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Semiconductors: a globalised market and a European dependency

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Shortages of semiconductors in recent years have revealed not only the central and strategic role of these components, but also the EU's high dependence on imports.

Since the turn of the 2010s, France's semiconductor imports have increased: in 2022, these imports reached €7 billion, 90% of which being in the form of finished products, whereas domestic production is around €5 billion. Around 100 companies are active in the semi-conductor sector[2] in France, two thirds of which are SMEs. They account for about 35,000 jobs.

1 The authors thank Louis de Catheu and Jean-Eric Michallet for their contributions and careful review.

2 The European Commission, as part of its Dependency Review exercise SCAN, has established a list of semiconductor finished products, which is the scope of this entire study. This list is available appendix A.1 to the document accessible from the following link: Applying the SCAN methodology to the Semiconductor Supply Chain, JRC Working Papers in Economics and Finance, 2023/8

France and the European Union are dependent on a limited number of producing countries, mainly located in East Asia, thus creating a situation of vulnerability in certain sectors, such as IT, electronics, the automotive industry or some equipment manufacturing industries.

For more than a decade, both in France, which has established itself as a key player in Europe, and in the EU, the semiconductor sector has been the subject of massive support plans to strengthen production capacity and secure supply. These various plans pursue the objective of the European Chips Act, which is for European producers to achieve a market share of 20%.

1 The semiconductor market has undergone considerable transformations in recent decades

A Semiconductor production is capital and R&D intensive

The term 'semiconductor' originally refers to materials with special physical properties[3] having enabled, in particular, the creation of modern electronic circuits, but also, photovoltaic cells. As Pierre-Gilles de Gennes recalled in 1994, "the properties of semi-conductors are at the origin of all modern electronics". Because of its solidity and robustness, the most widely used semiconductor material is silicon, but there are others such as germanium or gallium arsenide. By extension, the word «semiconductor» refers to miniaturized electronic circuits, themselves made from semiconductor materials: it is the meaning used in this publication..

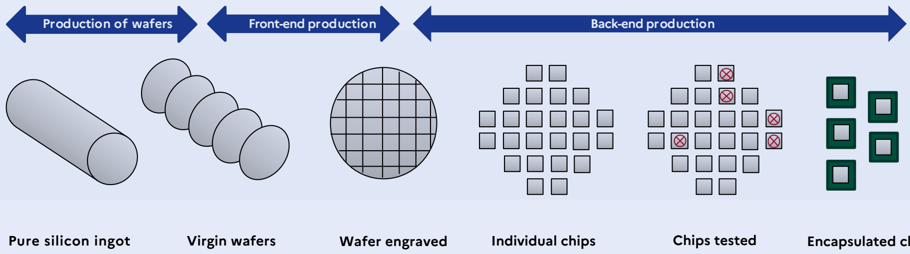
Semiconductor production requires considerable investment. Due to the pace of technological developments in the sector, and the performance race they are engaged in, producing companies must continually invest in new plants and equipment to remain competitive. According to professionals, the construction of a state-of-the-art semiconductor manufacturing plant would involve investments estimated at least between $10 and $20 billions[4].

3 Semiconductor materials adopt, depending on their environment, either the behaviour of an insulating material, or the behaviour of a conductive material (metal). It is by playing with these different properties that transistors or miniature diodes, the basic building blocks of electronic circuits, can be designed.

4 Shih, W. (2021), Why the global chip shortage is making it so hard to buy a PS5.

BOX 1
From Silicon to Chip: the semiconductor manufacturing process?

The semiconductor value chain includes a design phase, which consists in choosing the components and architecture of a chip according to its use, and a manufacturing phase. While the design of the semiconductor is usually undertaken by the seller, manufacturing can be outsourced to other specialised actors. Manufacturing can itself be divided into three main stages: wafer manufacturing, so-called «front end» production and so-called «back end» production.



The substrate used for semiconductor production is the wafer: a very thin disc of semiconductor material. To manufacture a wafer, a semiconductor material (most often silicon) is purified, melted and then resolidified into a cylindrical ingot of very high purity (less than one foreign particle per billion). This ingot is then cut into thin slices less than 1 mm thick and generally between 150 and 300 mm in diameter. The wafer diameter is a key factor in the productivity of semiconductor fabrication plants.

The so-called 'front end' production consists in the manufacturing, on a wafer substrate, of the various semiconductor components. This stage of semiconductor manufacturing is both the longest (several months), the most expensive in terms of resources (energy, raw materials and rare metals), the most technical and intense in terms of R&D and capital due to the advanced equipment required. During this stage, wafers undergo numerous treatments: material deposits, etching, mechanical and chemical treatments, etc. These treatments make it possible to manufacture the constituents of integrated circuits (transistors, diodes, converters, capacitors, etc.) and their interconnections.

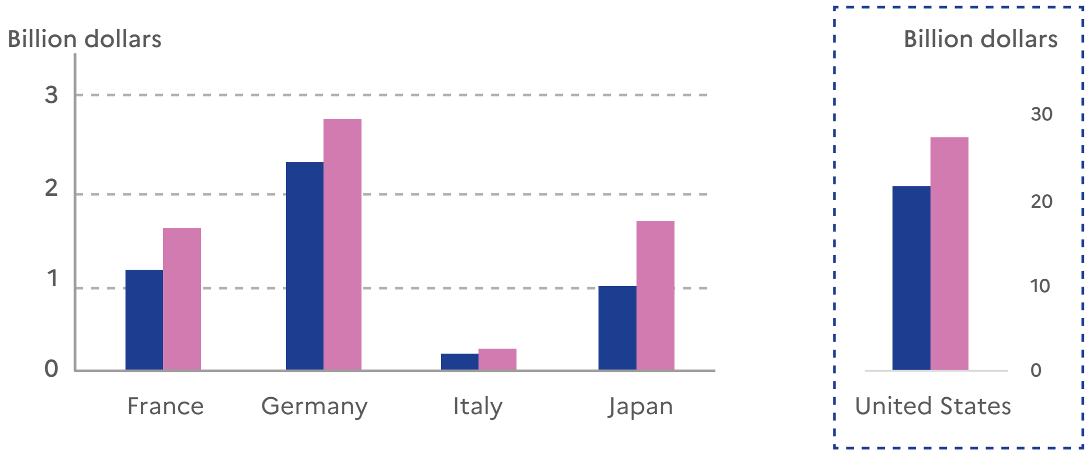
The so-called 'backend' production consists in cutting the wafers into individual chips and integrating them into their environment. During this shorter stage (around one week), the wafers are cut into individual chips. Chips can then undergo verification tests before being integrated into a physical system allowing their use (integration into a casing, connection to a power source, etc.).

