# TAIWAN AND THE GLOBAL SEMICONDUCTOR SUPPLY CHAIN

## - Japan's Semiconductor Industry

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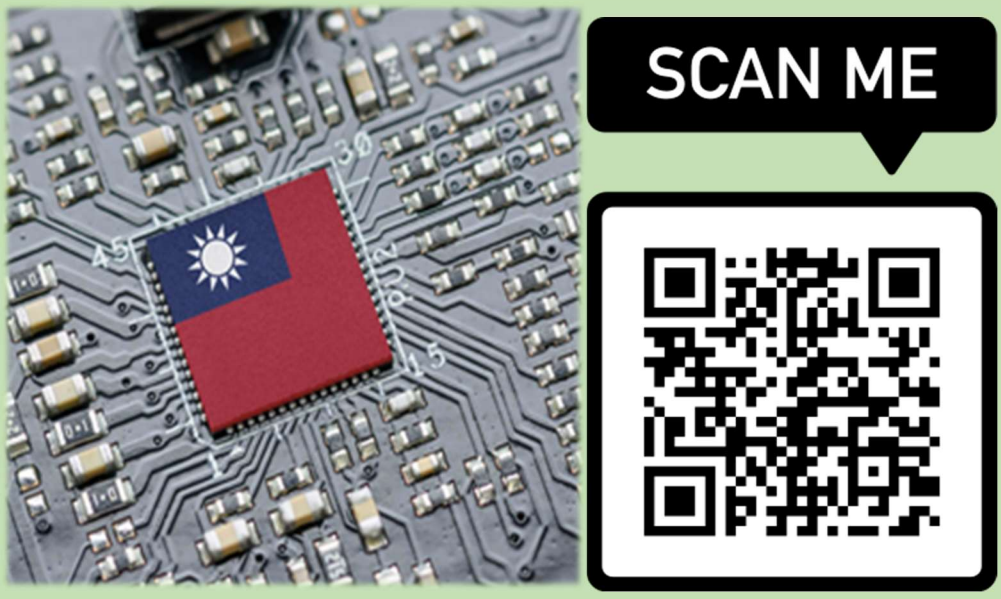
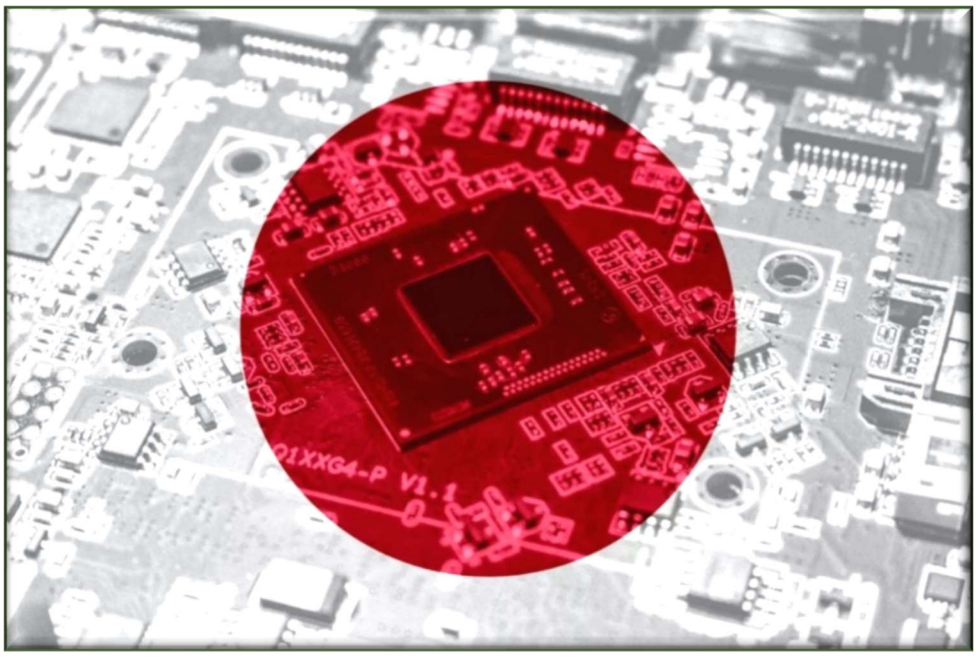


## IN THE SPOTLIGHT

# Japan's Semiconductor Industry

- **Japan's once dominant share of global chip production has declined but it remains a key player in the global semiconductor supply chain, especially in the production of essential materials and equipment.**
- **The Japanese government has designated semiconductors as "specified critical materials" and is providing subsidies to attract both domestic and international semiconductor companies.**
- **Taiwan's semiconductor companies, particularly TSMC, is playing a pivotal role in Japan's semiconductor revitalization efforts and economic growth.**



Source: Image: Twitter / techspot.com

## OVERVIEW

Semiconductors play a crucial role in driving technological advancements and powering various electronic devices worldwide. Japan's Ministry of Economy, Trade and Industry (METI) referred to semiconductors as the "rice of the industry," because they are indispensable for industrial products, and their importance is increasing as society becomes more digitized.[1] On top of that, semiconductors have emerged as an increasingly prominent issue with far-reaching geopolitical and economic implications amidst U.S.-China tensions. Japan, like other countries, is seeking to enhance the resilience of its semiconductor supply chains, by partnering with Taiwan.

[1] Ministry of Economy, Trade and Industry, Japan, "Strategic Energy Plan," October 2021, p. 126.

## • Japan's Share of the Global Semiconductor Market

Japan's share in the global semiconductor industry has seen significant changes over the years. Back in the 1980s, Japan was one of the biggest semiconductor players globally.[2] Buoyed by government and private sector investment, Japan dominated the global rankings for worldwide semiconductor sales and also accounted for the largest share of global semiconductor production.

In 1989, for example, Japanese companies dominated the top ten positions on the list of the top ten semiconductor vendors by revenue worldwide. Japan's Nippon Electric Company (NEC) topped the list which also included five other Japanese companies, namely, Toshiba, Hitachi, Fujitsu, Mitsubishi and Matsushita; three companies from the U.S.A. and one company from Europe.[3] However, in the 1990s, Japan's semiconductor industry faced strong competition from other countries such as South Korea, leading to a decline in its market share.[4] In 2023, Japanese companies were absent from the top 10 rankings of semiconductor vendors (see Table 1).

***Table 1: Top 10 Semiconductor Vendors by Revenue Worldwide (excluding pure play foundries): 1989 vs 2023***

| 1989 Ranking | | 2023 Ranking | |
|---|---|---|---|
| Rank | Vendor (Country of Headquarters) | Rank | Vendor (Country of Headquarters) |
| 1 | NEC (Japan) | 1 | Intel (U.S.) |
| 2 | Toshiba (Japan) | 2 | Samsung Electronics (South Korea) |
| 3 | Hitachi (Japan) | 3 | Qualcomm (U.S.) |
| 4 | Motorola (U.S.) | 4 | Broadcom (U.S.) |
| 5 | Fujitsu (Japan) | 5 | NVIDIA (U.S.) |
| 6 | Texas Instruments (U.S.) | 6 | SK Hynix (South Korea) |
| 7 | Mitsubishi (Japan) | 7 | Advanced Micro Devices (U.S.) |
| 8 | Intel (U.S.) | 8 | STMicroelectronics (Switzerland) |
| 9 | Matsushita (Japan) | 9 | Apple (U.S) |
| 10 | Philips (Netherlands) | 10 | Texas Instruments (U.S.) |

Source: Gartner statistics cited in 福田昭, "日本の半導体が 1980 年代に興隆した最大の理由は「運が良かった」から," ビジネス + IT, August 2, 2021; Gartner, Press Release: "Gartner Says Worldwide Semiconductor Revenue Declined 11% in 2023," January 16, 2024.

[2] Semiconductor Industry News (Sangyo Times Co., Ltd.), "Episode 20 Rise and Fall of Japanese Semiconductors", Makimoto Library, January 9, 2008.

[3] Elizabeth Beattie, "Can Japan again master semiconductors to relive its glory days?" The Japan Times, January 29, 2024; IC Insights, Research Bulletin:"Tracking the Top 10 Semiconductor Sales Leaders Over 26 Years," December 12, 2011. https://www.icinsights.com/data/articles/documents/359.pdf

[4] Elizabeth Beattie, "Can Japan again master semiconductors to relive its glory days?" The Japan Times, January 29, 2024.

In terms of production, Japan's semiconductor industry accounted for over 50% of world production in the late 1980s but has also been facing significant challenges since the 1990s.

While the global market for semiconductors was driven by consumer electronics in the 1980s, it shifted towards personal computers in the 1990s. Japan's continued focus on dynamic random access memory (DRAM) chips instead of microprocessors and logic Large Scale Integration (LSI) chips led to it losing out to competitors like the United States.[5]

Moreover, major Japanese electronics companies such as NEC, Toshiba and Hitachi operated their semiconductor businesses as divisions within their corporate structure, unlike U.S. chipmakers such as Intel, Texas Instruments and Micron which are specialised firms or European chipmakers such as Siemens (Germany), Phillips (Holland) and Thomson (France) which are autonomous firms.[6] In recent years, however, major Japanese companies have divested their semiconductor business to adapt to the demands for increasingly short development cycles required for semiconductor chips. One example is Hitachi and Mitsubishi, which divested their semiconductor businesses and merged into Renesas Technology in 2003, with NEC Electronics, the semiconductor arm of NEC, joining Renesas in 2010.[7]

In 1987, Taiwan's Taiwan Semiconductor Manufacturing Company (TSMC) pioneered the pure-play foundry model, which allows semiconductor companies to go "fabless", that is, shift their focus away from in-house integrated circuit (IC) fabrication and instead concentrate on IC design and development.[8] Foundries, whose business model involves manufacturing of semiconductors from many customers, were in a better position than vertically integrated IDMs in terms of efficiency and rate of return on research and development (R&D) and capital investment. Moreover, faced with escalating costs associated with miniaturization technology, semiconductor companies adapted by specializing in specific technical fields and adopting a gradual horizontal division of labor. The fabless business model has been a game-

[5] Semiconductor Industry News (Sangyo Times Co., Ltd.), "Episode 20 Rise and Fall of Japanese Semiconductors", Makimoto Library, January 9, 2008, p. 3.

[6] Lim Tai Wei and Lam Peng Er, EAI Background Brief No. 1670: "Japanese Semiconductor Industry's Collaboration with Taiwan Semiconductor Manufacturing," East Asia Institute, September 29, 2022.

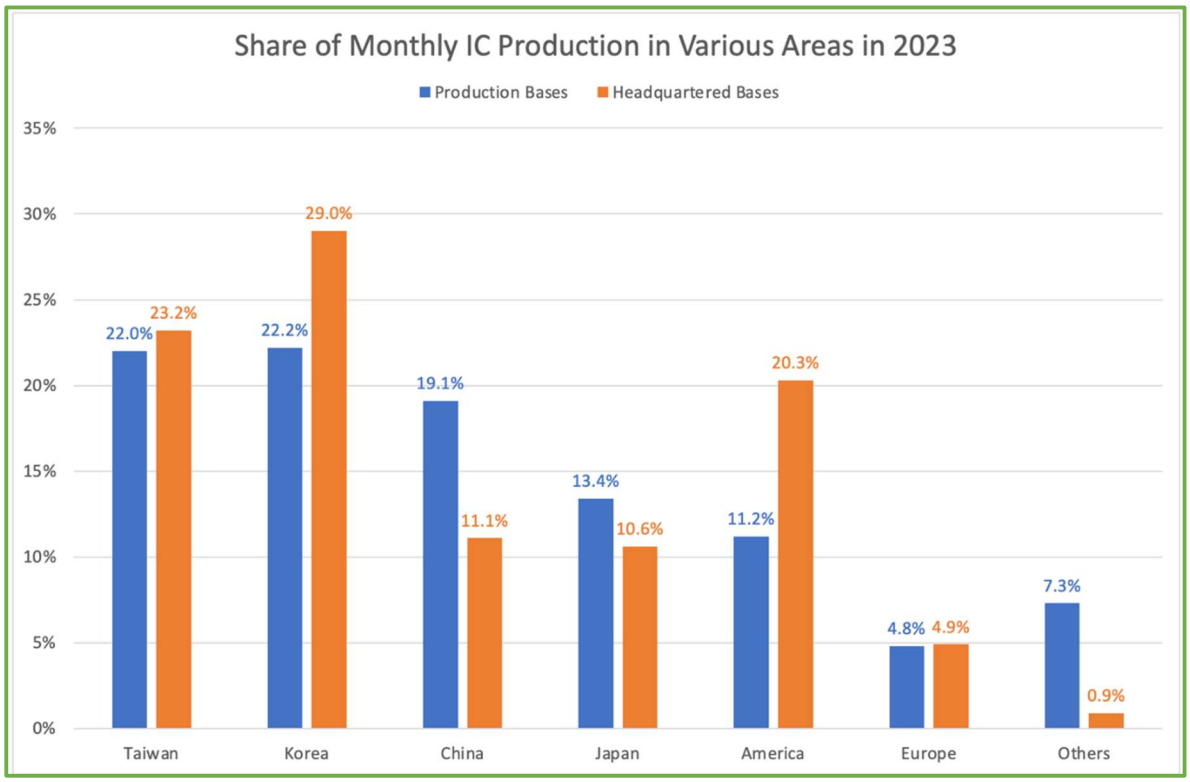
[7] Semiconductor Industry News (Sangyo Times Co., Ltd.), Episode 21: "Cheer Up! Nippon Semiconductors!" Makimoto Library, January 9, 2008, p. 1; David Manners, "Hitachi and NEC to sell off Renesas stakes," Electronics Weekly, February 7, 2024.

