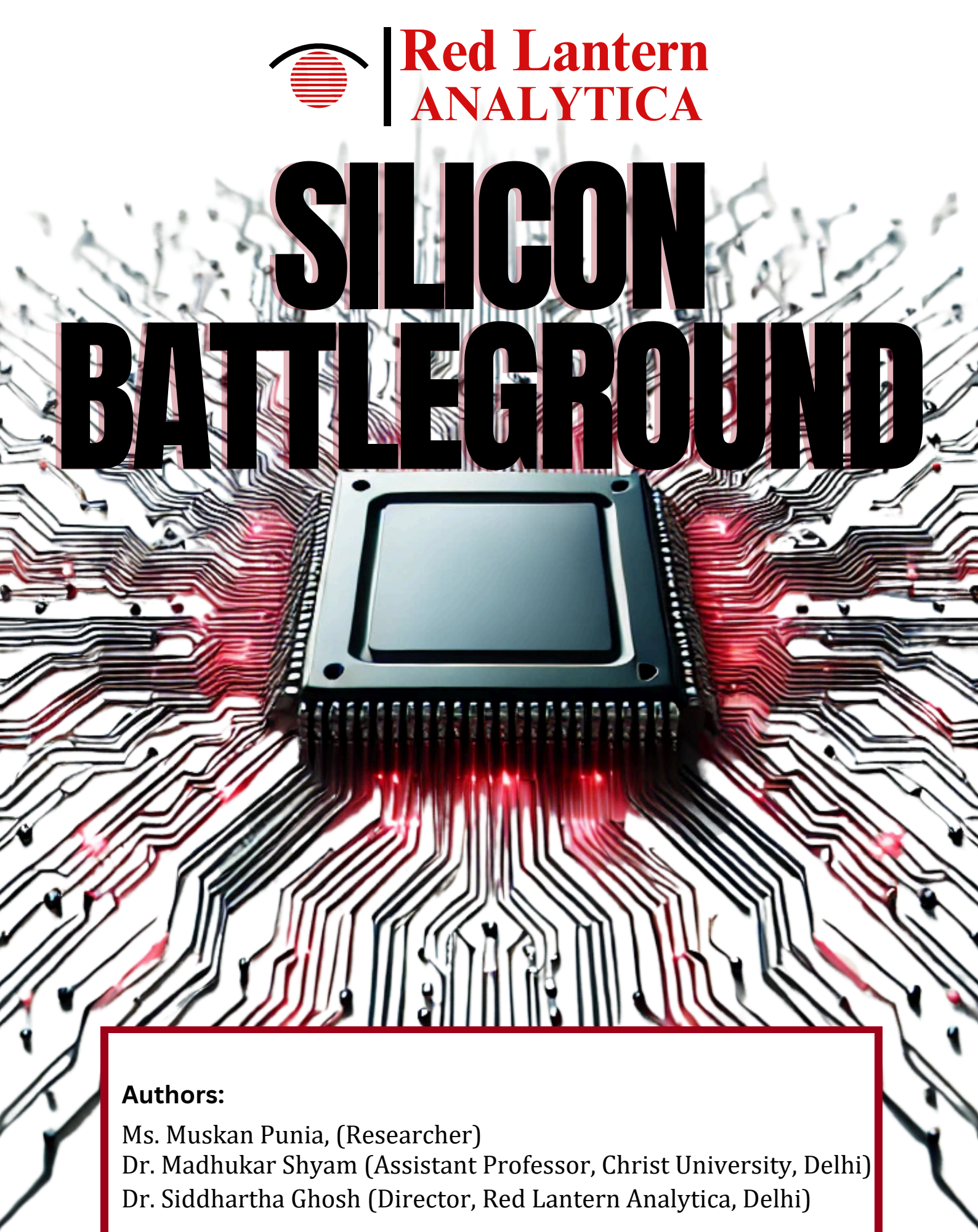
Red Lantern
ANALYTICA

# SILICON BATTLEGROUND

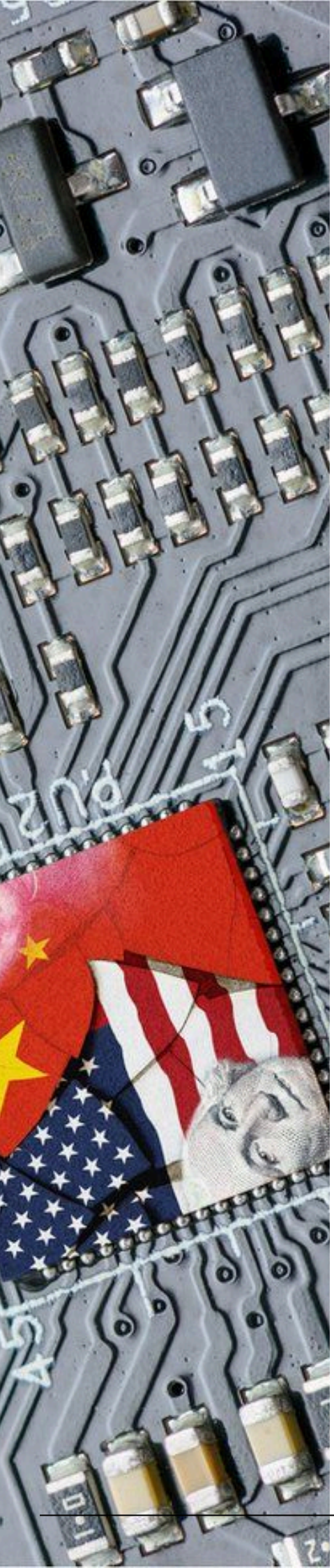



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# Introduction

Semiconductors, also known as microchips or integrated circuits, are a crucial component powering everything from smartphones, laptops, dishwashers, and automobiles to medical services, energy technologies and military equipment. With time, their size shrank, reaching nanometres. Though small, they can contain as many transistors as all the stones in the Great Pyramid of Giza[1], delivering immense computing power. The smaller the size, the higher the computing power; hence, there