R&D plays a crucial role in the semiconductor sector. Moore's law, stated in the 1970s, predicted a doubling of chip performance every two years. For years, this law has been verified, as manufacturers managed to reduce the size of chips' elementary components. Since the 2010s, the size of the components seems to have reached a limit: miniaturisation is becoming increasingly complex as devices approach the size of the atom. Manufacturers have nevertheless managed to improve the performance of semiconductors by playing on other parameters, such as materials or structures.

In France, private R&D expenditure in the sector has increased strongly over the recent period. According to the OECD, they increased from $1.1 to $1.6 billion between 2016-2017 and 2020-2021, an increase of around 40% (see Figure 1). In absolute terms, this expenditure remains lower than in Germany, reflecting the relative size of the sectors in both countries, with the share of R&D expenditure in the value added (VA) of the sector being similar in France and Germany (around 8-9%). By contrast, the United States largely dominates R&D activities in the sector with very high private spending (more than 20% share of VA in 2021).

In the case of France, public research organisations play a crucial role in semiconductor research. CEA-Leti in France, a world-renowned state-of-the-art R&D centre in semiconductor technologies in particular, is forging research partnerships with leading companies both domestically and internationally, with the recent examples of GlobalFoundries and Intel.

Figure 1 : R&D expenditure by semiconductor in OECD the countries (B$ purchasing power parity, right-hand scale for the US)



Source : OECD, Key Nanotechnology Indicators

Scope: Companies that devote at least 75% of their R&D or production to nanotechnologies.

B The world organisation for semiconductor production has evolved considerably in recent decades, particularly in connection with the development of new technologies

Until the late 2000s, the semiconductor market was dominated by integrated players setting up supply chains in low-cost countries. The first economic players in the field of semiconductors were mainly so-called integrated companies because they were responsible for design, production and downstream phases (see Box 2). However, for the scale of the necessary investments and the high production costs have led these companies to relocate part of their production to low-cost countries. As P. Antras points out in his various works[5], these companies have favoured the creation of local chains rather than the use of subcontracting because of the need to control production, to ensure direct control over specific and expensive assets and to protect the intellectual property engaged in production. However, the semiconductor **market has moved towards a less integrated and more fragmented international environment since the 2010s.** The production structure of the semiconductor market is currently characterised by the importance of outsourcing and the increasing use of subcontracting: fabless companies are only responsible for design, while foundries are responsible for the production of semiconductors. This structure has only arisen over the recent period thanks to the considerable improvements in the means of communication, which have enabled the further splitting of the production chain and thus led to an outsourcing of production activities at global level.

Several factors have thus enabled the development of this new international organisation for the production of semiconductors. First, the increase in global demand has allowed foundries to benefit from economies of scale and reduce their unit costs by producing for several fabless customers. Secondly, the fast pace of technical innovation and the short life cycles incite fabless companies to refocus their activities on fast product adaptation, innovation and speed to market. Finally, this organisation allows fabless companies to quickly adapt their production to market changes by working with several subcontractors and always benefiting from the most advanced production technologies without having to update equipment.

5 See in particular Antras, Pol. 2016. Global Production : Firms, Contracts, and Trade Structure. Princeton University Press.
Antràs, Pol, and Elhanan Helpman. 2004. "Global Sourcing." Journal of Political Economy 112 (3) : 552-80

BOX 2
The actors of the semiconductor market

Four main categories of players are active on the semiconductor market: integrated device manufacturers (IDM), fabless companies, foundries and outsourced semiconductor assembly and test (OSAT) companies.

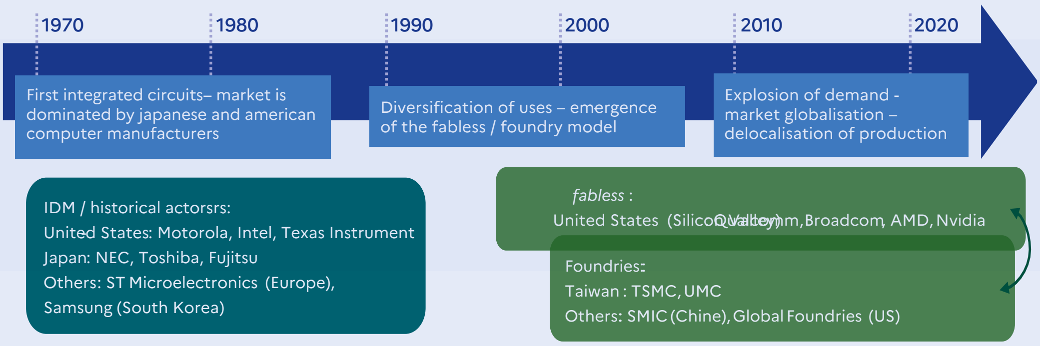
Although the first semiconductors were intended for the defence and space sectors, the market developed massively in the late 1960s with computer manufacturers. These companies have developed on the so-called IDM model as they designed, produced and marketed their own products. The first major IDMs are American companies (Motorola, IBM, Texas Instruments or Intel) and Japanese companies (NEC, Toshiba or Fujitsu).

From the 1990s, semiconductor applications began to go beyond the field of computing and many companies, particularly in the video game and consumer electronic sectors (hi-fi, television, etc.), began to design semiconductors by subcontracting production to historical manufacturers. This business model, known as fabless, is particularly present today in the United States[6], with companies such as Qualcomm or Nvidia, which joined the Dow Jones Index in 2024, replacing Intel.

To meet the growing demand for production, a third category of players is developing: foundries, which hold a portfolio of technologies that they offer to their fabless customers. Since 2010, the fabless-foundries model has taken precedence over the IDM model: a growing number of historical manufacturers rely on foundries for the production of their own chips, in particular because of the importance of the investments needed to master the most advanced technologies. This outsourcing is a new step in the splitting of the global production chain

Finally, a fourth category of players, the OSATs, specialise in assembly and testing (back-end production phase). These actors with lower value added are mainly located in East Asia.

The timeline below summarises the main market developments from 1970 to present.