[8] TSMC website: https://www.tsmc.com/english/aboutTSMC. Accessed on May 9, 2024.

changer for U.S. semiconductor companies like Xilinx, Altera, and Qualcomm, enabling them to focus on design, collaborate with foundries, and stay competitive in a rapidly evolving industry.[9]

Japanese companies, on the other hand, largely followed the traditional integrated device manufacturer (IDM) model, where companies controlled the entire value chain from design and development, wafer manufacturing, packaging and testing, all the way down to sales.[10] By the end of the 2000s, foundries have become the core of technology clusters. TSMC, in particular, saw its international status rise, and foundries in other countries also gained prominence. As Japan lagged in embracing the foundry model, its market share declined.[11] By 2023, Japan's share of global production has fallen behind that of Taiwan, Korea and China (see Figure 1).

***Figure 1: Share of Monthly IC Production Capacity of 8-Inch Equivalent by Geography: 2023***




Source: Chia-Chen Lee, "Policy-Driven Regional Semiconductor Manufacturing development," IEK, ITRI, March 20, 2024, p. 1.

[9] Daniel Nenni and Paul McLellan, A Semiwiki.com Project: "Fabless: The Transformation of the Semiconductor Industry," June 2019. https://semiwiki.com/books/Fabless%202019%20Version%20PDF.pdf. Accessed on May 9, 2024.

[10] Nippon.com, "Japan Making Major Investments in its Semiconductor Industry," April 22, 2024.

[11] Ibid.

Figure 1 above shows the global distribution of monthly production capacity of 8-inch equivalent ICs of pure-play foundries, IDMs and other types of semiconductor companies by geography in 2023. According to Knometa Research, the total global monthly production capacity of ICs (including image sensors) on 8-inch equivalent wafers in 2023 was approximately 23.2 million wafers, and this is expected to increase to 24.3 million units per month in 2024.

In terms of production bases (include fabs of domestic and foreign-invested companies in the country), Japan ranks fourth with its production of 3.1 million wafers per month, accounting for 13.4% of global capacity. In terms of headquartered bases (include fabs in home country and various host countries of multinational semiconductor companies), Japan's ranking slips to fifth with a production of 2.5 million wafers monthly, accounting for 10.6% of global capacity (see Figure 1).

Despite the challenges faced by the Japanese semiconductor industry, Japan contributes significantly to the global semiconductor supply chain, playing a pivotal role in the Indo-Pacific region, alongside Taiwan, South Korea, and China. According to a 2023 U.S. BIS report, the world's 30 largest semiconductor companies accounted for approximately US$ 684.5 billion or 75 % of global semiconductor and semiconductor manufacturing service revenue in 2022.[12] Four Japanese IDMs, namely, Murata, Kioxia, Renasas and Sony – Imaging and Sensing Solutions, are among the top 30 ranks, accounting for a 6.7% share of the world's 30 largest semiconductor companies, or US$ 46.1 billion in total revenue in 2022 (see Table 2).

[12] Office of Technology Evaluation, Bureau of Industry and Security, U.S. Department of Commerce, "Assessment of the Status of the Microelectronics Industrial Base in the United States," December 2023.

## *Table 2: World's 30 Largest Semiconductor Companies: 2022*

| Company | Primary Segment | Process Role | Country of Headquarters | Revenue (US$ Billions) |
|---|---|---|---|---|
| Samsung* | Memory | IDM | South Korea | $76.2 |
| TSMC | Foundry | Foundry | Taiwan | $75.9 |
| Intel | Micro | IDM | U.S.A. | $63.1 |
| Qualcomm | Logic | Fabless | U.S.A. | $43.0 |
| Apple** | Logic | Fabless | U.S.A. | $40.0 |
| SK Hynix | Memory | IDM | South Korea | $34.0 |
| Broadcom | Logic | Fabless | U.S.A. | $33.2 |
| Nvidia | Logic | Fabless | U.S.A. | $29.6 |
| Micron Technology | Memory | IDM | U.S.A. | $27.2 |
| Advanced Micro Devices | Micro | Fabless | U.S.A. | $23.6 |
| Advanced Semiconductor Engineering | AT&P | AT&P | Taiwan | $22.2 |
| Texas Instruments | Analog | IDM | U.S.A. | $19.6 |
| MediaTek | Logic | Fabless | Taiwan | $18.4 |
| Western Digital | Memory | IDM | U.S.A. | $16.4 |
| STMicroelectronics | Analog | IDM | Switzerland | $16.1 |
| Infineon | Discretes | IDM | Germany | $15.8 |
| Murata | Sensors | IDM | Japan | $14.0 |
| NXP Semiconductors | Micro | IDM | Netherlands | $13.2 |
| Analog Devices | Analog | IDM | U.S.A. | $12.0 |
| Kioxia | Memory | IDM | Japan | $11.7 |
| Renesas | Analog | IDM | Japan | $11.3 |
| United Microelectronics Corporation | Foundry | Foundry | Taiwan | $9.2 |
| Sony-Imaging and Sensing Solutions*** | Optoelectronics | IDM | Japan | $9.1 |
| onsemi | Discretes | IDM | U.S.A. | $8.3 |
| GlobalFoundries | Foundry | Foundry | U.S.A. | $8.1 |
| Microchip Technology Incorporated | Micro | IDM | U.S. | $8.1 |
| Semiconductor Manufacturing International Corporation (SMIC) | Foundry | Foundry | China | $7.2 |
| Amkor Technology | AT&P | AT&P | U.S.A. | $7.1 |
| Marvell Semiconductor, Inc. | Logic | Fabless | U.S.A. | $5.8 |
| Skyworks Solutions | Analog | IDM | U.S.A. | $5.3 |
| **Japan Total** | | | | **$46.1** |
| **Top 30 Total** | | | | **$684.5** |

Data is based on annual and quarterly financial filings via company websites and U.S. Securites and Exchange Commission.
*Data is for Samsung's Semiconductor (DS) segment.
**Estimated value of Apple's semiconductor production based on publicly reported share of TSMC's revenue.
***Data is for Sony's Imaging and Sensing Solutions segment.

Source: Office of Technology Evaluation, Bureau of Industry and Security, U.S. Department of Commerce, "Assessment of the Status of the Microelectronics Industrial Base in the United States," December 2023, p. 15.

## • Japan's Role in the Global Semiconductor Supply Chain

The global semiconductor supply chain involves a wide range of highly specialized companies and institutions that are geographically dispersed but interconnected through a supply chain encompassing the seven sectors, each with its own specialized role (see Table 3).[13] Each sector plays a crucial role in the semiconductor ecosystem, contributing to the advancement of technology and innovation.

***Table 3: Sectors in Semiconductor Supply Chain***

| | SECTOR | DESCRIPTION |
|---|---|---|
| **1.** | **Research & Development (R&D)** | The R&D sector determines the future capabilities and performance of semiconductor devices. |
| **2.** | **Design** | The blueprints for semiconductor devices, including the architecture and circuit design are created by engineers during this phase. |
| **3.** | **Front-End Manufacturing: Wafer Fabrication** | After the design stage, semiconductor chips are fabricated in facilities often referred to as fabs or foundries. |
| **4.** | **Back-End Manufacturing: Assembly, Testing and Packaging (ATP)** | After the wafers are fabricated, they are cut into individual chips, assembled into packages, tested for quality and functionality, and then prepared for shipment. |
| **5.** | **Electronic Design Automation (EDA) and Core Intellectual Property (IP)*** | EDA refers to the software tools used for designing semiconductor devices. Core IP involves the essential designs and patents that are part of the semiconductor devices. |
| **6.** | **Equipment and Tools*** | This sector provides the specialized machinery and tools required for semiconductor manufacturing, such as lithography equipment, etchers, and testers. |
| **7.** | **Materials*** | Semiconductors require high-purity materials, including silicon, various gases, and chemicals used throughout the manufacturing process. |

* These components are considered a specialized support ecosystem of chip manufacturing.
Source: SIA/BCG, April 1, 2021

[13] Antonio Varas, Raj Varadarajan, Ramiro Palma, Jimmy Goodrich, and Falan Yinug, "Strengthening the Global Semiconductor Supply Chain in an Uncertain Era," Semiconductor Industry Association (SIA) & Boston Consulting Group (BCG), April 1, 2021.

Semiconductor supply chains include R&D, production, production inputs, and distribution for end-use. R&D underpins all production and its inputs. Semiconductor production includes three segments, namely, design, manufacturing, and assembly, testing, and packaging (ATP). The packaged chips are then distributed to various end-users, including electronics manufacturers, automotive companies, and consumer electronics firms. These end-users incorporate the chips into their products, such as smartphones, cars, and various appliances.

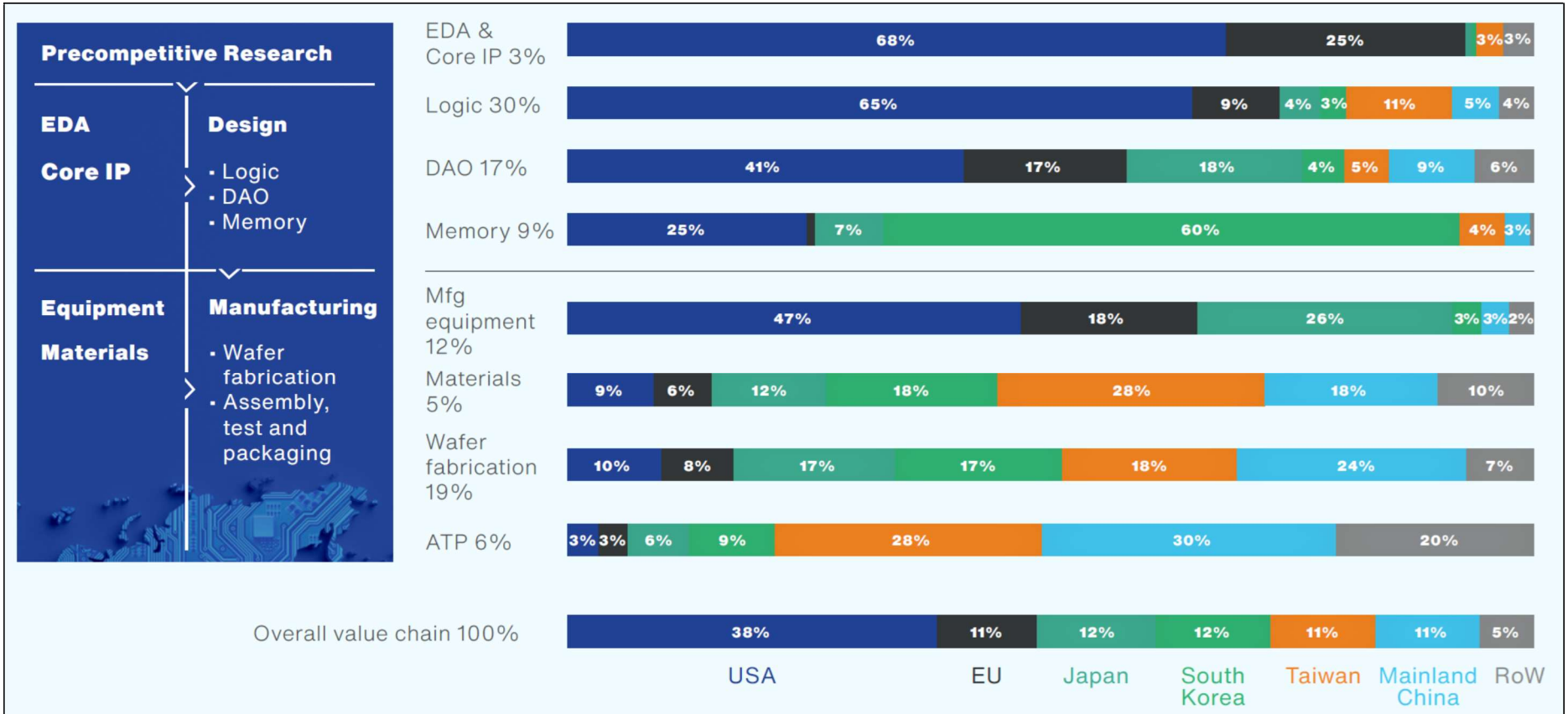
Production of semiconductors relies on associated elements of the supply chain: semiconductor manufacturing equipment (SME), electronic design automation (EDA) software, and intellectual property related to chip designs (called core IP). The highest value and most technologically complex parts of this process are the design and fabrication segments of production, and the SME element of the supply chain.

In addition, the semiconductor manufacturing ecosystem is a global network characterized by its complexity and specialization (see Figure 2). The semiconductor industry is highly concentrated, with companies headquartered in the United States, Taiwan, South Korea, Japan, China and the European Union accounting for nearly all semiconductor revenue.[14] Within each process role, the industry is further concentrated, with companies from specific locales dominating the market.

With a 38% share in global semiconductor value chain in 2022, the U.S. remains a powerhouse. Japan held 12% share of the global value chain, as does South Korea. They are followed by the E.U., Taiwan and China, with each holding 11% share of the global semiconductor value chain in 2022 (see Figure 2).

[14] Office of Technology Evaluation, Bureau of Industry and Security, U.S. Department of Commerce, "Assessment of the Status of the Microelectronics Industrial Base in the United States," December 2023.