is a race and competition to build and acquire the smallest chips, which also become the most advanced.

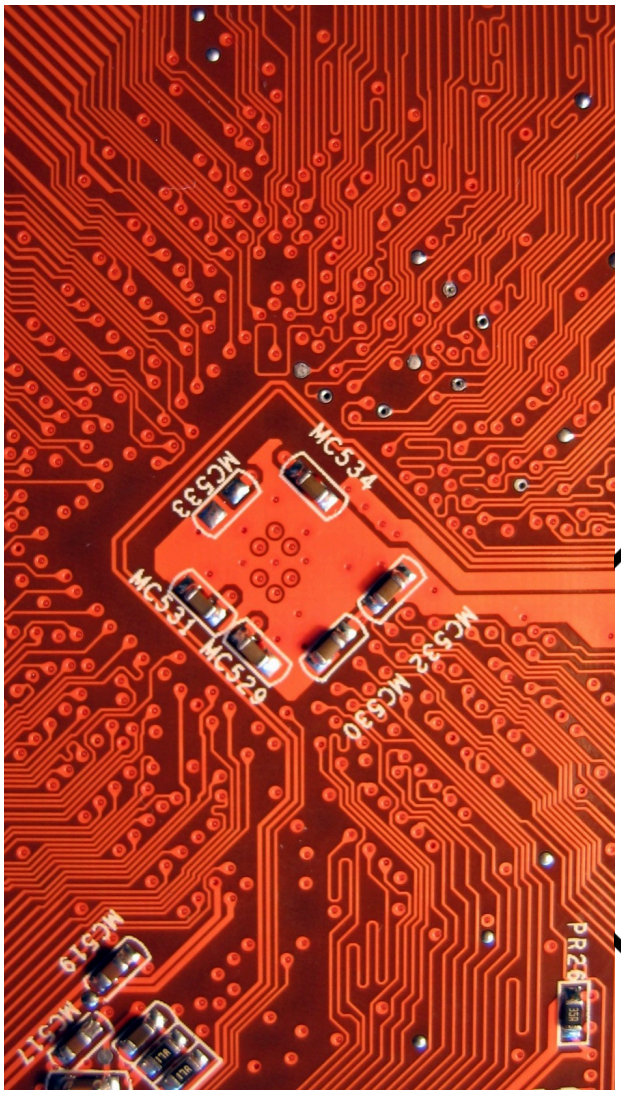
With semiconductors at the heart of a $500 billion industry projected to double by 2030[2], governments worldwide recognize the strategic importance of semiconductors; hence, they are making new laws and investing heavily in strengthening domestic production. Currently, the UK, the US, Europe, and China remain highly dependent on Taiwan, i.e., the Taiwan Semiconductor Manufacturing Company (TSMC), which supplies over half of the world's semiconductors to companies like AMD, Apple, ARM, Broadcom, Marvell, MediaTek, and Nvidia.