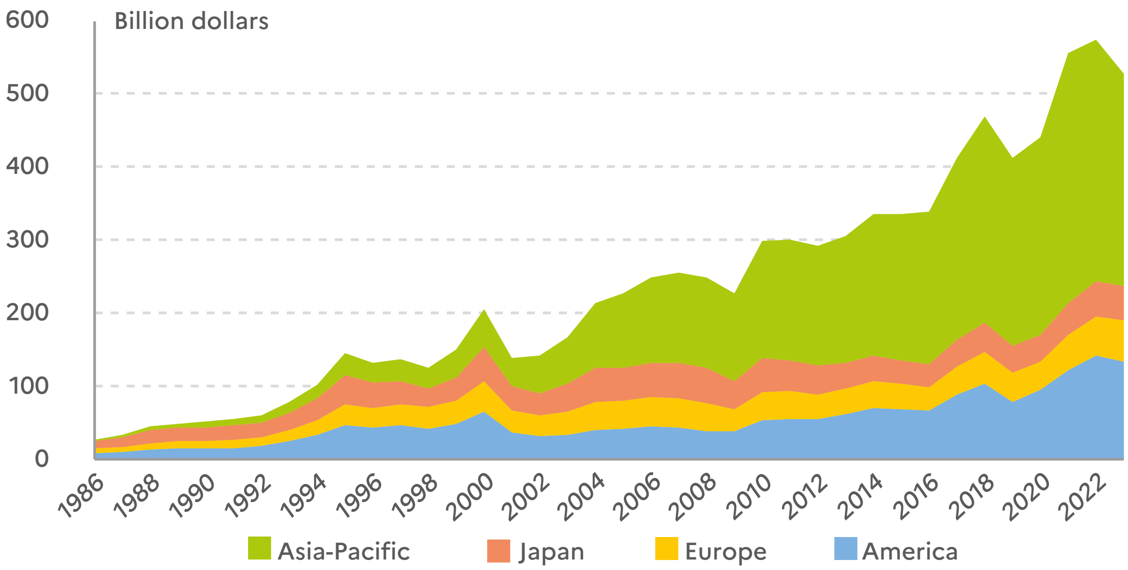


6 In 2021, US companies accounted for 68% of the overall turnover of fabless companies..

C The semiconductor market has grown strongly since the 1990s, but is particularly volatile

The global semiconductor market has grown at a steady pace in recent decades: in value terms, it increased from $50 billion to more than $500 billion between 1990 and 2023, an average annual increase of +7% over this period. Several factors contributed to this strong momentum: (i) the increase in demand for electronic devices linked to the digitalisation of economies; (ii) the increasing integration of semiconductors in finished products (such as in the automotive industry[7] or the Internet of Things), as well as in industrial production processes (e.g., to detect anomalies in a production chain), made possible by the progressive miniaturisation of chips and (iii) the development of artificial intelligence and machine learning, enabled by new types of semiconductors. Public investment support policies implemented in many countries have also contributed to lowering semiconductor costs and facilitate their use.

Figure 2 : Global semiconductor sales by major region of the world ($ billion)



Source : World Semiconductor Trade Statistic.

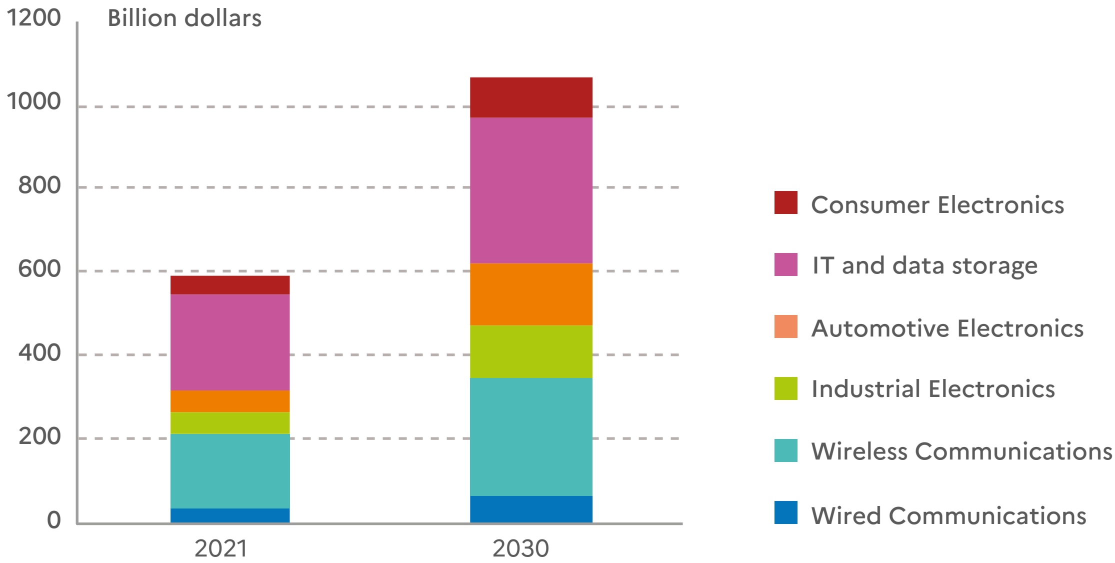
This market growth has fluctuated sharply over the past few decades. Average annual growth was 12% in the 1990s, compared with 1% in the 2000s and 6% in 2010-2023[8]. This is slightly above the growth level of global GDP over the same period (around 5%). Thus, despite robust growth over the long term, the semiconductor market remains subject to high volatility resulting from several factors. First, technological innovation leads to high uncertainty with a high risk of technological or business failure, the latter possibly leading investors to reassess the level of risk upwards and reduce their investments. Next, the length of the value chain, the size of the investments to be made, and the duration of the manufacturing process (generally more than 6 months) force producers to operate on the basis of order forecasts which remain difficult to anticipate and cause each player to amplify anticipated market movements ('bullwhip' effect).

7 The number of chips in a car today is between 1 500 and 3000 depending on the model.

8 This nominal growth does not take into account technological progress in the semiconductor market.

According to Mc Kinsey, the semiconductor market could grow rapidly by 2030 (+80% in value compared to 2021, see Figure 3), driven in particular by automotive electronics (+180%), industrial electronics (+120%) and consumer electronics (+100%). In 2021, the main applications of semiconductors remain computing and data storage (38%), wireless communications (29%), industrial electronics (10%), automotive (9%), consumer electronics (8%) and wired communications (6%).