## *Figure 2: Semiconductor industry value-added by activity and region: 2022 (%)*



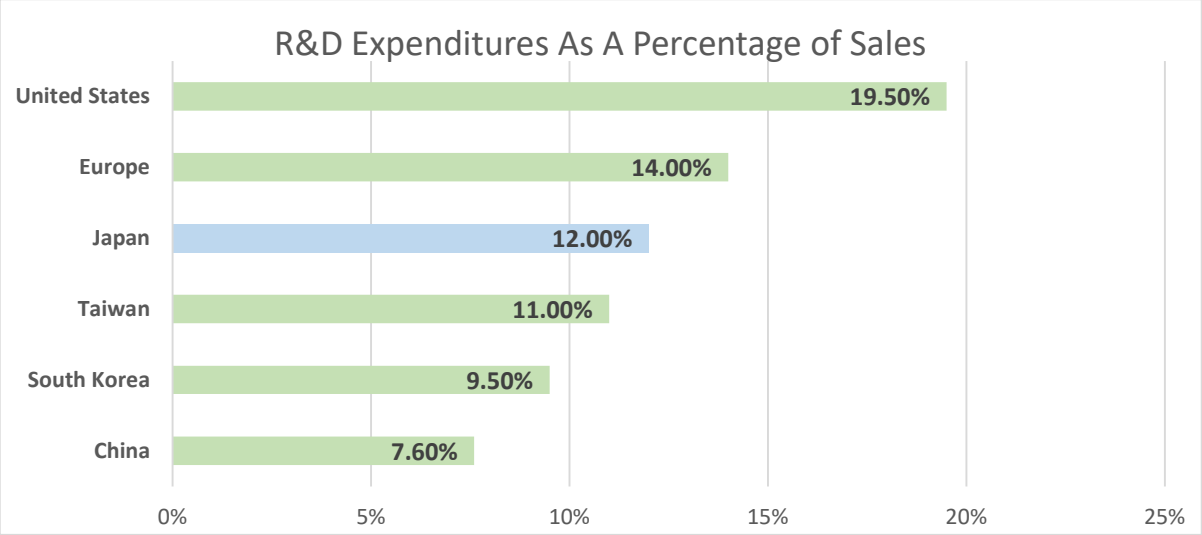

Notes on regional breakdown:

- EDA, design, manufacturing equipment, and raw materials based on company revenues and company headquarters location.
- Wafer fabrication and assembly & testing based on installed capacity and geographic location of the facilities.
- RoW includes Israel, Singapore and the rest of the world.

Source: Raj Varadarajan, Iacob Koch-Weser, Chris Richard, Joseph Fitzgerald, Jaskaran Singh, Mary Thornton, Robert Casanova and David Isaacs, "Emerging Resilience in The Semiconductor Supply Chain," Boston Consulting Group, May 2024, p. 10.

## IC Research & Development

***Figure 3: Semiconductor Industry R&D Spending Across Regions: 2022***




Source: Semiconductor Industry Association, SIA 2024 Factbook, May 14, 2024, p. 18.

R&D is critical to creating a thriving semiconductor ecosystem and plays a vital role in maintaining Japan's position as one of the biggest semiconductor players in the Asia Pacific region. According to the Semiconductor Industry Association, Japanese semiconductor companies invested 12% of the total sales in R&D in 2022 (see Figure 3). Tokyo Electron Limited (TEL), for example, invested ¥ 600 billion (US$ 4 billion) between FY2018 and FY2022, with plans to invest over ¥ 1 trillion (US$ 6.7 billion) between FY2023 and FY2027.[15] TEL also holds 21,645 patents as of March 31, 2023 for semiconductor production equipment, making it the global industry leader.[16]

U.S. semiconductor companies have been at the forefront of R&D spending, investing 19.5% of the total sales in R&D in 2022. The largest U.S. players are Intel, NVIDIA and Advanced Micro Devices. Taiwanese semiconductor companies invested 11% while South Korean semiconductor companies invested 9.5% of the total sales in R&D in 2022.

[15] The World Folio, Interview: "TEL: the power behind the MAGIC," October 31, 2023.
[16] Tokyo Electron Limited, Research & Development, "Intellectual Property Initiatives." https://www.tel.com/sustainability/competitiveness/research-development/ .Accessed on May 21, 2024.

## IC Design, Electronic Design Automation and Core Intellectual Property

Japan was once a leader in IC design, with companies like NEC, Renesas, and Fujitsu making significant contributions.[17] In contrast to leading semiconductor companies outside Japan that focus primarily on the fabless business model (high-value design and innovation of ICs while leveraging the manufacturing capabilities of specialized foundries), many Japanese semiconductor companies operated under the Integrated Device Manufacturer (IDM) model, where they design and develop chips solely for their own products. According to the U.S. BIS, Japan's fabless semiconductor market share is relatively modest at 1% in 2022 (see Table 4). Compared to its fabless semiconductor companies, Japan's IDMs are more prominent, accounting for a 17% share of the global semiconductor IDM market in 2022.

Over the past few decades, as Japanese electronics lost their competitiveness, Japan's share of the global semiconductor industry declined as well.[18] Fabless semiconductor companies from other regions, such as the U.S.A.'s NVIDIA, Qualcomm, and Broadcom and Taiwan's MediaTek, Novatek Microelectronics, and Realtek Semiconductor have overtaken Japanese semiconductor companies as the top global players in IC design. These fabless semiconductor companies generate their revenue primarily through IC design, electronic design automation (EDA), and core intellectual property (IP).

Japan, however, remains internationally competitive in certain semiconductor device types—such as memory, CMOS image sensors (CIS), micro-controller units (MCU), and power semiconductors.[19] Notable players in these fields include Kioxia for NAND memory, Sony for CIS, Renesas for MCU in the automotive sector, and Toshiba, ROHM, DENSO, and Mitsubishi for power semiconductors.[20]

[17] Ramiro Palma, Raj Varadarajan, Jimmy Goodrich, Thomas Lopez, and Aniket Patil, "The Growing Challenge of Semiconductor Design Leadership," Boston Consulting Group and Semiconductor Industry Association, November 2022.

[18] Kazuto Suzuki, "Japan's Economic Security and Semiconductor Industry," AJISS-Commentary, The Association of Japanese Institutes of Strategic Studies, February 3, 2022.

[19] Sujai Shivakumar, Charles Wessner, and Thomas Howell, "Japan Seeks to Revitalize Its Semiconductor Industry," Center for Strategic and International Studies, August 25, 2023.

[20] Lih-Jen Hou and Pradeep Thiagarajan, "The Resurgence of Japan's Semiconductor Industry," Siemens, December 7, 2023.

### *Table 4: Market Share of Process Roles by Location of Company Headquarters: 2022*

| Market Share of Process Roles by Location of Company Headquarters | | | | | | |
|---|---|---|---|---|---|---|
| | Fabless | IDM | Total Semiconductor Providers | Foundry | OSAT | Total Outsourced Manufacturing |
| **Total (US$ Billions )** | **$248** | **$412** | **$660*** | **$139** | **$50** | **$190** |
| United States | 72% | 42% | 53% | 6% | 15% | 8% |
| Taiwan | 14% | 2% | 6% | 65% | 58% | 63% |
| South Korea | 1% | 22% | 14% | 16% | 1% | 12% |
| Japan | 1% | 17% | 11% | 1% | 0% | 0% |
| China | 12% | 2% | 6% | 9% | 20% | 12% |
| Germany | 0% | 5% | 3% | 1% | 0% | 0% |
| Switzerland | 0% | 4% | 3% | 0% | 0% | 0% |
| Netherlands | 0% | 4% | 2% | 0% | 0% | 0% |
| BIS' data is based on publicly reported sales and estimates of the revenues of major non-public companies | | | | | | |

* The BIS estimates may exceed those of the Semiconductor Industry Association (US$ 574 billion, via SIA 2023 Factbook) and Gartner (US$ 600 billion, April 26 2023 press release) in part because it is revenue focused, and thus may not have fully accounted for non-semiconductor revenue or integration of semiconductors into other semiconductor devices.

Source: Office of Technology Evaluation, Bureau of Industry and Security, U.S. Department of Commerce, "Assessment of the Status of the Microelectronics Industrial Base in the United States," December 2023.

While facing challenges in EDA and core IP, Japan's share with regard to the value added in the area of design for discrete, analog, and other (DAO) semiconductors in the global DAO semiconductor industry is 18% in 2022, second only to the U.S.A. Its share with regard to the value added in the area of design for logic chips and memory chips in the global semicondustry is 4% and 7% respectively (see Figure 2).

Companies based in the United States are particularly strong in design processes, accounting for 72% of all fabless revenue, 42% of revenue among companies that do both design and manufacturing, and 53% of global semiconductor product revenue. Taiwan- and China-based companies account respectively for the second and third largest share of the fabless market, due largely to their dominance of the outsourced semiconductor fabrication and assembly, testing, and packaging (see Table 4).

Frontend Manufacturing: Wafer Fabrication

Japan's share with regard to the value added in the area of wafer fabrication in the global semiconductor industry is 17% in 2022. Its share is the same as Korea's, but behind that of China (24%) and Taiwan (18%) (see Figure 2).

In front-end wafer fabrication, Japan has a significant strength in the production of legacy chips. Legacy chips, which are 28 nanometer (nm) or larger, are less advanced but still critical components used in a wide range of devices, from automobiles to consumer electronics. As of March 2024, the most advanced generation of chips produced in Japan is the 40 nm chip, while Taiwan and South Korea are mass producing 3 nm chips.[21] Recently, the Semiconductor Equipment and Materials International (SEMI) announced that it is expected that both TSMC and Intel will potentially complete the construction of 2 nm wafer fabs by the end of this year.[22]

Backend Manufacturing: Assembly, Testing and Packaging

Assembly, testing and packaging (ATP) generally involves fewer complex processes and tools than other portions of the semiconductor manufacturing supply chain and is correspondingly more labor intensive. With each successive shrinking of transistor size and density, however, ATP has quickly become more complex.

Japan's share with regard to the value added in the area of ATP in the global ATP semiconductor industry is 6% in 2022 (see Figure 2). Meanwhile, Japan's outsourced manufacturing is almost non-existent (see Table 3) since IDMs in Japan handle the full range of IC fabrication, assembly, packaging, and testing internally. Japanese companies such as Shinko Electric Industries Company, Ibiden Company and Toppan Holdings are prominent players in the semiconductor packaging industry, both in Japan and globally.[23] The majority of ATP is concentrated in China and Taiwan, with China leading in APT due to its scale and cost advantages, while Taiwan's expertise in advanced packaging sets it apart.[24]

[21] Kizuna, JapanGov, "Japan's Pursuit of a Game-Changing Technology and Ecosystem for Semiconductors," March 1, 2024. https://www.japan.go.jp/kizuna/2024/03/technology_for_semiconductors.html

[22] TrendForce, Press Release: "Global Acceleration in the Construction of 2nm Wafer Plants," April 3, 2024.

[23] Makiko Yamazaki and Sam Nussey, "Japan state-backed JIC to buy out Fujitsu chip-packaging unit for $4.7 bln," Reuters, December 13, 2023.

[24] Max A. Cherney, "TSMC leads in advanced chip packaging wars, LexisNexis patent data says," Reuters, August 2, 2023.

Semiconductor Manufacturing Equipment

The US$ 110 billion semiconductor equipment market spans more than 50 types of specialized equipment.[25] Three segments—lithography, deposition, and materials removal & cleaning—comprise 70% of the market, each dominated by a handful of key vendors. Netherlands' ASML makes up 87% of the lithography market. In deposition as well as materials removal and cleaning, three companies—two based in the United States and one based in Japan— comprise 70%–80% of the market. Japan's share with regard to the value added in the area of manufacturing equipment in the global semiconductor industry is 26% in 2022 (see Figure 2).

Japan's Tokyo Electron Limited (TEL), Advantest Corporation and Hitachi High-Tech are among the world's leading semiconductor equipment manufacturers.[26] According to a 2023 report by the World Economic Forum on Japan's semiconductor industry, Japanese companies hold a significant global market share of 32% in manufacturing equipment.[27] In the semiconductor photoresist market, where barriers to entry are high, Japanese manufacturers currently dominate the global market and account for 92% of revenue for semiconductor manufacturing equipment for photoresist processing (see Figure 4). Among the top global players, four Japanese companies, namely, JSR Corporation, Tokyo Ohka Kogyo Company, Shin-Etsu Chemical Company and Fujifilm Electronic Materials stand out.

Additionally, Japanese semiconductor manufacturing equipment vendors are also an important player in manufacturing automation (see Figure 4). Key Japanese companies in this field include Omron, which provides automation solutions for front end processing of semiconductors such as advanced controllers that offer synchronous control of all tool devices and advanced functionality related to motion, robotics and database connectivity.[28]

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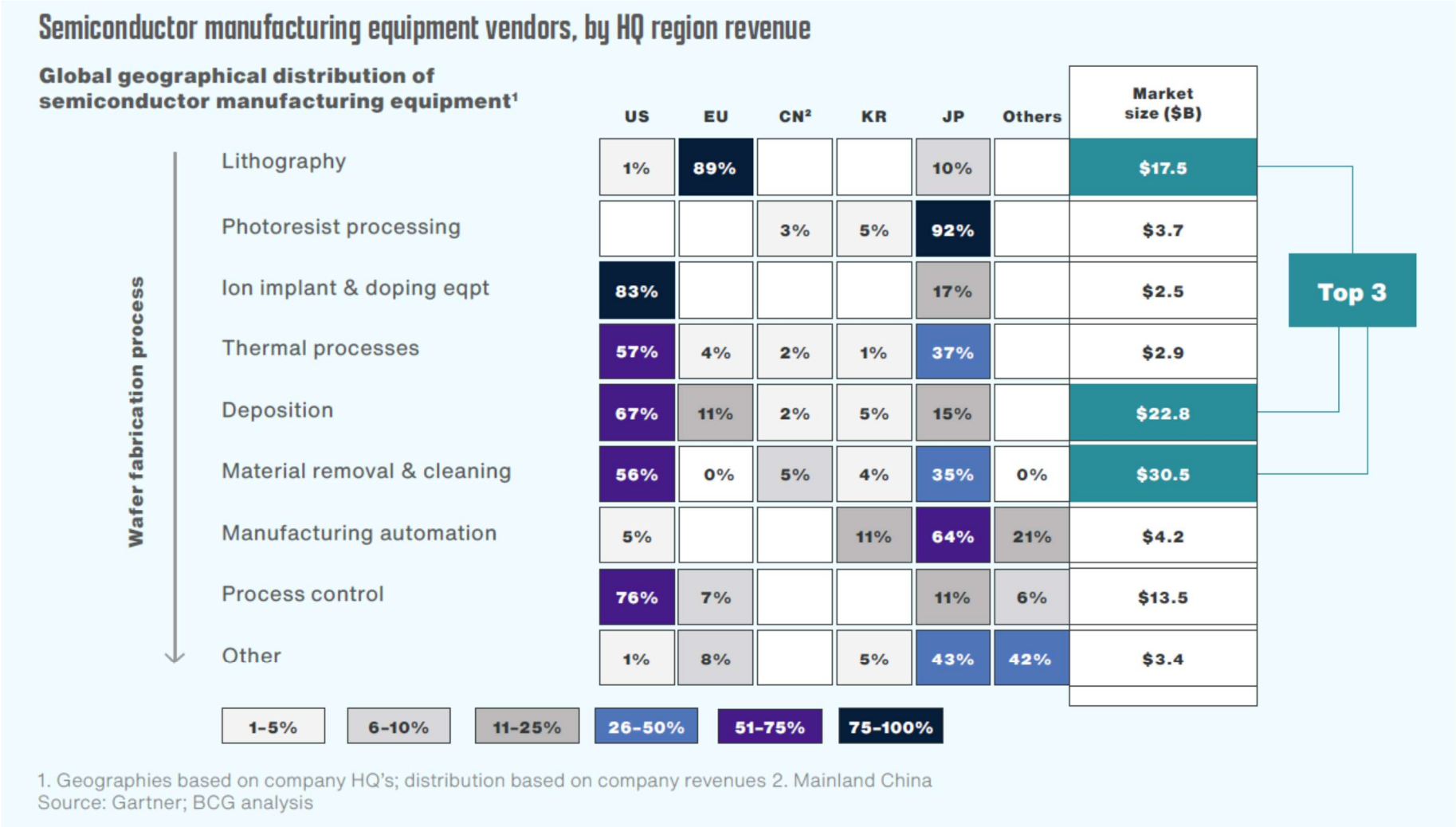
[25] Raj Varadarajan, Iacob Koch-Weser, Chris Richard, Joseph Fitzgerald, Jaskaran Singh, Mary Thornton, Robert Casanova and David Isaacs, "Emerging Resilience in The Semiconductor Supply Chain," Boston Consulting Group, May 2024.