It produces over 90% of the world's most advanced chips, especially those with cutting-edge 5nm and 3nm process nodes.[3] However, disruptions caused by the COVID-19 pandemic and geopolitical tensions between the US and China have exposed the vulnerabilities and dependence of these countries on the supply chain, which was spread out due to globalisation. Semiconductors were invented in the US, but over time, East Asia emerged as a manufacturing hub, largely because of government incentives, including subsidies[4]. While the USA dominates in Design (fabless companies like Nvidia), the Netherlands (ASML) in high-tech Lithographic machines, and Japan in chemicals, TSMC does most of the manufacturing.

Still, China's threat to the reunification of Taiwan, even though it means resorting to force, has only increased these vulnerabilities.[5] The US is increasingly investing to bring chip manufacturing within its borders, with TSMC committing to triple its planned investments in Phoenix, Arizona, in 2022.[6] However, delays have surfaced due to a shortage of skilled workers, a gap India is working to fill.[7] In the early 2000s, integrating China into the global community was considered a strategic decision, believing economic interdependence would promote stability and mutual economic gain. However, China used this economic partnership to implement a "Military-Civil Fusion" plan[8], which uses civilian technology—much of it from US partners—to strengthen its military capabilities. The United States and its allies dominate over 90 % of global semiconductor equipment manufacturing, and China relies heavily on foreign sources for chips. The USA uses this leverage to slow China's chip industry growth, particularly in artificial intelligence (AI).

They're adopting a "small yard, high fence" approach where restricted technologies will be comparatively small, but the restrictions will be extremely stringent.[9]

One key conclusion, however, is that there is "no way back" to the global semiconductor ecosystem that existed before the pandemic. The U.S. chip supply chain is too alarming to allow a reversion. Further, Chinese perceptions of the United States' supplier reliability have also changed.[10]