Figure 3 : The semiconductor **market in 2021 by area of application, forecast for 2030 ($ billion)**



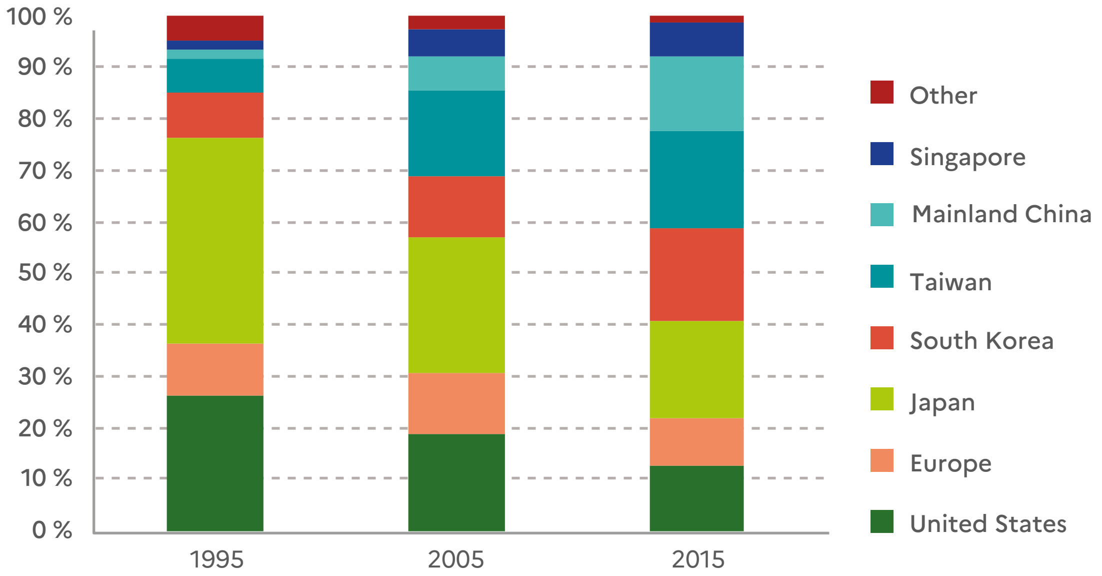
Source: McKinsey on Semiconductor: Creating Value, pursuing innovation and optimizing operations, november 2021.
Data: Gartner

2 The EU and France remain largely dependent on semiconductor imports

A Global semiconductor production remains dominated by Asia, while the US is a leader in the design and sale of finished products

Semiconductor production capacity is now mainly located in Asia, as illustrated in Figure 44. In 2015, almost 80% of global production capacity was located in East Asia. The high share of Asian countries in production capacity is linked to the importance of foundries, which are mainly located in this geographical area.

Figure 4: Geographical distribution of overall semiconductor production capacities



Source: ESIA, European Semiconductor Industry Association. Data: SEMI
Reading note: In 2015, Japan accounted for 18% of global semiconductor production capacity compared to 40% in 1995.

While production is linked to the nationality of producers, the United States is the market leader in semiconductors with 48% of global sales of finished products in 2022[9]. Although production is often carried out by Asian companies, it is frequently on behalf of American fabless companies, which design the chips and market them. For its part, Europe is playing a more limited role and is positioning itself on very specialised markets, in which the robustness and reliability of products are more important factors than computing power (health, automotive, defence, etc.), thus promoting the commercialisation of more mature technologies, less relevant in the most innovative sectors (smartphones, data centres, etc.).

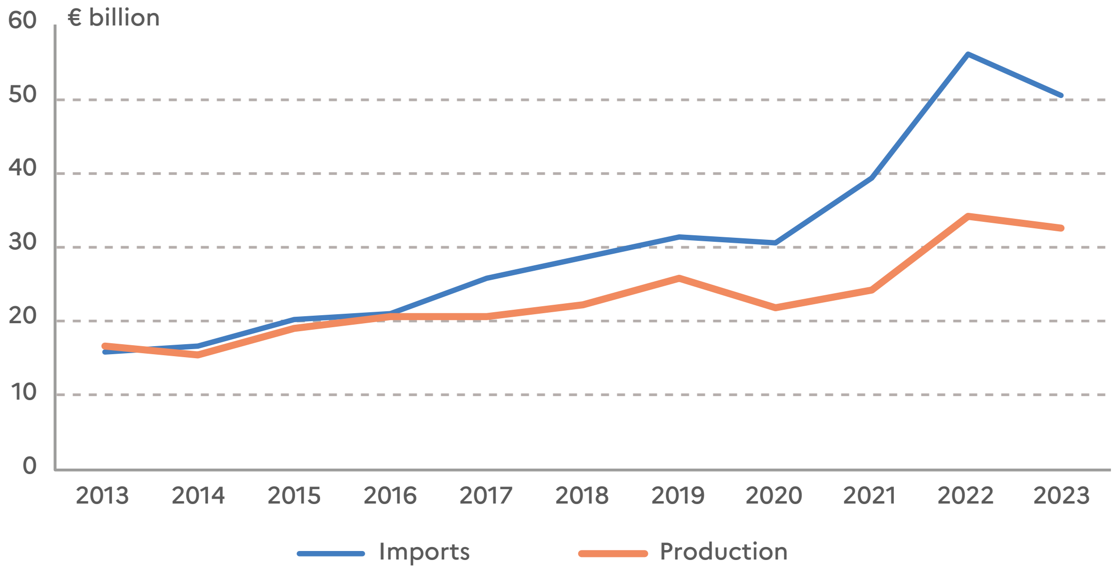
These developments have led to a significant dependence of the EU on the rest of the world. Although European semiconductor production has doubled since 2013, imports have more than doubled, reaching €50 billion in 2023 (see Figure 5). Semiconductor production and imports are identified from the European Commission's list of SCAN[2] products. Since 2017, the level of imports has become significantly higher than the level of production and this gap has increased in the following years. The trade deficit widened to €19 billion in 2023; +191% compared to 2017. This increase in imports underlines the EU's growing dependence on some Asian countries for its semiconductor supply, as shown by the semiconductor shortages during the crisis of the Covid-19 (see Box 3). Nevertheless, the increase in imports may also reveal a complexification of the value chain and the fragmentation of production steps.