[26] Elaine Huang, "Meet Japan's largest semiconductor technology company," Commonwealth Magazine, March 4, 2024; TechInsights, Press Release: "Advantest reigns as the number 1 ATE supplier," June 21, 2023; TechInsights, Press Release: "The Best Semiconductor Equipment Supplier Rankings for 2023," May 18, 2023.

[27] Naoko Tochibayashi and Naoko Kutty, "How Japan's semiconductor industry is leaping into the future," World Economic Forum, November 20, 2023.

[28] Omron Automation, "Advancing semiconductor wafer processing," https://automation.omron.com/en/ca/industries/semiconductor/front-end/wafer-processing. Accessed June 5, 2024.

## *Figure 4: Semiconductor Manufacturing Equipment Vendors: 2022*




Source: Raj Varadarajan, Iacob Koch-Weser, Chris Richard, Joseph Fitzgerald, Jaskaran Singh, Mary Thornton, Robert Casanova and David Isaacs, "Emerging Resilience in The Semiconductor Supply Chain," Boston Consulting Group, May 2024, p. 18.

Japan's Nikon Precision Inc. and Canon Inc. are prominent global players in the lithography systems market, alongside Netherlands's ASML Holding. Japanese DUV (deep ultraviolet) photolithography machines, vertical chemical vapor deposition (CVD) and oxidation diffusion equipment, sputtering equipment, chemical-mechanical polishing (CMP) equipment and factory handling equipment occupy an important position in the industry. On October 13, 2023, Canon announced the launch of the FPA-1200NZ2C Nano-imprint Lithography (NIL) semiconductor equipment, which opens up a new path for small semiconductor manufacturers to produce advanced chips.[29] Canon's nano-imprint lithography is reportedly capable of producing a minimum 5 nanometer (nm) process size at significantly lower cost, posing a challenge to ASML's extreme ultraviolet (EUV) radiation exposure machines in the 5 nm process segment of the advanced semiconductor manufacturing equipment market.[30]

Japan exports most of the semiconductor equipment it manufactures. In 2022 alone, Japan had US$ 8.35 billion in domestic demand for equipment, accounting for 7.8% of the global market. However, equipment exports were significantly higher, amounting to ¥ 4.3 trillion (approx. US$ 28.5 billion), with about 23.8% (approx. US$ 6.78 billion) exported to Taiwan.[31]

The Semiconductor Equipment Association of Japan (SEAJ) reports that the total annual sales of semiconductor equipment in Japan amounted to roughly ¥ 3.29 trillion (approximately US$ 22.3 billion) in 2023, the second-highest sales record in history, second only to the ¥ 3.85 trillion (approximately US$ 26.1 billion) recorded in 2022.[32]

In addition, SEAJ predicts that aside from the recovery of foundries and logic manufacturers, expenditures from memory manufacturers are expected to significantly rebound in the second half of the fiscal year 2023 (from September 2023 to March 2024). It is anticipated that the compound annual growth rate (CAGR) will continue at 10% until March 2026.[33]

[29] Canon, Press Release: "Nanoimprint lithography semiconductor manufacturing system that covers diverse applications with simple patterning mechanism," October 13, 2023.

[30] TrendForce, Press Release: "Canon's Nano-imprint Lithography Reduces Production Costs for Advanced Processes, Narrowing the Gap with ASML," December 26, 2023.

[31] Invest Taiwan, Ministry of Economic Affairs, Republic of China (Taiwan)

[32] TrendForce, Press Release: "News: Semiconductor Equipment Sales in Japan Reach Nearly JPY 3.3 Trillion in 2023," January 31, 2024.

[33] Ibid.

Moreover, driven by the demand for new expenditures related to artificial intelligence (AI), semiconductor equipment sales in Japan are forecasted to surge by 27% in the fiscal year 2024 (starting from April 2024), reaching ¥ 4.03 trillion (approximately US$ 27 billion).[34]

Semiconductor Materials

The US$ 64 billion semiconductor materials market comprises chemicals and materials used in the frontend (US$ 40 billion) and back-end (ATP) (US$ 24 billion) of the supply chain. Companies headquartered in Japan, the United States, and the EU lead in materials. Japan, for example, is home to four major photo resist vendors, namely JSR, Tokyo Ohka Kogyo, Shin-Etsu Chemical and Fujifilm Electronic Materials (see Figure 5).[35]

According to a 2023 report by the World Economic Forum on Japan's semiconductor industry, Japanese companies hold a significant global market share of 56% in materials.[36] Shin-Etsu Chemical Co. and SUMCO Corporation, for example, control about half the global wafer market.[37] The rising investments and initiatives of AI in Japan and across the world will drive the demand for innovative materials to power AI-driven applications.

[34] Semiconductor Equipment Association of Japan, Market Forecast Report: "Semiconductor and FPD Manufacturing Equipment Released in January 2024 (Fiscal years 2023 to 2025)," January 18, 2024.
[35] Raj Varadarajan, Iacob Koch-Weser, Chris Richard, Joseph Fitzgerald, Jaskaran Singh, Mary Thornton, Robert Casanova and David Isaacs, "Emerging Resilience in The Semiconductor Supply Chain," Boston Consulting Group, May 2024 .
[36] Naoko Tochibayashi and Naoko Kutty, "How Japan's semiconductor industry is leaping into the future," World Economic Forum, November 20, 2023.
[37] Sam Nussey, "Japan to give SUMCO $530 million to boost wafer capacity, Nikkei reports," Reuters, July 11, 2023.

*Figure 5: Market Size and Number of Major Vendors by Semiconductor Materials Segment*


Source: Raj Varadarajan, Iacob Koch-Weser, Chris Richard, Joseph Fitzgerald, Jaskaran Singh, Mary Thornton, Robert Casanova and David Isaacs, "Emerging Resilience in The Semiconductor Supply Chain," Boston Consulting Group, May 2024, p. 19.

Broadly, although Japan's semiconductor industry has lost ground in terms of IC design and manufacturing, it still has advantages in upstream equipment and raw materials, and it produces many older technology semiconductors.

## JAPAN'S SEMICONDUCTOR STRATEGY AND POLICIES

In recent years, Japan has been actively developing its semiconductor industry as a "national project" through policy changes, strategic investments and collaboration (see Figure 6).[38]

The "Strategy for Semiconductors and the Digital Industry," published by Japan's METI in June 2021 and revised in June 2023, emphasized revitalising the domestic manufacturing base, with a focus on joint ventures with overseas foundries and upgrading suppliers while taking into account changes in the immediate geopolitical landscape and advanced technology like generative artificial intelligence (AI).[39]

Japan has promised ¥ 3.9 trillion (US$ 25.7 billion) in subsidies between 2022 and 2025 to help triple sales of domestically produced chips to more than ¥ 15 trillion by 2030.[40] The strategy focuses on five areas: advanced logic ICs, advanced memory, industrial use semiconductors, advanced packaging, and manufacturing equipment and components/materials. It is estimated that by 2030, the public and private sector investments in advanced semiconductors and their supply chains will exceed ¥ 5 trillion (US$ 32.1 billion). Additionally, Japan aims to strengthen its domestic semiconductor equipment manufacturing supply chain and develop equipment for next-generation technology, including advanced and green manufacturing equipment.[41]

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[38] Ministry of Economy, Trade, and Industry, Japan, The Strategy for Semiconductors and the Digital Industry (Summary)," June 4, 2021. https://www.meti.go.jp/english/press/2021/pdf/0604_005a.pdf. Accessed on May 7, 2024.

[39] Ministry of Economy, Trade, and Industry, Japan, "Strategy for Semiconductors and the Digital Industry (Compiled)," June 4, 2021. https://www.meti.go.jp/english/press/2021/0604_005.html. Accessed on May 7, 2024; Hiroshi Hiyama, "Rapidus 'last opportunity' to put Japan back on global chip map," AFP, May 17, 2024.

[40] Kazuhiro Ogawa, "Japan outspends U.S., Germany on chip subsidies as share of GDP," Nikkei Asia, April 10, 2024; Ministry of Economy, Trade, and Industry, Japan, METI website (in Japanese), "Semiconductor and Digital Industry Strategy," May 31, 2024, p. 79. https://www.meti.go.jp/policy/mono_info_service/joho/conference/semicon_digital/0011/3_strategy.pdf. Accessed on May 7, 2024.

[41] Ministry of Economic Affairs, Republic of China (Taiwan), InvesTaiwan website: "Japan's Semiconductor Equipment Industry Policies and Guidelines," February 29, 2024. https://investtaiwan.nat.gov.tw/intelNewsPage202404150001eng?lang=eng&search=202404150001#:~:text=Measures%20include%20encouraging%20foreign%20investments,chips%20to%2020%25%20by%202030. Accessed on May 28, 2024.

## *Figure 6: Japan's Semiconductor Policy*

| | | |
|---|---|---|
| Guidance | **Target** | ¥ 15 trillion (US$112.55 billion) in semiconductor sales by 2030. |
| | **Policy** | **Strategy for Semiconductors and the Digital Industry**<br>(launched in 2021, revised in 2023)<br>• Jointly develop cutting-edge semiconductor manufacturing technology and securing sufficient production capability<br>• Accelerate digital investment and strengthen the design and development of cutting-edge logic semiconductors<br>• Promote green innovation<br>• Strengthen portfolio of the domestic semiconductor industry and enhance its resilience<br>• Strengthen efforts to develop and produce advanced semiconductors critical for economic security measures and advanced technology like generative AI |
| Measures | **Key Incentive Amounts** | ¥ 3.9 trillion (US$ 25.7 billion) in subsidies<br>(does not include subsidies by local governments) |
| | **Key Initiatives** | • 'Specified critical materials' designation for semiconductors<br>• Acquisition of JSR by Japan Investment Corporation (JIC) to promote the consolidation of the semiconductor materials sector<br>• National fiscal funding<br>• R&D: Leading-Edge Semiconductor Technology Center |
| Outcome | **Key Investments To Boost Domestic Production** | • **Rapidus**: ¥ 920 billion (US$ 6.1 billion) subsidy for buying chipmaking equipment and developing advanced back-end chipmaking processes.<br>• **TSMC**: ¥ 476 billion (US$ 3.3 billion) subsidy for TSMC's Kumamoto factory, a joint venture named Japan Advanced Semiconductor Manufacturing Inc. (JASM), ¥732 billion (US$ 4.9 billion) subsidy for TSMC's Kumamoto Fab 2<br>• **Kioxia Holdings Corporation**: ¥ 243 billion yen (U$1.64 billion) subsidy for Kioxia's Yokkaichi and Kitakami plants to mass produce cutting-edge chips.<br>• **Micron**:¥ 192 billion (US$ 1.3 billion) for Micron's production of next-generation chips at its Hiroshima plant.<br>• **ROHM and Toshiba Electronic Devices & Storage**: up to ¥129.4 billion (US$ 900 million) subsidy, or a third of the total investment, for ROHM and Toshiba to jointly produce power chips. |

Source: METI website (in Japanese), "Semiconductor and Digital Industry Strategy," May 31, 2024, p. 79. https://www.meti.go.jp/policy/mono_info_service/joho/conference/semicon_digital/0011/3_strategy.pdf. Accessed on June 1, 2024; Agence France Presse, "Japan-backed Fund Completes $6.5-bn Takeover Of Chip Linchpin JSR," April 17, 2024; Dashveenjit Kaur, "Japan revamps semiconductor strategy as competition and

geopolitical tensions heightens," TechWire Asia, June 7, 2023; Riho Nagao, "Japan's Rapidus to get state loan guarantees for 2-nm chip facility," Nikkei Asia, May 30, 2024; NHK, "経産省 ラピダス新工場に最大 5900 億円支援へ 総額 9000 億円余に Ministry of Economy, Trade and Industry to provide 590 billion yen in support for Rapidus' new factory, totaling over 900 billion yen," April 2, 2024; Nikkei Asia, "Kioxia, Western Digital to invest $4.9bn in cutting-edge memory chips," February 6, 2024; Yoshiaki Nohara, "Japan Inks $1.3 Billion in Subsidies for Micron's Chip Plant," Bloomberg, October 3, 2023; Toshiba, Press Release: "ROHM and Toshiba Agree to Collaborate in Manufacturing Power Devices-METI recognizes joint plan as supporting stable, secure supply," December 7, 2023; Raj Varadarajan, Iacob Koch-Weser, Chris Richard, Joseph Fitzgerald, Jaskaran Singh, Mary Thornton, Robert Casanova and David Isaacs, "Emerging Resilience in The Semiconductor Supply Chain," Boston Consulting Group, May 2024, p. 9.