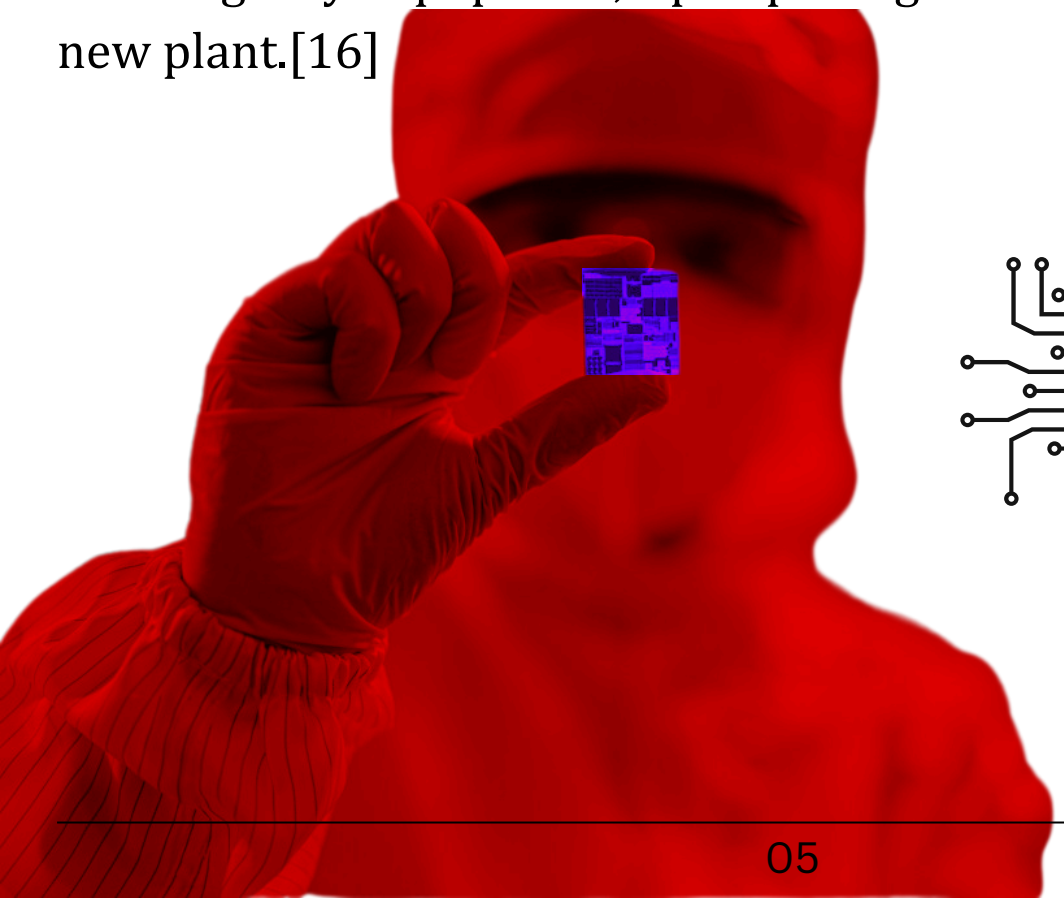

## China's chip war with the US

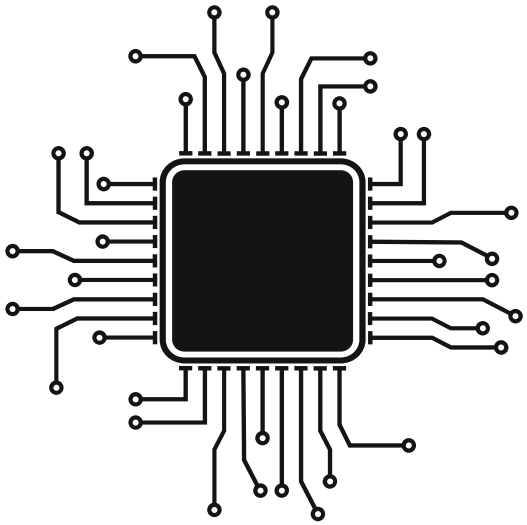
Since the export controls, Chinese semiconductor output plummeted by 17 % in early 2023.[11] Furthermore, the US restrictions on Chinese access to Nvidia's A100 and H100 chips and Dutch firm ASML's most advanced extreme ultraviolet (EUV) lithography tools restrict China's ability to produce advanced chips at the 2 and 3nm nodes.[12] The Netherlands later announced new rules restricting exports of computer chip technology to China following pressure from the US.[13] Japan restricted exports of 23 types of semiconductor manufacturing equipment, of which Japan holds a near or total monopoly.

This can impede Chinese chipmaking in the advanced nodes and capacity expansions for 14- and legacy 28-nanometer nodes.[14] However, there are gaps between U.S. and allied systems of export control, leaving substantial leaks in the restrictive net envisioned by U.S. policymakers.