However, the analysis of dependencies is made more complex by the fragmentation of semiconductor value chains. The front-end and back-end stages of production are generally separated geographically and numerous international exchanges take place during the production process. For example,

9 Source: Semiconductor Industry Association Factbook 2023.

Germany is a major exporter of silicon (the raw material used to manufacture wafers), but the wafers themselves are mainly exported from Japan to Taiwan, which subsequently exports chips and integrated circuits to China, which ultimately uses them for the production of electronic devices intended in particular for the European and American markets. The EU's supply of semiconductors is particularly dependent on the major players in East Asia: Japan, China, Taiwan and South Korea, which are also among the main global players. Taiwan is the main supplier of EU countries (21% of extra-EU imports 2023).

Figure 5 : Production and import of semiconductors in Europe (€ billion)



Source : Eurostat.

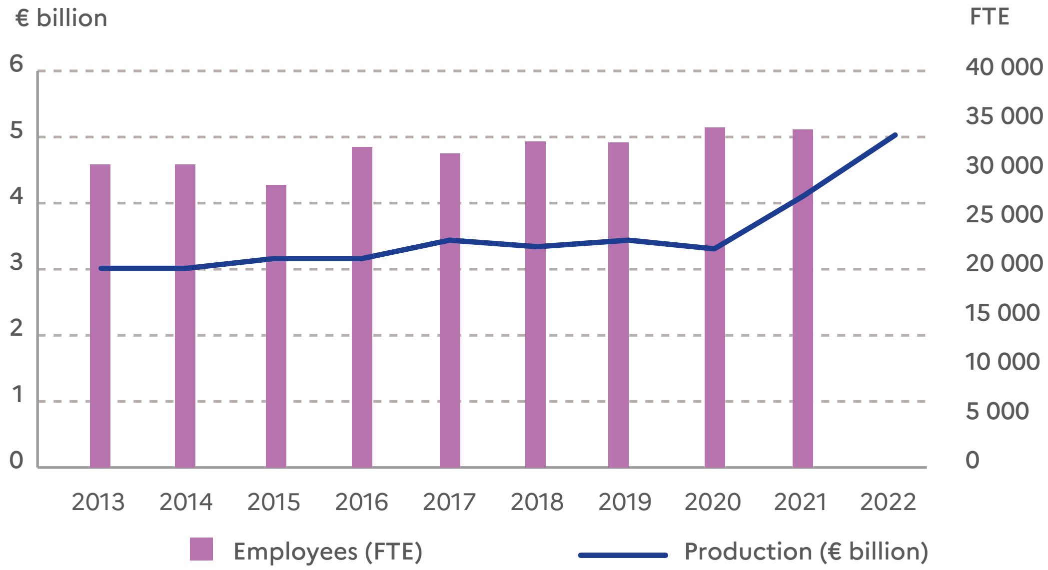
Reading note: all the products used in this section to break down the semiconductor value chain come from the list of products drawn up by the European Commission (JRC - Semi- Conductor Value Chain (europa.eu). Only the finished products have been retained here (integrated circuits, chips, memories, transistors).

B The French production capacity remains limited, leading downstream industries to import significant volumes of semiconductors

French semiconductor production accounts for 11% of EU production in 2022. It was relatively stable over the period 2017-2020, before declining moderately between 2019 and 2020 at the time of the Covid-19 crisis (see Figure 6). Production subsequently jumped from €3.4 billion to €5 billion between 2020 and 2022, an increase of almost 50%. This strong increase is linked to the increase in demand over the period, but also to a price effect linked to the increase in the costs of raw materials, energy and other inputs.

French semiconductor production is particularly concentrated. While 115 companies appear to be active in the semiconductor market in France, five of them accounted for 85% of production in 2022. Two thirds of semiconductor producers are SMEs. In total, semiconductor producers account for around 35000 jobs.

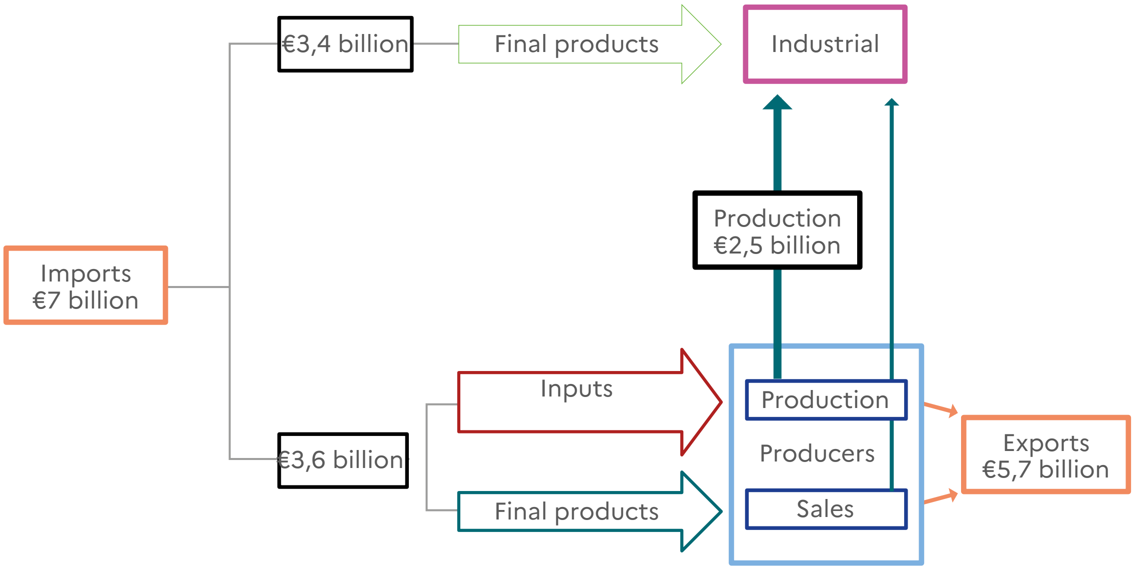
Figure 6 : Production (€ billion) and number of employees (FTE) of semiconductor companies in France



Source : DGE. Data: Annual Production Survey, Fare.
Scope: List of finished products and wafers SCAN (European Commission).
Reading note: In 2021, French semiconductor production reached €4.1 billion and the number of employees employed in semiconductor companies amounted to 35,000 full-time equivalent (FTE) jobs.