On December 20, 2022, 11 materials, including semiconductors, were designated as "specified critical materials" under Japan's Act for the Promotion of Economic Security.[42] To bolster the resilience of Japan's supply chains, the Economic Security Promotion Act guarantees subsidies for operators whose equipment investment exceeds ¥ 30 billion, which will enhance supply chain resilience and domestic manufacturing capabilities.[43]

From March 19 to April 16, 2024, state-backed fund Japan Investment Corporation (JIC) bought more than 84% of JSR Corporation's shares for ¥ 900 billion (US$ 6.5 billion).[44] Based on the strong results of the tender offer bid, Nikkei announced that JSR would be removed from the Nikkei Semiconductor Stock Index on May 1, 2024.[45] JIC is set to buy the remaining shares, which will make JSR a fully-owned subsidiary. JSR has about a 30% share in the global market for photoresist, a light-sensitive polymer used in the circuit formation process of chip manufacturing.[46] The acquisition of the world's largest photoresist manufacturer will provide Japan with a greater control over a technological process of which it is already a global leader and is aimed at accelerating its growth as semiconductors have increasingly taken on strategic importance in the age of digitalization.[47]

[42] According to Ministry of Economy, Trade, and Industry of Japan's "Act on the Promotion of Security Assurance through Integrated Economic Measures" (Act No. 43 of 2022), the 11 materials classified as "specified critical materials" under the Act for the Promotion of Economic Security: semiconductors, storage batteries, permanent magnets, critical minerals, machine tools and industrial robots, aircraft parts, cloud programs, natural gas, ship parts, antimicrobial agents, and fertilizer. Chi Hung Kwan, "Decoupling proceeding amid lingering U.S.-China tensions—Rising Concerns about the Impact on Japanese Companies," Research Institute of Economy, Trade and Industry, May 16, 2023.

[43] Ministry of Economy, Trade, and Industry, Japan, Press Conference by Minister Nishimura:"Approval of plans based on the Act on the Promotion of Ensuring National Security through Integrated Implementation of Economic Measures (the "Economic Security Promotion Act")," June 16, 2023.

[44] Japan Investment Corporation, Press Release: "Announcement Regarding Commencement of Tender Offer for JSR Corporation (Securities Code: 4185)," March 18, 2024; Takako Fujiu and Riho Nagao, "Japan chip materials maker JSR seeks to scale up after $6bn takeover," Nikkei Asia, April 18, 2024.

[45] Nikkei, Index News: "Deletion from Nikkei Semiconductor Stock Index," April 17, 2024.

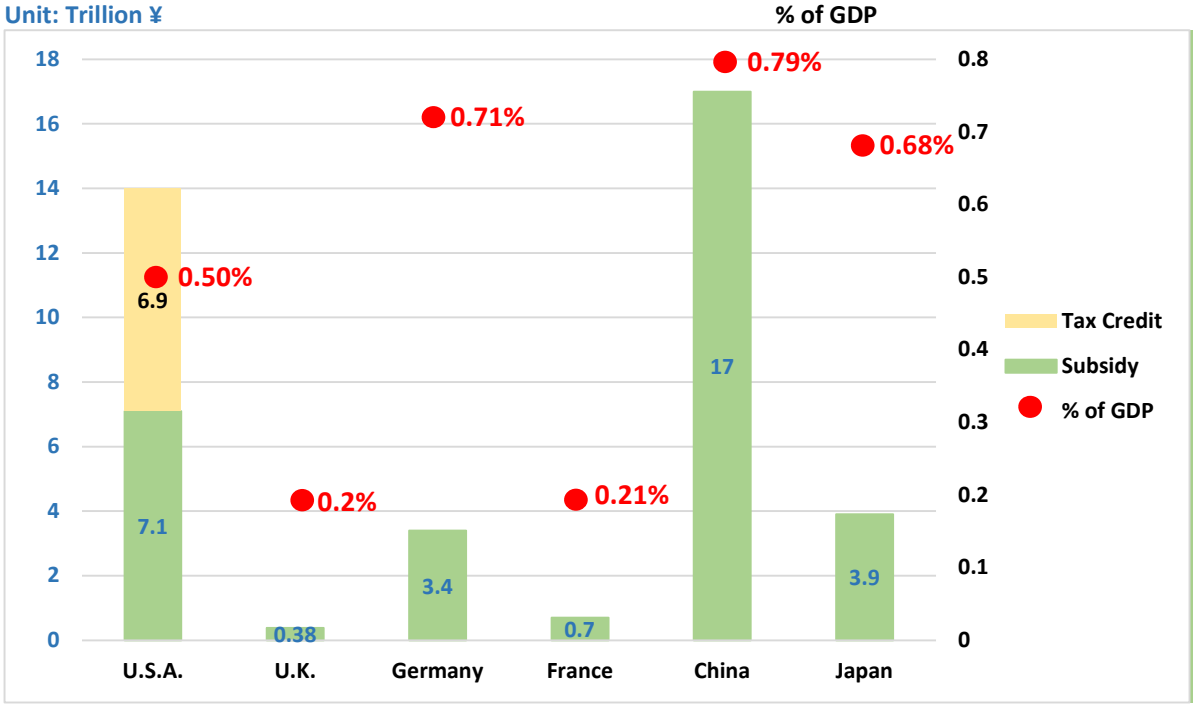
[46] Kyodo News, "Japan state-backed fund to buy JSR to enhance chip supply chain," June 26, 2023.

[47] Takako Fujiu and Riho Nagao, "Japan chip materials maker JSR seeks to scale up after $6bn takeover," Nikkei Asia, April 18, 2024.

As Japan embarked on its 'two-track strategy' of attracting overseas companies and fostering the growth of domestic companies, it has appropriated large grant funds to be allocated on a national and project-specific basis, coupled with tax incentives.[48]

According to METI, the amount of financing Japan has given to the semiconductor industry is on par with the United States, Germany and China in relation to each country's gross domestic product.[49] Its May 2024 report reveals that Japan has provided subsidies of more than ¥ 3.9 trillion, which accounts for 0.68% of the country's GDP. Meanwhile, China's spending accounts for 0.79% of its GDP, Germany's accounts for 0.71% and the United States' accounts for 0.50% (see Figure 7).[50]

***Figure 7: Government Investments in Domestic Semiconductor Industry***




Note:
* With regards to GDP, METI used real figures, which excludes changes in price fluctuations.
** METI included preferential taxation treatments into its calculations of subsidies. The U.S. CHIPS Act provides tax credits of up to 25% for investments in semiconductor and manufacturing equipment. Japan's strategic tax system does not allow the application of subsidies and tax systems to the same investment plan, while the US CHIPS Act allows the overlapping application of subsidies (5-15%) and tax systems (25%).

Source: METI website (in Japanese), "Semiconductor and Digital Industry Strategy," May 31, 2024, p. 79.
https://www.meti.go.jp/policy/mono_info_service/joho/conference/semicon_digital/0011/3_strategy.pdf

[48] The Dong-a Ilbo, "Japan supports up to 50% of semiconductor investments," December 26, 2023.
[49] Source: METI website (in Japanese), "Semiconductor and Digital Industry Strategy," May 31, 2024, p. 79. https://www.meti.go.jp/policy/mono_info_service/joho/conference/semicon_digital/0011/3_strategy.pdf
[50] Ibid.

According to METI, the local governments of countries such as the U.S.A., China and Japan provide additional incentives for investments in the semiconductor industry. In the U.S.A., on top of the ¥ 7.1 trillion (US$ 50 billion) provided by the central government, each state offers support, such as a 5% tax credit in New York State.

While the U.S. CHIPS Act allows the overlapping application of subsidies (5-15%) and tax systems (25%), Japan's strategic tax system does not allow the application of subsidies and tax systems to the same investment plan. However, local authorities are supporting Japan's efforts to attract and grow the semiconductor industry. The Kumamoto prefecture government, for example, provides subsidies for capital investment, R&D, product development, and other initiatives undertaken by companies in the prefecture.[51] It also provides support for bridging business transactions and technology linkages between large companies and companies in the prefecture, as well as for testing technologies and prototypes that are essential for their realization.[52]

The Chinese government's investment in its domestic semiconductor industry totalled more than ¥17 trillion (US$ 115 billion). With a recent infusion of US$ 47.5 billion into the third phase of the "China Integrated Circuit Industry Investment Fund", also known as the "Big Fund", the Chinese central government has made large-scale investments totaling more than US$ 81 billion in semiconductor-related technologies, while its local governments also have funds totaling more than US$ 34 billion (See Figure 7). In addition, China offers 10-year corporate tax exemptions and reductions.

To boost production of semiconductors in Japan, the Japanese government has indicated that it will subsidize up to one-third of the capital costs incurred by domestic and foreign manufacturers to produce designated types of semiconductor devices (including power devices, microcontrollers, and analog devices), equipment, materials, and raw materials. The subsidies are conditioned on a minimum of 10 years of domestic production, and they will require manufacturers to prioritize domestic shipments at times of global shortage.[53]

[51] Kumamoto Prefecture Government, "Kumamoto Semiconductor Industry Promotion Vision," March 6, 2023, p. 39. https://www.pref.kumamoto.jp/uploaded/life/168486_400886_misc.pdf. Accessed on 7 May 2024.
[52] Ibid.
[53] Sujai Shivakumar, Charles Wessner, and Thomas Howell, "Japan Seeks to Revitalize Its Semiconductor Industry," Center for Strategic and International Studies, August 25, 2023.

Japanese semiconductor companies that have responded to the call for investments include the government-backed startup Rapidus Corporation, which aims to produce 2 nm chips in Hokkaido as early as 2027; Kioxia Holdings Corporation, a world leader in memory solutions, to develop and produce cutting-edge flash memory at the Yokkaichi and Kitakami plants in Japan; and Toshiba and Rohm's ¥ 388.3 billion (US$ 2.7 billion) to jointly produce power chips, which will be subsidized up to ¥ 129.4 billion (US$ 900 million), or a third of the total investment, as part of an effort to help the domestic power chip industry retain its competitiveness. [54]

Leading foreign semiconductor companies, including Taiwan's TSMC and U.S.'s Micron, likewise, are also establishing new semiconductor plants in Japan. In the case of Micron, for example, its Hiroshima plant received a ¥ 46.5 billion (US$ 332 million) subsidy from the Japanese government in 2022 to support the expansion of its advanced memory manufacturing facilities and improve the mass production yield of 1β (1-beta) DRAM.[55] Additionally, in October 2023, Japan's government approved as much as ¥ 192 billion (US$ 1.3 billion) in subsidies for Micron Technology Inc.'s Hiroshima factory as part of its efforts to bolster next-generation chip production at home.[56] Foreign investments like this will not only improve semiconductor production but also raise the demand for semiconductor fabrication materials in Japan.

With strong support from the Japanese government and in response to future medium- and long-term memory market demands such as AI, data centers, and self-driving cars, Micron announced in October 2023 that it will invest ¥ 500 billion (US$ 3.6 billion) in the next few years to introduce EUV equipment at its Hiroshima factory.[57]

Japan's semiconductor policy also sought to strengthen its R&D to develop advanced chips. To this end, Japan set up the Leading-Edge Semiconductor Technology Center (LSTC), a public research organization that was modeled after and was intended to work with the U.S. National Semiconductor Technology Center.[58] The LSTC is chaired by Rapidus Chairman

[54] Ryohtaroh Satoh, "Japan's Rapidus and universities aim for 'beyond 2nm' chip tech," Nikkei Asia, February 9, 2024.
[55] Reuters, "Micron launches mass output of advanced chip in Japan," November 16, 2022.
[56] Yoshiaki Nohara, "In Boost for Chip Ambitions, Japan Inks $1.3 Billion in Subsidies for Micron Plant," Bloomberg, October 3, 2023.
[57] Ibid.
[58] Brad Glosserman, "Semiconductors are back to center stage in the Japan-U.S. alliance," The Japan Times, March 5, 2024.

Tetsuro Higashi and includes research institutions and universities.[59] It spearheads the research and development while Rapidus handles production.

The Japanese government has committed ¥ 920 billion (US$ 6.1 billion) billion) to Rapidus, a joint venture involving Sony, Toyota, IBM and others, which is now building its fab in the Hokkaido region.[60] Founded in 2022, Rapidus looks to produce the cutting-edge 2 nm chips on the northern island of Hokkaido by 2027, at an estimated cost of ¥ 5 trillion (US$ 31.8 billion). According to Nikkei, Japan's government plans to offer loan guarantees for Rapidus to facilitate its access to bank funding for the mass production of advanced semiconductors.

South Korea's Samsung Electronics, too, will be getting a subsidy of up to ¥ 20 billion (US$ 140 million) for setting up an advanced semiconductor R&D facility in the Minato Mirai district of Yokohama, south of Tokyo.[61] In 2023, it announced that it would develop technology for advanced semiconductor production over the next five years in cooperation with semiconductor material and chip equipment manufacturers.[62]

With the establishment of Rapidus, TSMC, United Microelectronics Corporation (UMC) and Powerchip Semiconductor Manufacturing Corporation (PSMC) in Japan's semiconductor industry, TrendForce has identified three prospective semiconductor hubs in Japan, namely Hokkaido, Tohoku and Kyushu (see Figure 8).

Hokkaido is home to Rapidus, and government plans indicate that Rapidus could be a magnet for upstream equipment and material suppliers.

