia is the third-ranked region in the EU in terms of the capture of foreign investment projects, the fifth-ranked for jobs created and eleventh in investment volume in semiconductors attracted since the announcement of the European Chip Act (2022)

Catalonia, preferred destination in Spain: it concentrates 66.7% of the projects, 70.7% of the jobs created, and 40.3% of the invested capital.

Ranking by regions in the EU (projects)



Catalonia, a dynamic semiconductor ecosystem

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SWOT of semiconductors in Catalonia

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8. Success Stories in Catalonia



Success Stories in Catalonia



QORVO designs, manufactures and supplies radio frequency systems for applications that power wireless broadband communications.



Draco Systems has recentralized its production plant in Sant Adrià de Besòs, with a cutting-edge fully digitalized production line.

IDEADED is opening the largest private semiconductor

clean room in the sector in Southern Europe, with 500

m² for the production of short series of microchips.



Monocrom specializes in the development of laser diodes and researches and innovates in the field of semiconductor lasers with the most advanced technology and research centers.



UniSCool is a Catalan startup that's created an innovative liquid cooling solution for chips, optimized for any kind of heat load scenario.



IDEADED

Cisco has opened its first microchip design center in Europe in the Catalan capital, at its cutting-edge technological innovation hub in Ca l'Alier del Poblenou in Barcelona.



Quside is a Catalan startup at the forefront of quantum entropy semiconductors for cybersecurity and communications applications.

MSTECH Europe is investing in Vilanova i la Geltrú to **METECH** provide a manufacturing center and machinery R&D&I for the microelectronics and electronics industries.

UAB Universitat Autònoma de Barcelona

The UAB is working on the development of new flexible substrates for innovative chips.



Lace Lithography is developing innovative chip patterning technology, extending Moore's Law beyond the current technology.

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Interviews with institutions and companies

For the availability and provision of data and information for the drawing up of this technology report on semiconductors, **we'd** like to thank:







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More information about the sector, news and opportunities: https://catalonia.com/key-industriestechnologies/technologies/semiconductors-in-catalonia