In 2022, French imports of semiconductor-related products reached €7 billion. These imports have increased significantly in recent years (+65% since 2019). They are divided between (i) imports of finished products for downstream industrial sectors, excluding the semiconductor sector, for an amount of €3.4 billion in 2022, and (ii) imports of finished or intermediate products for the semiconductor industry for an amount of €3.6 billion (see Figure 7). These imports are broken down into intermediate consumption and finished products.

Figure 7 : Summary of imports of semiconductors from French industry in 2022



Source : DGE calculations. Data: FARE, Customs and EAP.

Reading note: The manufacturers considered are the French users of semiconductors, they are companies that import products included in the list of finished semiconductor products (SCAN). In addition, producers include all companies that declare that they produce at least one product from this list, as well as companies in the following sectors: 26.11Z, 27.11Z and 46.11Z.

The French dependencies on the various links of the semiconductor value chain can be further analysed depending on the production stage:

- production equipment and machinery[10] are mainly imported from the United States: France accounts for 28% of imports of equipment for semiconductor plants in 2023. The Netherlands is also one of the main exporters of this type of equipment;
- for wafers, France is mainly dependent on Japan: imports reached €553 million in 2023, 57% of which came from Japan. This dependence on Japan is all the more important since it also extends to the inputs necessary for the production of value-added wafers;
- for finished product semiconductors, France's dependence on some East Asian countries is strong and growing. Dependence is particularly pronounced regarding Taiwan, which is the main supplier of French industry (26% of imports in 2023). The other suppliers of the French market are mainly Malaysia and China (14% of imports in 2023 for each country).

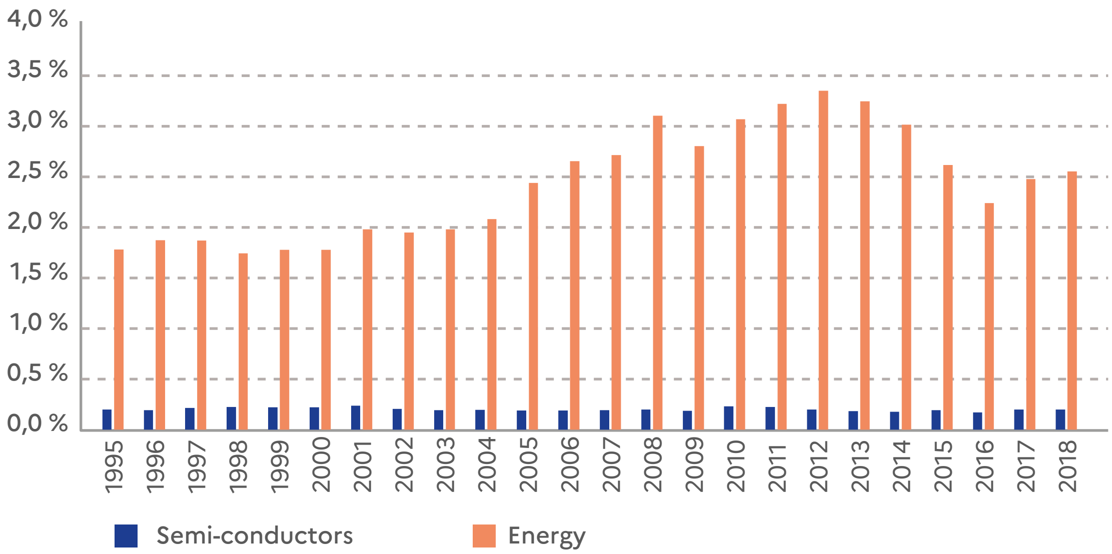
In 2022, electronic and optical computer products and transport equipment accounted for 59% of total French semiconductor imports in the form of finished products (excluding imports from wholesale trade and producers).

10 Here, we look at all the equipment and materials needed in the production of semiconductors and wafers (fans, machines, etc.).

C At the macroeconomic level, the economic impact of French or European dependencies in the field of semiconductors remains rather moderate

Macroeconomically, EU's dependence on imported semiconductors appears limited. The « foreign input reliance »[11] (FIR) indicators developed by the OECD measure the value of foreign production used as an input for a given economy. This figure reached around 0.2% over the period 1995-2018 for semiconductors: This indicates that on average, 0.2 % of the value of a European product, comes from imported semiconductors. By way of illustration, over the same period, the FIR indicator of energy imports is 8 to 15 times higher than that of semiconductors depending on the year. Moreover, the dependence of the European economy appears to be relatively stable over the period considered.

Figure 8: EU dependence on foreign inputs for semiconductors and energy (1995-2018)



Source : DGE calculations. Data: International Input-Output Tables and TIVA Industry Classification (OECD).

Reading note: The energy sector includes the following two activities: 'Coke and petroleum products' (19) and 'Electricity, gas, steam and air conditioning' (35). Dependence on foreign semiconductor inputs is calculated as the foreign production needed to produce one unit of GDP.

This apparent relatively low macroeconomic dependence of the European economy on semiconductors can have several explanations. First, it reflects the limited importance of manufacturing in Europe compared to other geographical areas. In contrast to the EU, the OECD's estimated FIR for semiconductors is around 5% for Thailand, Mexico and China and up to around 10% for Malaysia[12]. In addition, semiconductors are also imported indirectly in the EU as intermediate components integrated into finished products (e.g., telephones and computers) manufactured in other countries, which contributes to a reduced apparent measured dependency.

On the other hand, even if this indicator suggests limited macroeconomic dependence, **component shortages can create bottlenecks and have a**

11 *cf*. Haramboure, A. et al. (2023), "Vulnerabilities in the semiconductor supply chain", OECD Science, Technology and Industry Working Papers, No. 2023/05, OECD Publishing, Paris.

12 Source : idem.

significant economic impact on some sectors. For example, the OECD estimates that the semiconductor shortage in the first nine months of 2021 led to a significant drop in GDP in several EU countries (up to 0.5% in Germany and 0.5% to 1% in the Czech Republic[13]. This significant macro-economic impact can be explained by the exceptionally high intensity of the shortage linked to the Covid-19 in both countries and the importance of these products in many value chains.

BOX 3
China's lockdown during the Covid-19 crisis, a revealing sign of France's dependence on foreign semiconductor producers

The closure of China's borders, from February to April 2020, during the COVID-19 crisis[14], revealed the dependence of French semiconductor importers on Chinese producers.