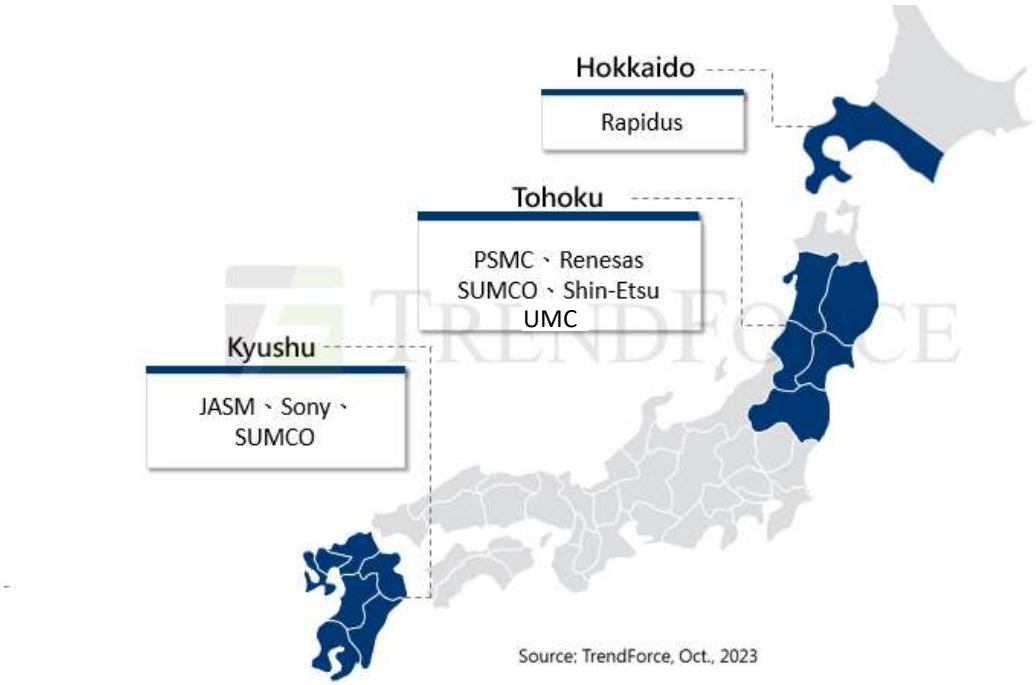
Meanwhile, Tohoku, home to the Renesas Yonezawa plant, and major raw wafer producers SUMCO and Shin-Etsu, is the heart of the semiconductor raw materials industry. In October 2019, UMC fully acquired Mie Fujitsu Semiconductor Ltd and renamed the company United Semiconductor Japan

[59] Sam Nussey, "Japan offers $300 mln backing for chip research organization," Reuters, February 9, 2024.
[60] Riho Nagao, "Japan's Rapidus to get state loan guarantees for 2-nm chip facility," Nikkei Asia, May 30, 2024; NHK, "経産省 ラピダス新工場に最大 5900 億円支援へ 総額 9000 億円余に Ministry of Economy, Trade and Industry to provide 590 billion yen in support for Rapidus' new factory, totaling over 900 billion yen," April 2, 2024
[61] Nikkei Asia, "Samsung to receive up to $140m in subsidies for Japan chip facility," December 21, 2023.
[62] Gokhan Ergocun," Japan to subsidize Samsung's semiconductor facility up to $140M," Anadolu Agency, December 22, 2023.

Corporation (USJC).[63] USJC is UMC's fourth 12-inch wafer foundry and rolls out chips made on mature processes ranging between 40 nm and 90 nm.[64] On October 31, 2023, PSMC officially unveiled plans to build a 12-inch wafer plant in Sendai, initially focusing on the 40 nm process technology, with advanced processes in the roadmap.[65] Automotive electronics will be a production priority, further amplifying Tohoku's semiconductor significance.The future addition of PSMC, where automative electronics is a priority, will further amplify Tohoku's semiconductor significance.

Lastly, Kyushu hosts JASM (TSMC's Kumamoto Plant), Sony and SUMCO, a behemoth in raw wafer production, and numerous small and medium-sized semiconductor-related enterprises, creating a synergy across the semiconductor supply chain (see Figure 8).

***Figure 8: Three Regional Semiconductor Bases That Will Emerge in Japan in the Future***




Source: TrendForce, Press Release: "Japan Flexes Its Advantages in Semiconductor Upstream Equipment and Raw Materials, and Unveils Strategic Progress of Key Players in Kyushu, Tohoku, and Hokkaido, Says TrendForce," October 31, 2023; TrendForce, Press Release: "[Insights] In-Depth Analysis of TSMC, PSMC, and UMC's Latest Overseas Expansion Strategies," November 17, 2923.

[63] Chang Chien-chung and Frances Huang, "UMC's fab in Japan unaffected by strong earthquake: TrendForce," Focus Taiwan, March 1, 2024.
[64] Ibid.
[65] TrendForce, Press Release: "Japan Flexes Its Advantages in Semiconductor Upstream Equipment and Raw Materials, and Unveils Strategic Progress of Key Players in Kyushu, Tohoku, and Hokkaido, Says TrendForce," October 31, 2023.

Despite these developments, Japanese semiconductor equipment manufacturers remain cautious above moving production capacity overseas, mainly due to considerations of geographical location and preventing technology outflow.[66] In line with the New Export Controls on Semiconductor Equipment announced in March 2023, Japan, similar to the U.S.A., will impose controls on semiconductor equipment that may be diverted for military purposes. However, countries on Japan's list of friendly countries, including the United States, Taiwan, South Korea, and Singapore, are exempt from this restriction.[67]

On top of its policy changes and strategic investments, Japan has also actively collaborated with governments and enterprises from various countries to enhance the resilience of its semiconductor supply chain and bridge the gap in advanced technology fields. One example is the Japan-U.S. Summit Meeting of 2022, which established the Basic Principles on Semiconductor Cooperation, wherein the two nations committed to jointly bolstering supply chain resilience within the free trade market and supporting each other in addressing shortfalls in semiconductor manufacturing, manpower, technology and semiconductors.[68]

On May 18, 2023, METI held an Exchange of Views on the areas of collaborative investments and cooperation in the development of next-generation semiconductors with senior executives of global semiconductor companies including TSMC, Intel, Micron, Samsung, Applied Materials and Interuniversity Microelectronics Centre.[69]

Japan has also formed a semiconductor partnership with the United Kingdom on May 19, 2023, and UK Research and Innovation (UKRI) and the Japan Science and Technology Agency (JST) announced a joint investment of up to £2 million (US$ 2.5 million) for early-stage research into semiconductors.[70]

[66] InvesTaiwan, Ministry of Economic Affairs, Republic of China (Taiwan), “Japan’s Semiconductor Equipment Industry Policies and Guidelines,” February 29, 2024.
[67] TrendForec, Press Release: “Strengthening Controls on Semiconductor Equipment Exports to China, Japan Reportedly Tightens Export Control Measures Further,” April 29, 2024.
[68] Brad Glosserman, “Semiconductors are back to center stage in the Japan-U.S. alliance,” The Japan Times, March 5, 2024.
[69] Prime Minister’s Office of Japan, Press Release: “Exchange of Views with the Senior Executives of the Global Semiconductor Companies,” May 18, 2023.
[70] Department for Science, Innovation & Technology, United Kingdom, “UK-Japan Digital Partnership: Progress Report (January 2024),” January 18, 2024.

Additionally, Japan's METI announced in March 2023 the resumption of semiconductor material exports of fluorinated polyimide, hydrogen fluoride and photoresist to South Korea, ending a trade dispute that lasted three years and nine months.[71]

## ROLE OF TAIWANESE COMPANIES IN JAPAN'S SEMICONDUCTOR INDUSTRY

Japan's new commitment to support not only Japanese companies but foreign ones as well shows its determination to regain the country's former leading role as a semiconductor powerhouse. Taiwan and Japan's shared interest in semiconductors has fostered collaboration between the two countries, benefiting both nations. Taiwan's growing partnership with Japan in the semiconductor sector is solidifying, as reflected in TSMC's expansion in Kumamoto. Additionally, Japan's efforts to rebuild its semiconductor industry are getting a further boost from not just Taiwanese semiconductor companies that are expanding there to support TSMC but also other companies that are excited about the Japanese sector's prospects.

### • TSMC

TSMC has a historical presence in Japan's semiconductor ecosystem since setting up its Japan subsidiary in 1997, establishing the Japan Design Centre in 2019 to service its global clientele and opening the TSMC Japan 3DIC research and development center in Tsukuba, Ibaraki Prefecture, to develop leading-edge microchip technology in 2022.[72]

In 2021, TSMC collaborated with Japanese partners to establish Japan Advanced Semiconductor Manufacturing, Inc. (JASM), becoming the first recipient of the subsidy offered under the "Strategy for Semiconductors and the Digital Industry". Sony Group Corporation and DENSO Corporation, a major Japanese auto parts maker, each have a minority stake in JASM. Toyota Motor Corporation has also announced its capital participation in the operating firm.[73] The TSMC majority-owned plant in Kumamoto, Japan, which cost US$ 8.6

[71] Isabel Reynolds, "Japan Ends Curbs on Exports of Chip Materials to South Korea," Bloomberg, March 23, 2023; Ministry of Economy, Trade and Industry, Japan, Press Release: "Japan-Korea Export Control Policy Dialogue Held," March 16, 2023.

[72] Sony, Press Release: "TSMC to Build Specialty Technology Fab in Japan with Sony Semiconductor Solutions as Minority Shareholder," November 9, 2021; Ayumi Shintaku, "TSMC to open semiconductor R&D facility in Tsukuba," The Asahi Shimbun, June 1, 2021.

[73] Kyodo News, "TSMC opens 1st Japan chip plant amid supply chain concerns," February 24, 2024.

billion, received subsidies of ¥ 478 billion (approximately US$ 3.23 billion), the biggest ever sum granted to a single foreign enterprise from the Japanese government.[74]

TSMC celebrated its opening in February 2024, and is set to start mass production of mature-technology semiconductors using the mature 12-, 16-, 22-, and 28-nanometer process technologies, in the fourth quarter this year.[75]

The new TSMC plant in Japan took a relatively short one year and eight months to build, earning praise from the firm's founder Morris Chang, 92, who made a rare overseas trip to open the plant in February this year.[76] In contrast, TSMC's Arizona facility has been delayed and has seen disputes with unions despite the U.S. government offering subsidies of US$ 52.7 billion for the sector.[77] Production at the first Arizona factory is slated to begin during the first half of 2025, the second in 2028 and the third before 2030.[78]

Lured by more Japanese government support, TSMC and minority investors Sony Semiconductor Solutions (SSS), DENSO and Toyota announced in February this year (2024) that it will be building a second Japanese plant, which will make more advanced chips. The decision is also a vote of confidence by TSMC in Japan where construction of its first fab has run smoothly.[79] The second fab is expected to require an investment of approximately ¥ 2 trillion (US$ 13.9 billion), and is promised ¥ 730 billion (US$ 4.85 billion) in subsidies by the Japanese government.[80] It is scheduled to begin operation by the end of 2027.

With both fabs, JASM's Kumamoto site is expected to offer a total production capacity of more than 100,000 12-inch wafers per month starting from 40, 22/28, 12/16 and 6/7 nanometer process technologies for automotive, industrial, consumer and high-performance computing (HPC)-

[74] Elaine Huang, "The Japan-Taiwan semiconductor island chain," CommonWealth Magazine, March 7, 2024.
[75] Chang Chien-chung and Frances Huang, "Kumamoto fab to start mass production in Q4 as planned: TSMC," Focus Taiwan, February 17, 2024.
[76] Tomohiro Osaki, "Japan Next-generation Chip Venture Handed $3.9bn Subsidies," AFP, April 1, 2024; TrendForce, Press Release: "High Efficiency in TSMC Kumamoto Plant Construction Sets Stage for Potential Advanced Packaging Investment in Japan," February 17, 2024.
[77] Ibid.
[78] Russ Wiles and Corina Vanek, "TSMC to build third Phoenix factory with new $6.6 billion from CHIPS Act," Arizona Republic, April 8, 2024.
[79] TSMC, Press Release: "JASM Set to Expand in Kumamoto Japan," February 6, 2024.
[80] Riho Nagao, "Japan prepares $4.9bn in funds for TSMC's 2nd Kumamoto chip plant," Nikkei Asia, February 24, 2024.

related applications.[81] The overall investment in JASM will exceed US$ 20 billion with strong support from the Japanese government. Together, the two fabs are expected to directly create more than 3,400 high-tech professional jobs.[82]

TSMC's Kumamoto fabs are a key development in advancing industrial-use semiconductors in the Kyushu region. The Kyushu Economic Research Association estimates that the two fabs will contribute ¥ 10.5 trillion (US$ 67.4 billion) to the economy of Kumamoto Prefecture over the next decade.[83] In fact, since the establishment of JASM at the end of 2021, at least 46 semiconductor-related manufacturers have made new investments in the Kyushu region, promoting local economic development and enhancing Japan's competitive position in advanced semiconductor manufacturing.[84] Notably, Japanese conglomerations such as Sony, Mitsubishi Electric Corp, SUMCO Corp and Kyocera Corp have all made major semiconductor-related investments in Kyushu. Fujifilm Holdings Corp also expanded manufacturing facilities in its semiconductor materials factory in Kumamoto's Kikuyo town in January this year (2024), where TSMC's plant is located, while Ebara Corp, a major industry machinery producer, in June last year announced plans to set up new factories to produce semiconductor-making equipment in Kumamoto.[85]

Although TSMC has said that more than 60 percent of its supplies would come from its Japanese partners, Taiwanese semiconductor companies are looking at potential opportunities in Kumamoto. In line with TSMC's expansion in Japan, its Taiwanese partners such as Materials Analysis Technology Inc. (MA-tek) and Finesse Technology Co. have started new capacity expansion plans such as labs or new production lines in Kumamoto.[86] Finesse Technology provides semiconductor equipment and maintenance services to TSMC, while MA-tek provides material and failure analyses. Advanced Semiconductor Engineering (ASE) Group, too, is reportedly planning to construct its first advanced packaging plant in Kumamoto, potentially becoming the second Taiwanese semiconductor giant to to set foot in the region.[87]

[81] TSMC, Press Release: "TSMC Celebrates the Opening of JASM in Kumamoto, Japan," February 24, 2024.
[82] Ibid.
[83] TrendForce, Press Release: "Kumamoto Vying for TSMC's Third Fab, Looking to Build Semiconductor Hub," May 13, 2024.
[84] InvesTaiwan, Ministry of Economic Affairs, Republic of China (Taiwan), "Japan's Semiconductor Equipment Industry Policies and Guidelines," February 29, 2024.
[85] Taipei Times, "TSMC helps Kumamoto regain pivotal position: Japanese business leader," February 24, 2024.
[86] Taipei Times, "Editorial: Taiwan-Japan trade only to expand," January 23, 2024.
[87] TrendForce, "Following TSMC, ASE Reportedly Plans to Establish Plant in Kumamoto," April 29, 2024.