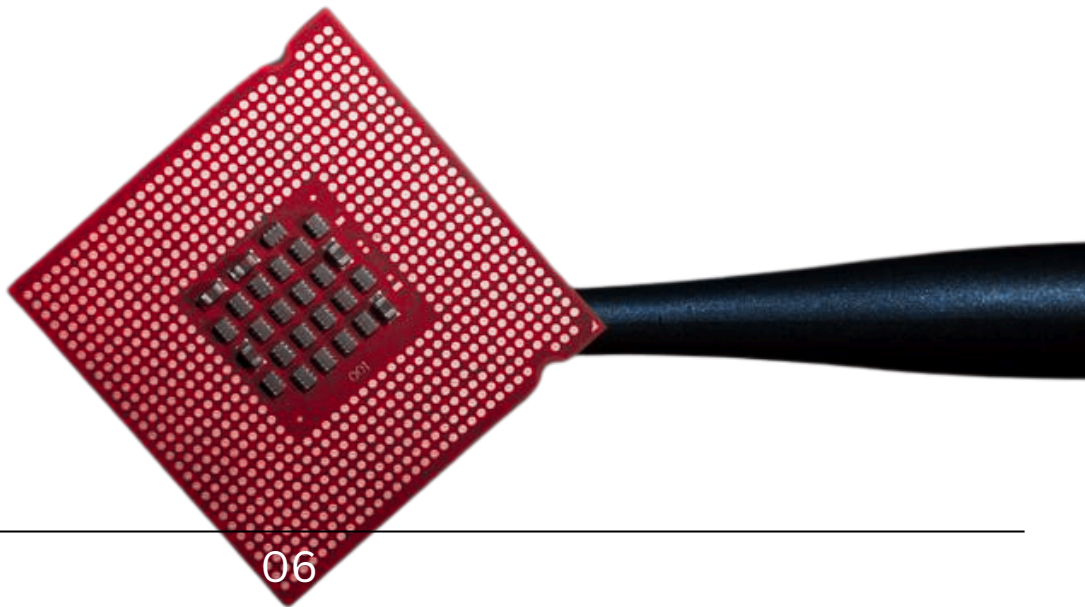
While the USA maintains an "entity list" of foreign companies and other entities barred from procuring designated technologies, Japan does not have a similar list. In contrast to U.S. controls, Japan and the Netherlands do not explicitly designate China as a country of concern. These firms operate in different parts of the semiconductor ecosystem, and their commercial interests do not share U.S. views of strategic competition.[15]

The impact was felt in February 2023 when China's largest semiconductor foundry, Semiconductor Manufacturing International Corporation (SMIC), warned about "difficulties in securing key equipment," postponing mass production at their new plant.[16]