Indeed, if on average French companies importing semiconductors experienced a sharp decline in activity (-25%) when the Chinese borders were closed (see dark blue outline figure 11), those importing semiconductors from China experienced an extra 5-point decrease in activity when the borders were closed (see. light blue outline figure 9). This additional decrease reflects the difficulty for companies to adapt in case of supplier failure.

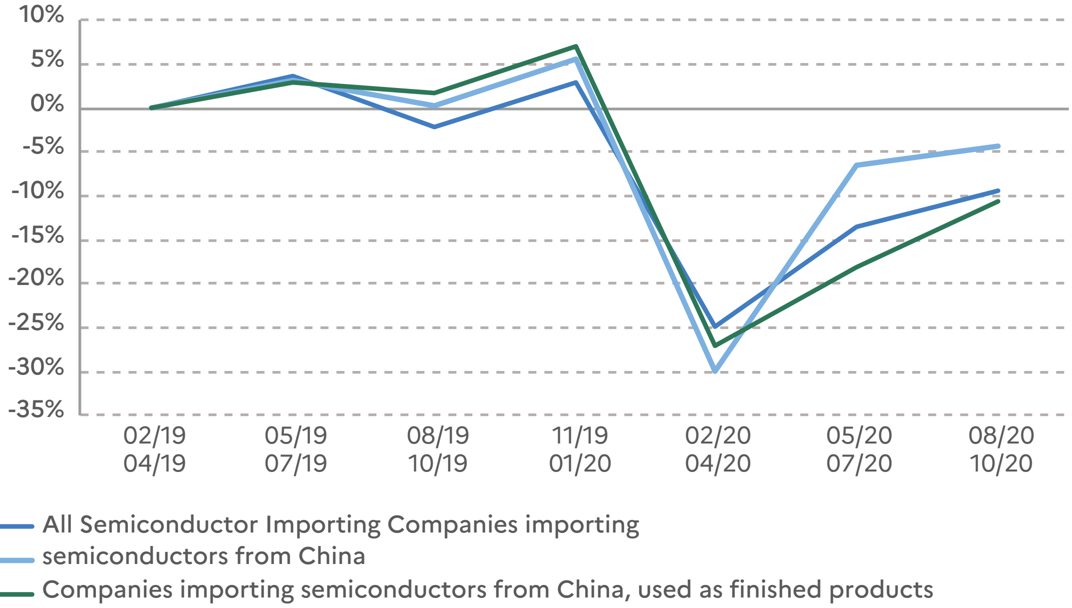
In addition, companies that consume semiconductors suffer a greater long-term impact than companies that produce or market semiconductors: while the latter are experiencing a rapid recovery from May, companies that consume semiconductors for the purposes of their business (see. grey plot Figure 9) experienced between May and July 2020 a decrease in their turnover of more than 10 additional points compared to the average.

Therefore, while the macroeconomic impact of the closure of China's borders has been limited, the results show that it is difficult for manufacturers to substitute Chinese imports with semiconductors from other countries.

13 OECD (2021), OECD Economic Outlook, Volume 2021 Issue 2, OECD Publishing, Paris, https://doi.org/10.1787/66c5ac2c-en.

14 Indeed, as China chose to completely close its borders between February and April 2020, companies sourcing from China experienced a supply shock, the impact of which can be measured by comparing the evolution of their sales with those of companies sourcing from other countries.

Figure 9: Evolution of the revenue of semiconductor-importing companies compared to the average of February – April 2019 (in percentage points)[15]



Source : DGE results. Data : french custom data, FARE.

Reading note : The results presented were obtained using the difference-in-differences method, applied to the group of companies importing products from the SCAN.

Results can thus be interpreted : In mai - july 2020, compared to the average of february - april 2019 :
- The revenue of companies which import semiconductor products decreased by 13%;
- The revenue of companies which import semiconductor products from China decreased by 6%;
- The revenue of companies which import semiconductor products from China, and use them as final products decreased by 17%.

3 For more than a decade, both in France and in the EU, the semiconductor sector has been subject to massive support plans to strengthen European production capacities in order to ensure technological mastery and security of supply

A Public support to the semiconductor sector is a central pillar of European industrial policy

Support for the semiconductor industry in the EU is based on three main instruments: Important Projects of Common European Interest (IPCEI), the "Horizon Europe" programme and the European Chips Act[16].

15 These results reflect the methodology of the work of Méjean et al.: 'Supply shocks in supply chains: Evidence from the early lockdown in China», 2022, IMF Economic Review, with R. Lafrogne-Joussier and J. Martin [Published Version here]

16 Other European schemes may also support the semiconductor sector, in particular the Digital Europe Programme (DIGITAL EUROPE, focusing on bringing digital technologies to businesses, citizens and public administrations) and the 'Alliance for Processors and Semiconductor Technologies', launched in 2021, which facilitates coordination and industrial alliances in this area. The Recovery and Resilience Facility (RRF) also enabled the European Commission to approve at the end of 2022 the construction of a €292 million ST Microelectronics plant in Catania, Sicily.

IPCEIs enable EU Member States funding for projects led by selected companies that meet common technological and industrial objectives[17]. Today, two IPCEIs target the semiconductor sector: the IPCEI "Microelectronics" and the IPCEI "Microelectronics and Connectivity" authorised by the Commission on 18 December 2018 and 8 June 2023 respectively. The first is based on €1.75 billion of public funding from Member States and focuses on innovation and the strengthening of production capacities in the field of semiconductors. The second, for which public funding amounts to €8.1 billion, has a broader scope covering both materials and tools related to chip design and communication technologies. The positive effects of both IPCEIs are manifold: increasing mastery of advanced technologies, accelerating innovation and improving environmental performance.

The "Horizon Europe" programme is the European Union's framework for research and innovation for the period 2021 to 2027. Within this programme, the "Digital, Industry and Space" cluster is particularly concerned with semiconductors, especially through the public-private partnership Key Digital Technologies. The latter, which aims in particular to develop advanced applications and semiconductors, is based on calls for proposals. For 2023, the programme includes three calls for proposals for an estimated expenditure of €317 million.