Likewise, Taiwanese banks and airlines also see new opportunities in Kumamoto. CTBC Commercial Bank Co's Japanese subsidiary, Tokyo Star Bank, has launched an office in Kumamoto, targeting growing corporate loan and housing mortgage demand in the region with the arrival of TSMC.[88]

According to various media reports, TSMC is reportedly eyeing a third and possibly a fourth plant in Japan.[89] Kumamoto's newly appointed governor, Takashi Kimura, who took office in April this year (2024), stated in a report by Bloomberg on May 11 that he would spare no effort to persuade TSMC to establish a third fab in the region. He also expressed his hope to attract numerous semiconductor-related enterprises and research institutions to Kumamoto, aiming to establish an industrial cluster similar to Taiwan's Hsinchu Science Park, where various industries stemming from semiconductors, including AI, data centers, and autonomous driving technologies are concentrated.[90]

Meanwhile, Taiwan's Ministry of Economic Affairs is considering establishing an overseas science park in Japan's Kyushu to assist Taiwanese supply chain companies there in serving both TSMC and local clients.[91]

- **UMC**

In 2019, UMC fully acquired Mie Fujitsu Semiconductor Ltd, a joint venture between UMC and Fujitsu Semiconductor Ltd, and operated the newly acquired business under the new company name, United Semiconductor Japan Company (USJC).[92] With its 12 fabs certified under the IATF 16949 automotive quality standard, UMC plays a significant role in automotive electronics and electric vehicle (EV) supply chains.[93]

The establishment of USJC allowed UMC to expand its presence in Japan's automotive semiconductor market.[94] In April 2022, USJC cooperated

[88] Taipei Times, "Editorial: Taiwan-Japan trade only to expand," January 23, 2024.
[89] Takashi Mochizuki And Jane Lanhee Lee, "TSMC eyes third Japan chip plant with cutting-edge 3 nanometer tech," Bloomberg, November 21, 2023.
[90] TrendForce, Press Release: "Kumamoto Vying for TSMC's Third Fab, Looking to Build Semiconductor Hub," May 13, 2024.
[91] Alison Hsiao, "Taiwan mulls overseas science park in Japan's Kyushu: Minister," Focus Taiwan, May 30, 2024.
[92] Morgan, Lewis & Bockius LLP, Press Release: "Morgan Lewis Represented United Microelectronics In Mie Fujitsu Semiconductor Acquisition," October 7, 2019
[93] UMC website, "About UMC," https://www.umc.com/en/About/about_overview#:~:text=Most%20of%20UMC's%2012%2Din,IATF%2016949%20automotive%20quality%20standard. Accessed on June 11, 2024.
[94] Lisa Wang, "UMC gets green light for Mie Fujitsu acquisition," Taipei Times, September 26, 2019.

with DENSO Corporation, a leading mobility supplier, to jointly build the first production line to manufacture insulated gate bipolar transistors (IGBT)[95] using 12-inch wafers, entering into a special automotive process.[96] As adoption of EVs accelerates, automakers are seeking to boost powertrain efficiency while also increasing cost-effectiveness of electrified vehicles. The new generation of IGBT produced at USJC offers 20% reduction in power losses compared with earlier generation devices. Production is expected to reach 10,000 wafers per month by 2025.[97]

With its expertise and capacity, UMC has contributed to solving critical challenges faced by companies like DENSO and successfully entered the automotive electronics and electric vehicle supply chains of Japanese automakers such as Toyota and Subaru.[98] For DENSO, its cooperation with UMC not only helps to address specific capacity shortages but also strengthens its supply chain resilience while supporting the growth of the EV industry.

- **PSMC and SBI Holdings' Foundry Joint Venture**

In August 2023, Powerchip Semiconductor Manufacturing Corporation (PSMC) and SBI Holdings (sometimes referred to as Strategic Business Innovator Group), jointly established JSMC Company, Ltd. as a preparatory company for establishing a semiconductor foundry and began preparations for setting up a wafer fab in Japan.[99] In late October 2023, PSMC, in collaboration with SBI Holdings, Inc., the Miyagi Prefecture of Japan, and JSMC Corporation, signed a memorandum of understanding, confirming its plans to build a chip plant in northern Japan's Miyagi prefecture.[100]

According to Japanese media, PSMC plans to construct multiple plants. For the first phase, the company will invest ¥ 420 billion (US$ 3.9 billion) for mass production of 10,000 12-inch equivalent wafers per month, beginning in

[95] An IGBT is a core device that acts as a switch in inverters to convert DC current from batteries to AC current to drive and control electric vehicle motors. Battery and plug-in electric cars require significantly more IGBT units than conventional ICE cars.
[96] UMC, Press Release: "DENSO and USJC Collaborate on Automotive Power Semiconductors- An IGBT production line will be established at USJC, the Japan fab subsidiary of UMC," April 26, 2022.
[97] UMC, Press Release: "DENSO and USJC Announce Mass Production Shipment of Automotive IGBT, Targeting Expanding Electric Vehicle Market," May 10, 2023.
[98] Yuki Fukumoto, "DENSO looks to Taiwanese partners in reshaping auto supply chains," Nikkei Asia, January 1, 2023.
[99] PSMC, Press Release: "Taiwan and Japan join hands to build JSMC's first fab in Miyagi Prefecture," October 31, 2023.
[100] Ibid.

2027.[101] It aims for 40,000 wafers a month when the plant is fully operational in 2029. The Japanese government is considering providing subsidies of up to ¥ 140 billion (US$ 890 million).[102]

While many semiconductor companies are directing their investments towards cutting-edge or advanced technologies, PSMC stands out with expertise in the business model of high-quality, cost-effective, and high-volume manufacturing of semiconductors, particularly those at 28 nm and above process technologies, which are known to account for over 90% of the semiconductor demand in the automotive sector. Under the current plans, JSMC's fab will manufacture semiconductors in the 28 nm, 40 nm, and 55 nm categories, with a targeted monthly output of 40,000 12-inch equivalent wafers.[103]

## CONCLUSION

Japan's semiconductor industry has undergone significant changes over the years. Once the world's largest semiconductor manufacturer, its market share has declined as other countries, including South Korea, Taiwan and the United States, have risen to the competition. Japan's significance in the global semiconductor supply chain, however, extends beyond semiconductor production, and its contributions in semiconductor equipment and materials are pivotal for the industry's success.

Semiconductors are at the heart of modern society, and governments worldwide recognize their strategic significance and growing importance for economic competitiveness and supply-chain resilience. More countries are implementing semiconductor-related policies to foster innovation, security, and growth. Japan, too, is strategically positioning itself to capitalize on the growth opportunities within the semiconductor supply chain. Collaborations between Japan's METI and the private sector are actively fostering innovation, and efforts to revitalize its semiconductor industry include subsidy programs for both domestic and foreign semiconductor companies investing in Japan.

The expansion of TSMC's global footprint into Japan holds promise for both the Japanese semiconductor industry and the global tech landscape. It

[101] Hideaki Ryugen and Takuya Matsuda, "Taiwan's PSMC to rev up auto chip business with Japan plant," Nikkei Asia, December 12, 2023.
[102] Ibid.
[103] SBI Holdings, "Notice Regarding the Selection of the Planned Semiconductor Foundry Construction Site in Japan," October 31, 2023.

also heralded a new era of semiconductor cooperation between Japan and Taiwan. TSMC's arrival in Kumamoto has led to an economic ripple effect, benefiting the local economy, supply chain, infrastructure, and knowledge base.

The renewed interest and investments in Japan's semiconductor industry by leading semiconductor companies from Taiwan and other countries serve as a testament to their confidence in the Japanese semiconductor market. Indeed, with strategic investments, innovation, and collaboration, the Japanese semiconductor market is poised for a resurgence.

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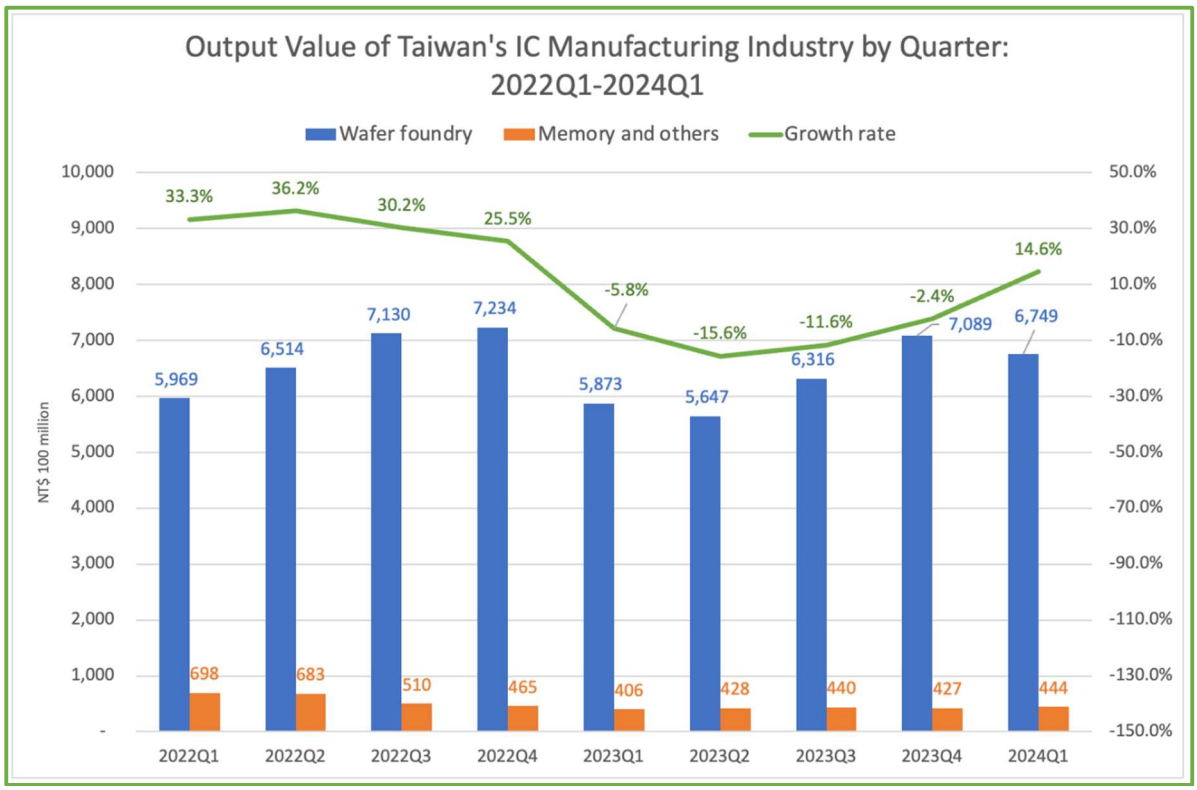
# SEMICONDUCTOR STATISTICS AT A GLANCE

## *Figure 9: Output Value of Taiwan's IC Manufacturing Industry by Quarter: 2022Q1-2024Q1*




Source: Hui-Hsiu Huang, "Taiwan IC Manufacturing Industry and Future Development in 2024Q1," IEK. ITRI, June 4, 2024, p. 1.

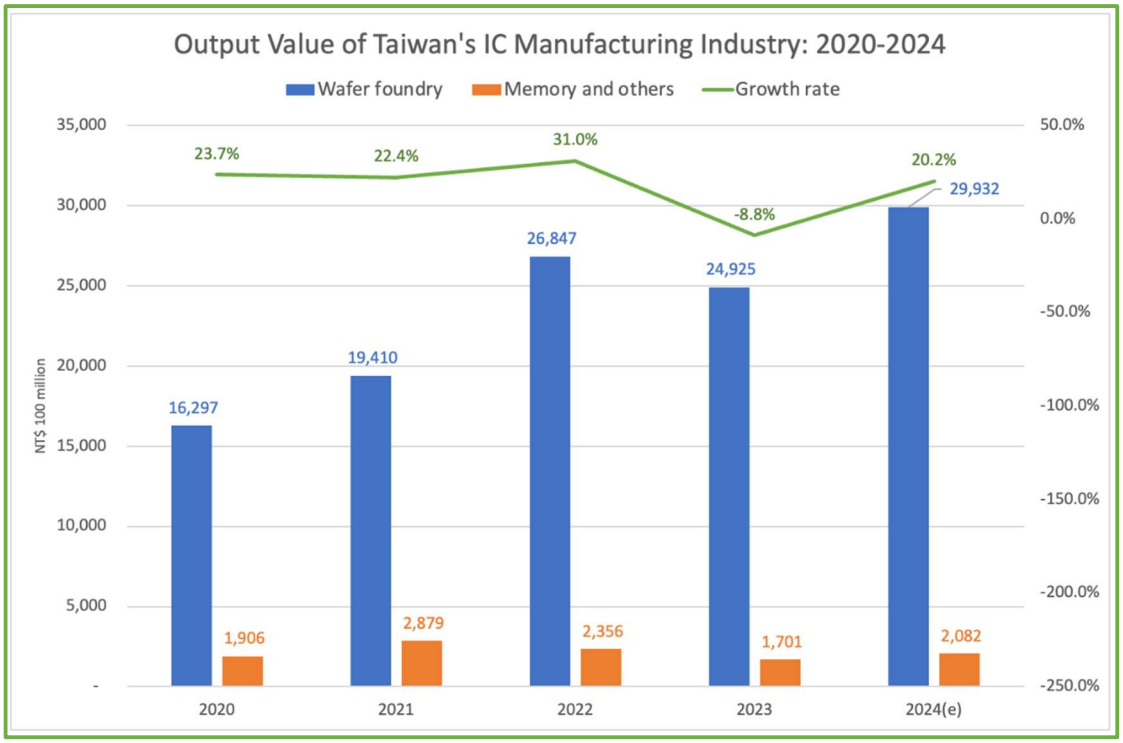
Figure 9 shows the output value of Taiwan's IC manufacturing industry by quarter, from the first quarter of 2022 to the first quarter of 2024. In the first quarter of 2024, the output value of Taiwan's IC manufacturing industry reached NT$ 719.3 billion (US$ 23.1 billion), a 4.3% decline compared to the previous quarter, but a 14.6% growth compared to the same quarter last year.