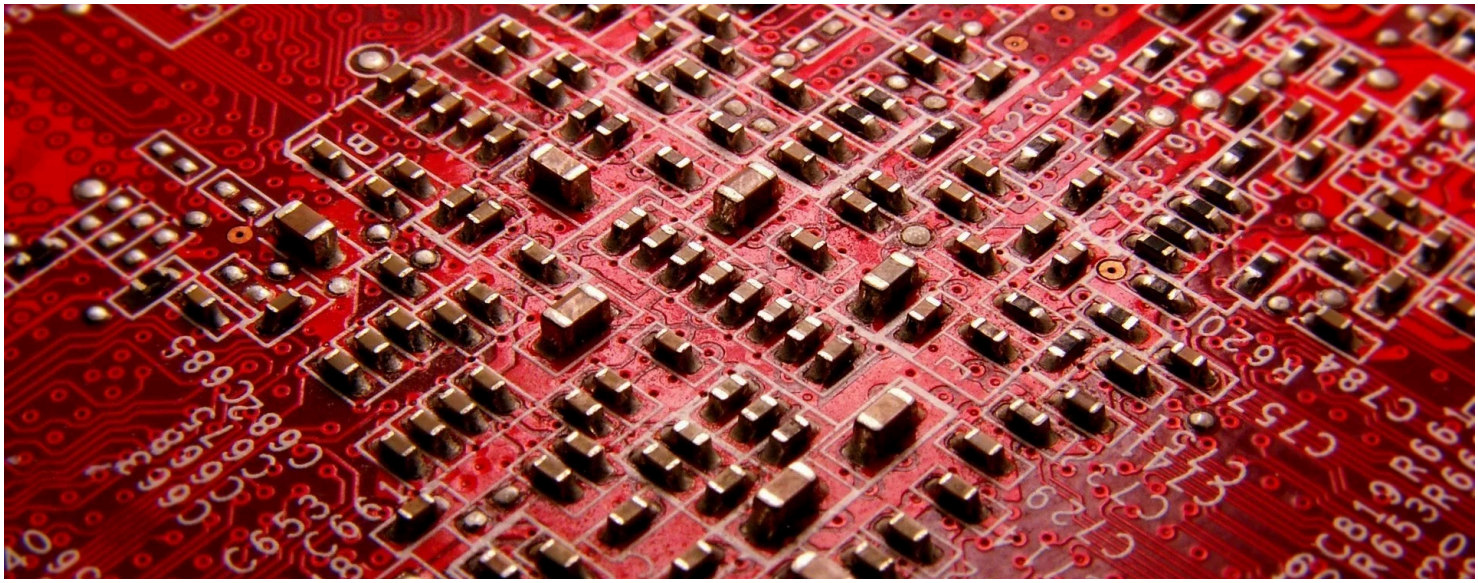




However, Chinese tech giants stockpile high bandwidth memory (HBM) semiconductors from Samsung Electronics, accounting for about 30% of Samsung's HBM chip revenue in the first half of 2024. HBM chips are crucial components in developing advanced processors, such as Nvidia's graphics processing units, that can be used for generative AI work.[17] However, China has leverage in other key areas of the semiconductor supply chain—mainly rare earth elements essential for making chips. China extracts 60 % of the world's rare earth minerals and handles over 85 % of processing. China has restricted gallium and germanium exports in response to US export controls.[18] The semiconductor export controls have significant consequences. In US chip companies, 30–40 % of sales go to China, causing substantial financial risks due to the loss of the Chinese market. The US Chamber of Commerce in China projects that this could result in an annual loss of $83 billion in sales and 124,000 jobs.[19] Paradoxically, these export controls may also catalyze China's efforts to establish an independent semiconductor supply chain. In 2023, Huawei released the Mate Pro 60, featuring a 7nm chip produced by SMIC, a feat previously thought impossible without restricted extreme ultraviolet technology machines. While full replacement of US suppliers will take time, the incentives for this transition are now firmly in place.[20]

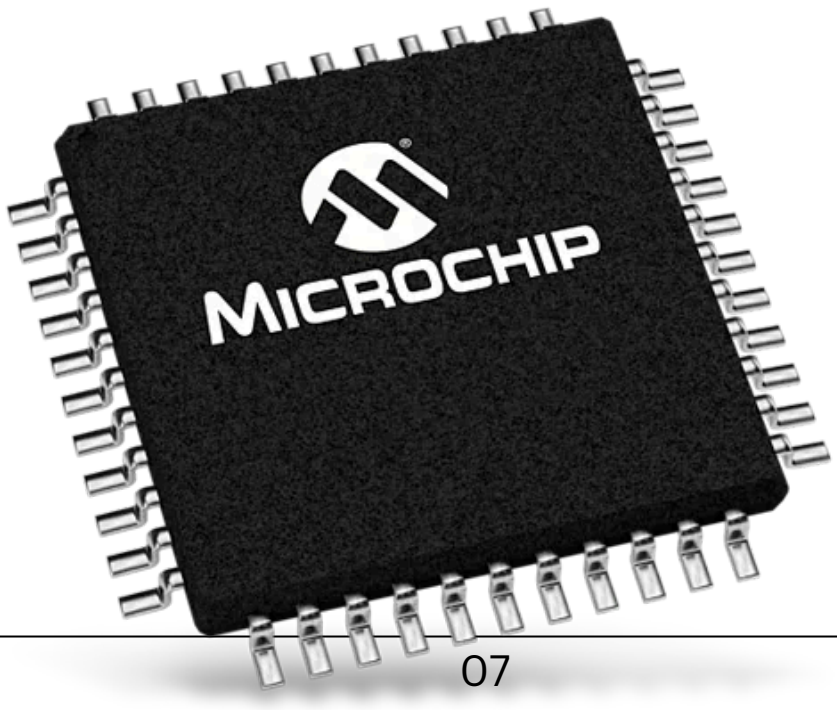


# China's Response to US Sanctions



Chinese military and affiliated institutions have reportedly purchased Nvidia's advanced H100 chips in small batches despite U.S. controls.[21]

Loopholes in U.S. export controls have allowed Chinese firms to obtain restricted semiconductor technologies, including 7nm chips developed using foreign equipment. As recently as January 2023, Chinese military and affiliated institutions have purchased Nvidia's most advanced H100 chips from sources within China in small batches, suggesting controlled chips are making their way into China.[22] Moreover, the SMIC can secure European and U.S. equipment to manufacture chips for Huawei's new smartphone.