The European Chips Act, which entered into force on 21 September 2023, aims at strengthening both the EU's semiconductor production capacities with a target of 20% of the global market by 2030 compared to 10% today and the research, design and testing capacities. This regulation, which provides for €43 billion in public and private investment, is based on strengthening technological and innovation capacities, increasing public and private investment, and improving coordination between the Commission, the Member States and other stakeholders. This regulation makes it possible, for example, to facilitate certification procedures for energy-efficient chips, to help start-ups access equity financing, to encourage skills in this area and to set up long-term contracts with some producing countries. The investments under this programme complement those of Horizon Europe as well as those from the Member States.

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17 *See. Thema No 17 "Important projects of common European interest, a tool for European industrial policy", January 2024.*

BOX 4 :
The *Chips and Science Act*

The Chips and Science Act designates a U.S. federal law enacted in August 2022 that authorizes approximately $280 billion in new funding over 10 years to support R&D and production in the field of semiconductors. In particular, this law provides $39 billion in subsidies for chip manufacturing, as well as investment tax credits in this area, $13 billion for semiconductor R&D and training of the semiconductor workforce and $174 billion in funding for the global ecosystem of public research in science and technology. Following the entry into force of the Chips and Science Act, new plant projects were publicly announced in the United States by some of the main players in the sector (investments by TMSC in Arizona, Samsung in Texas, Intel, etc.).

B For several years, France has strengthened its support to the sector and has launched ambitious industrial and R&D projects

In France, support for the semiconductor sector is based on the "Nano" plans which are fully compatible with the European framework. The "Nano 2022" programme is the fourth generation of public support for microelectronics since 2008, as described in Figure 10 below. With a duration of 5 years, from 1 January 2018 to 31 December 2022, it mobilises €1.1 billion in public funding and its main objective is to support the R&D and first industrial deployment phases of innovative semiconductor projects. It makes it possible to meet the needs of the application sectors, in particular in the fields of automotive, connected objects, aerospace and defence. In addition, two local plans have also been put in place, with the "Rousset 2008" plan for the Provence-Alpes-Côte d'Azur region and "Tours 2015" plan for the Centre-Val de Loire region.

Figure 10 : Objectives, axes and actors of the four Nano plans (2008-2022)

2003	2007	2012	2017	2022
	Nano 2008 (€293 million)	Nano 2012 (€455 million)	Nano 2017 (€600 million)	Nano 2022 (€1 100million)
Overall objectives	Built around major industry companies and around fifty laboratories and SMEs in order to involve research and industrialization closely	Enables companies in the sector to stay in the race for miniaturisation by passing the nodes below 40nm (32 and 22nm) and diversifying by establishing world-class expertise in Silicon on Insulator (SOI) technology	First plan to integrate a European dimension, it mobilizes around the next generations of integrated circuits by focusing on the development of technologies enabling design and engraving on a finer scale	Deepening the European logic and co-constructed with 3 other Member States (PIIEC), it helps to support 6 industrial leaders, their partners and the CEA to improve the level of maturity of many future technologies
Main axes	Miniaturization and production capacity in 300 mm	Miniaturisation and development of new applications; Development of FDSOI	Miniaturisation and development of new applications; Growing exploitation of FDSOI	Support of R&D and first industrial deployment (FID) projects about innovative electronic components, and promotion of their integration into the innovation process of sectors located downstream of the electronics value chain (automotive, IoT, aerospace, defence and security)
Main actors	ST, NXP, Freescale, CEA-Leti	ST, IBM, CEA-Leti	ST, CEA-Leti	ST, SOITEC, X-FAB, Murata, UMS, Lynred, CEA-Leti

Source : DGE

French IPCEI 'Microelectronics' projects are financed of up to €0.3 billion with resources from the 'Nano 2022' programme. These projects relate to five fields: energy efficient chips, power semi-conductors, smart sensors, advanced optical equipment and compound materials[18]. IPCEIs make it possible to finance not only R&D, but also the first industrial deployment phase which is particularly expensive and capital intensive. At the French level, six industrial leaders (STMicroelectronics, SOITEC, X-FAB, Murata, UMS, Lynred) are developing R&D and, with the exception of UMS, first industrial deployment projects. To this end, they brought together more than 110 industrial and academic partners spread throughout the country.

On 28 April 2023, on the basis of the European Chips Act, the European Commission validated the semiconductor Gigafactory project led by GlobalFoundries and STMicroelectronics in Crolles, Isère. The total investment of this project amounts to almost €7.5 billion and is supported by the State up to €2.9 billion coming from the 'France 2030' programme[19]. The objective of this investment is to strengthen France and Europe's resilience in terms of

18 *See Thema No 17 "Important Projects of Common European Interest, A European Industrial Policy Tool", January 2024 for a more detailed description.*

19 This component includes funding of €5.5 billion over five years to double chip production in France by 2028 and trigger nearly €18 billion in investments in the country.

semiconductor supply and to strongly develop the FD-SOI[20] technology ecosystem through the supply of energy-efficient, high-performance components for the main European industrial sectors (automotive, industry, telecommunications for 5G/6G, IoT, space). This project plans an increase in French production capacity by around 620 000 wafers per year[21] by 2028, which corresponds to an increase of around 6% in existing European capacity on all technological nodes and around 40% on more advanced technological nodes, from 20 nm to 65 nm.

BOX 5
Specialised sources in the semiconductor market

Numerous sources of specialised data and production capacity projections for the semiconductor market are now available:

World Semiconductor Trade Statistic (WSTS) **:** is based on monthly sales data from manufacturers to end customers and distributors. Sales of IDMs and fabless are taken into account, but not those of foundries as they do not sell semiconductors to end customers. Sales are attributed to the place of delivery. This source presents demand projections for 2024 and 2025.

SEMI is an industry association that collects data, performs forecasts and market research in the field, at a global level. It is the main reference on the issue of production capacity and its geographical distribution.

ACSIEL Alliance Electronique is the professional organisation of industrial players in the electronics value chain in France. It publishes on its website market studies specifically on the French semiconductor market.

The Semiconductor Industry Association (SIA) is the trade association of US semiconductor manufacturers. It regularly publishes data and studies on the US or global market.

20 This technology is based on the addition of a thin layer of insulating silicon oxide to the architecture of the transistors, which makes it possible to achieve efficient and energy-efficient operation and to continue the challenge of miniaturisation.

21 The production capacity of a semiconductor production site shall be assessed on the basis of the number of wafers it is able to engrave per month or per year.

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