Two trends can be observed in Taiwan's IC manufacturing industry in the first quarter of 2024. On the one hand, affected by the traditional off-season and the reduction in smartphone shipments, the overall output value of Taiwan's IC manufacturing industry declined slightly from the previous quarter. On the other hand, compared with the same period last year , the IC manufacturing industry still shows significant growth.

In the first quarter of 2024, although wafer foundries will be greatly affected by fluctuations in the smartphone market, the continued strong demand for AI and high-performance computing will become an important

growth driver. TSMC's leadership in advanced processes, especially its continued advancement of 3 nm and 5 nm process technologies, will be an important growth driver in the coming quarters.

***Figure 10: Output Value of Taiwan's IC Manufacturing Industry: 2020-2024***

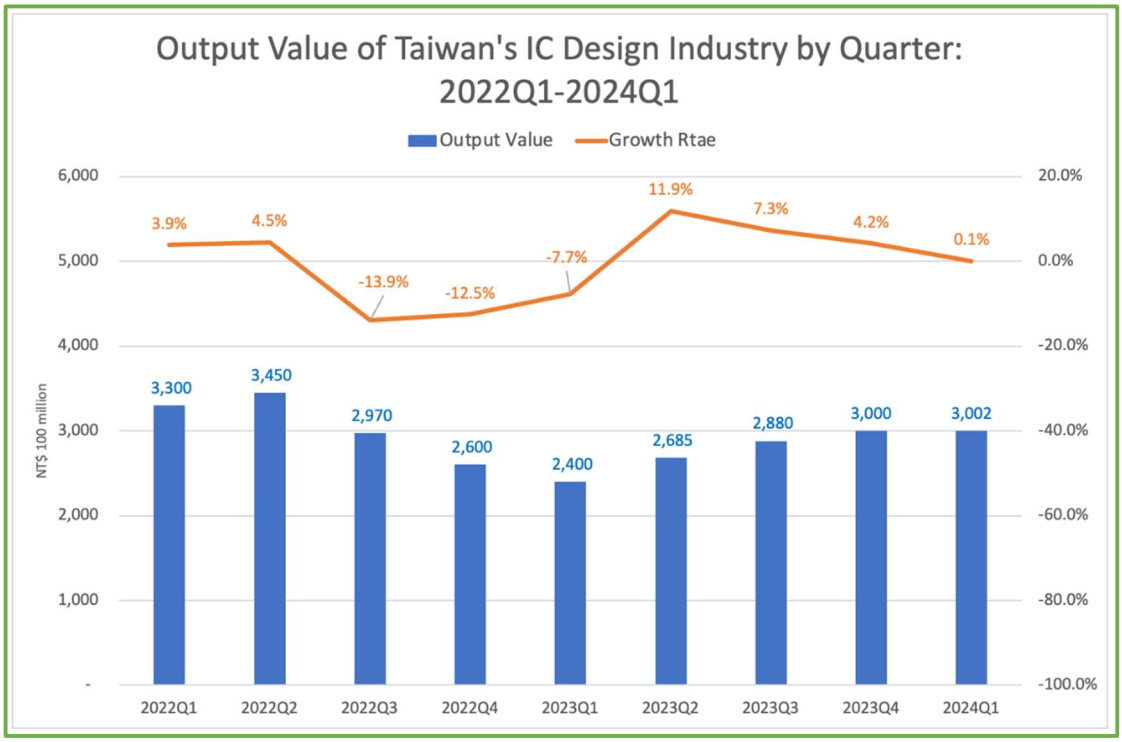



Source: Hui-Hsiu Huang, "Taiwan IC Manufacturing Industry and Future Development in 2024Q1," IEK. ITRI, June 4, 2024, p. 6.

Figure 10 shows the output value of Taiwan's IC manufacturing industry from 2020 to 2024. Looking ahead at the IC manufacturing industry in 2024, Taiwan's IC manufacturing output value is estimated to reach NT$ 3.2 trillion (US$ 114.3 billion), an increase of 20.2% compared with 2023. The output value of the wafer foundry industry is estimated to grow by 20.1% to NT$ 3.0 trillion (US$ 92.5 billion).

Additionally, the second half of the year is anticipated to outperform the first half second half of the year. Factors such as the demand for AI and high-performance computing semiconductors will push up demand for 3 nanometer chips. The output value of memory-related products is expected to grow by 22.4% in 2024, with an output value of NT$ 208.2 billion (US$ 6.4 billion).

*Figure 11: Output Value of Taiwan's IC Design Industry by Quarter: 2022Q1-2024Q1*

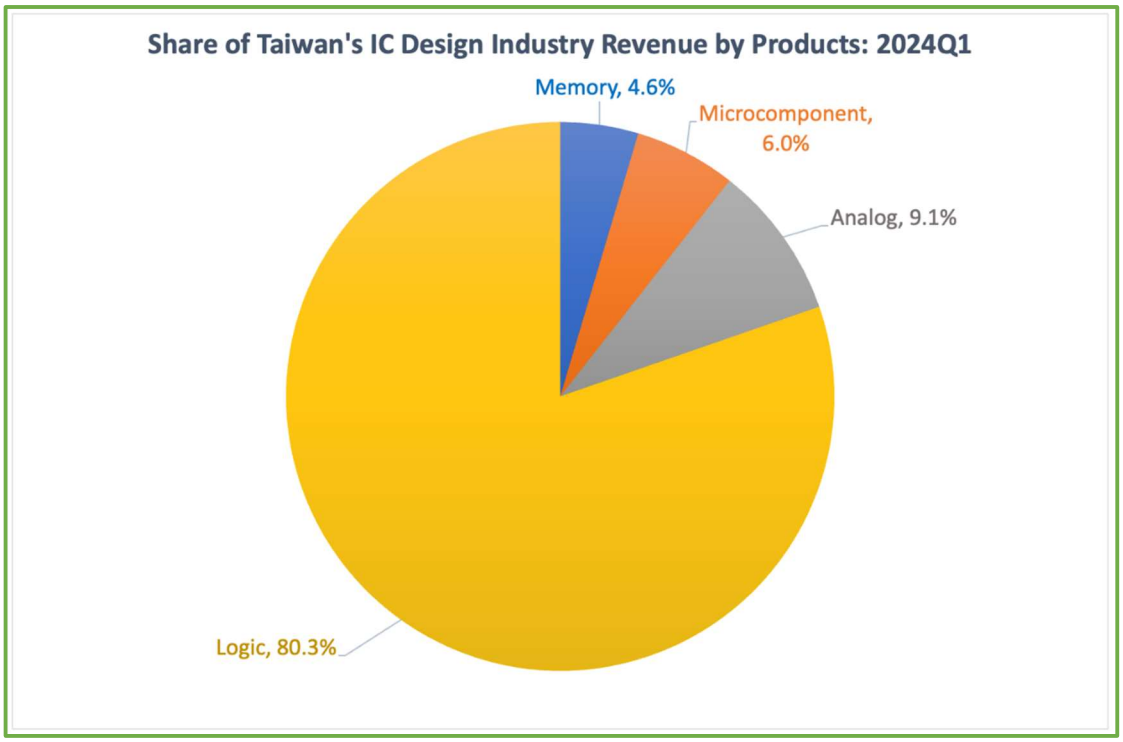



Source: Hsuan-Chih Wang," 2024 Q1 Industry Dynamics of IC design industry in Taiwan," IEK, ITRI, June 4, 2024, p. 1.

Figure 11 shows the quarterly output value of Taiwan's IC design industry from the first quarter of 2022 to the first quarter of 2024.

In the first quarter of 2024, output value of Taiwan's IC design industry has stabilized as inventory turnover sees some improvement. In the end-consumer market, robust demand in the personal computer sector, automotive industry, and network communications has contributed to a non-seasonal recovery in the semiconductor industry. Despite being the off-season, Taiwan's IC design industry remains resilient. Specifically, Taiwan’s IC design industry exhibited a slight upward trajectory in the first quarter of 2024, achieving an output value of NT$ 300.2 billion (US$ 9.3 billion)—a 0.1% increase compared to the fourth quarter of 2023, and an increase of 25.1% from the same period last year.

*Figure 12: Share of Taiwan's IC Design Industry Revenue by Products: 2024Q1*

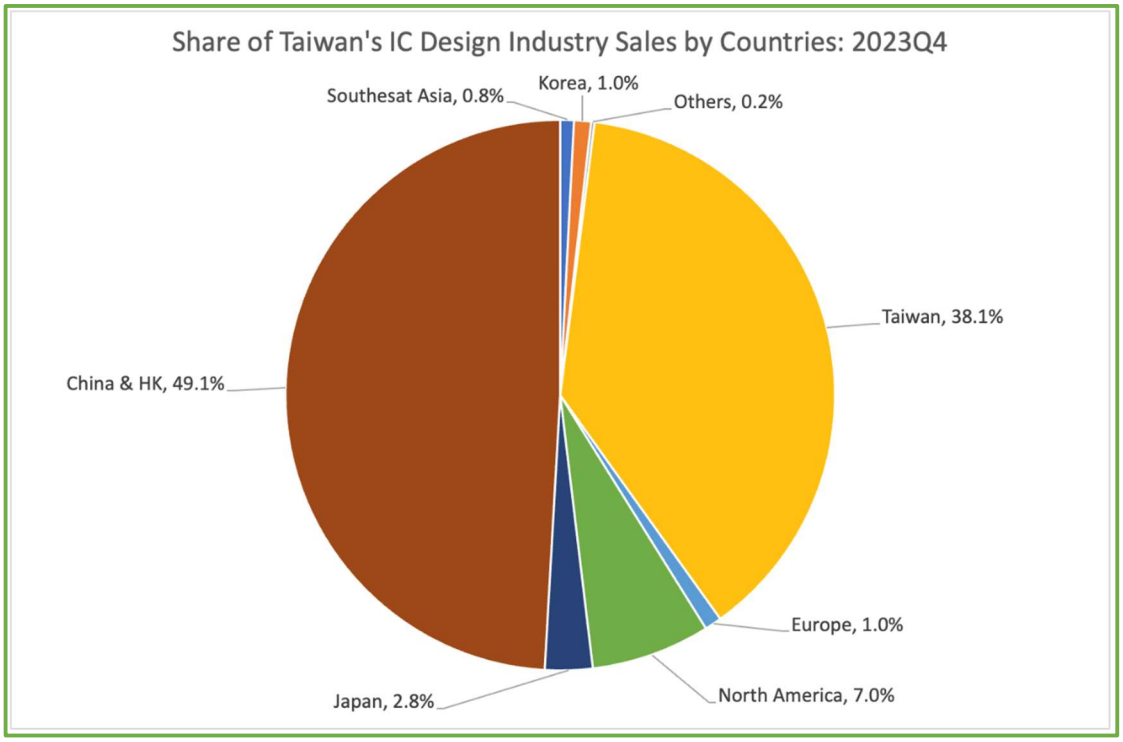



Source: Hsuan-Chih Wang," 2024 Q1 Industry Dynamics of IC design industry in Taiwan," IEK, ITRI, June 4, 2024, p. 2.

Figure 12 shows the share of Taiwan's IC design industry revenue by chip type in the first quarter of 2024. Taiwan's IC design companies primarily focus on logic chips (Logic IC), which include mobile phone chips, Netcom chips, and display driver chips. In the first quarter of 2024, logic chips accounted for 80.3% share of Taiwan's IC design industry revenue.

In contrast, analog, microcomponent and memory chips together account for 19.7% share of Taiwan's IC design industry revenue in the first quarter of 2024. Micro components, which include chips like microcontrollers (MCU), microprocessors (MPU), and digital signal processors (DSP), accounted for 6.0% share of Taiwan's IC design industry revenue. Analog chips, such as power management chips and audio processing chips, accounted for 9.1% of the market. Additionally, despite the rebound in consumer memory prices, Taiwan-related companies are actively targeting the High-Bandwidth Memory (HBM) market used in AI chips. As a result, Taiwan's memory chips accounted for 4.6% share of Taiwan's IC design industry revenue in the first quarter of 2024.

*Figure 13: Share of Taiwan's IC Design Industry Sales by Countries: 2024Q1*




Source: Hsuan-Chih Wang," 2024 Q1 Industry Dynamics of IC design industry in Taiwan," IEK, ITRI, June 4, 2024, p. 3.

Figure 13 shows the breakdown of Taiwan's IC design market share by countries in the first quarter of 2024.

China/Hong Kong remain the dominant market, accounting for 49.1% of Taiwan's IC design industry sales. Domestic demand within Taiwan constitutes the second-largest market share, contributing 38.1% to the industry. Chip sales to customers in North America, Japan, Europe and Southeast Asia account for 7.0%, 2.8%, 1% and 0.8% of the market respectively.

According to Taiwan's Industrial Technology Research Institute (ITRI), the outlook for Taiwan's IC design industry in 2024 appears promising. The main reasons include a rebound in consumer demand, the trend of AI mobile phones driving the popularization of high-end mobile phones, AI-powered personal computers and edge artificial intelligence hardware with high growth potential gaining traction, and the expanding deployment of network communication equipment. Together, these factors foster favorable conditions for technological upgrading and contribute to the growth of the output value of Taiwan's IC design industry. The estimated output value of Taiwan's IC design industry in 2024 is NT$ 1,261.7 billion (US$ 30.9 billion), representing a 15.1% increase compared to 2023.

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