US companies, too, to save its market, like Nvidia, are finding loopholes and rolling out three new AI graphics cards tailor-made for the Chinese market, balancing peak performance while staying in step with the latest US rules.[23]

Even companies on the US Entity List have found ways to access powerful computing resources through the cloud. For example, iFlytek, a Chinese AI firm blacklisted due to human rights concerns, has legally rented high-performance Nvidia chips via cloud services despite sanctions.[24]

Chip smuggling has also emerged to bypass export controls. Reports show entire servers housing top-tier Nvidia chips are being traded on the black market. Some cybersecurity experts suggest fitting server racks with global positioning system trackers to monitor their locations and usage.[25]

Hence, despite increasing investments in the semiconductor industry over the years, China remains dependent on the U.S. for high-end integrated circuits. The country's annual chip imports have surpassed crude oil in recent years, reaching $312 billion in 2018,[26] with a localization rate below 8% as of 2021,[27] and the national semiconductor investment funds having committed only about 4% of their total semiconductor investments to the equipment sector.[28]



## China's Countermeasures Against U.S. Restrictions

In May 2023, China barred key domestic infrastructure operators from purchasing products from U.S. memory chipmaker Micron Technology.[29] In July 2023, China imposed licensing requirements on exports of rare-earth metals like gallium and germanium, which are crucial for semiconductor manufacturing.[30]

## Strategic Plans for Technological Self-Reliance

The 20th National Congress of the Communist Party identified trade conflicts with the U.S. as an 'economic main battlefield.'[31] Under the 'Made in China 2025' strategy, China aims for 80% self-sufficiency in semiconductor consumption by 2030 (up from 24% in 2020).[32] China is prioritizing innovation in legacy chips, which still account for a significant portion of global semiconductor consumption. China could potentially control the supply chain for these critical components by investing heavily in legacy chip manufacturing.




Chinese firms already excel at efficiently producing these higher-node chips, accounting for most of global semiconductor consumption. China's increasing investments in manufacturing legacy chips, especially in the aftermath of export controls on advanced chips, may enable it to build more legacy chip fabs in the next few years than the rest of the world combined. Today, almost three-quarters of the manufacturing capacity for legacy chips is based in Taiwan and China, resulting in the same supply chain dependence as for advanced chips.[33]

China continues to expand its semiconductor industry, moving beyond assembly and packaging to manufacturing. The Boston Consulting Group's annual roster of the top 50 innovating companies in the world now includes Chinese firms such as Alibaba, Lenovo, Huawei, Xiaomi, JD.com, and Tencent. Moreover, China's leading chip foundry, SMIC, has narrowed the gap with world-leading semiconductor firms from trailing several generations in 2000 to several years behind now.[34]

# Opportunities for India

On 31 January 2023, India and the United States announced the joint initiative on Critical and Emerging Technology (iCET). As part of the iCET, the Semiconductor Industry Association in the U.S. and India's India Electronics Semiconductor Association (IESA) agreed to undertake a “readiness assessment" to identify near-term industry opportunities and facilitate the longer-term strategic development of their complementary semiconductor ecosystems.

In terms of readiness, India, in recent years, has demonstrated consistent improvement in global competitiveness indices such as the World Intellectual Property Organization (WIPO) and Global Innovation Index (GII) from 46th in 2021 to 39th in 2024[35],



innovation output- 45th to 33th [36] the Logistics Performance Index (LPI)—44 in 2018, to 38 in 2023[37], and the World Bank Ease of Doing Business report from 142nd in 2014 to 63rd in 2019.[38] Additionally, India is offering $30 billion in support for semiconductors and related industries, including $10 billion for the semiconductor/display sector, $7 billion for electronics manufacturing, and $13 billion for related sectors—such as solar photovoltaic cells, electric and other automotive vehicles, and white goods.[39] Since electricity supply is crucial in attracting semiconductor manufacturing investment, the Indian Union government has invested considerably in increasing electricity production and developing reliable and redundant electricity grids. India's installed capacity of 410 gigawatts (GW) is now the world's third largest[40], at least 172 GW, being renewable power, aiming to achieve 500 GW by 2030[41]. Policies like the Semiconductor policy by the government of Gujarat (2022-27) prove India's will to attract FDI.

It will give 75% subsidies on the first 200 acres of land purchase and, 50% on the subsequent purchase, 50% capital subsidy for the desalination plant for the initial 5 years to ensure a good quality and uninterrupted supply of water. More incentives like one-time reimbursement on stamp duty, power tariff subsidy and so on[42]

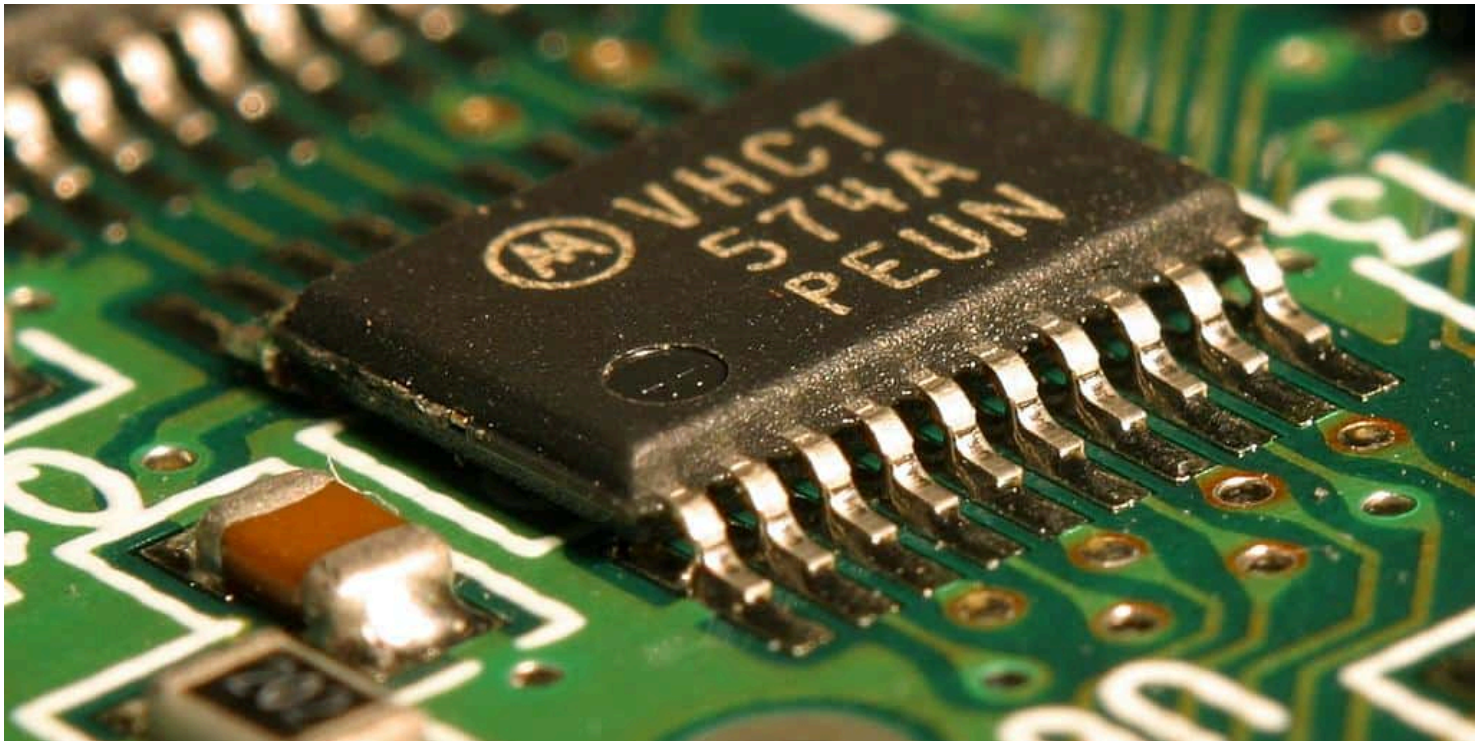
Moreover, India boasts several competitive advantages in the semiconductor industry. Its large, highly skilled workforce is a major draw for global companies. Reports suggest that 19% of the world's chip designers are based in India, reflecting its strength in semiconductor design[43]

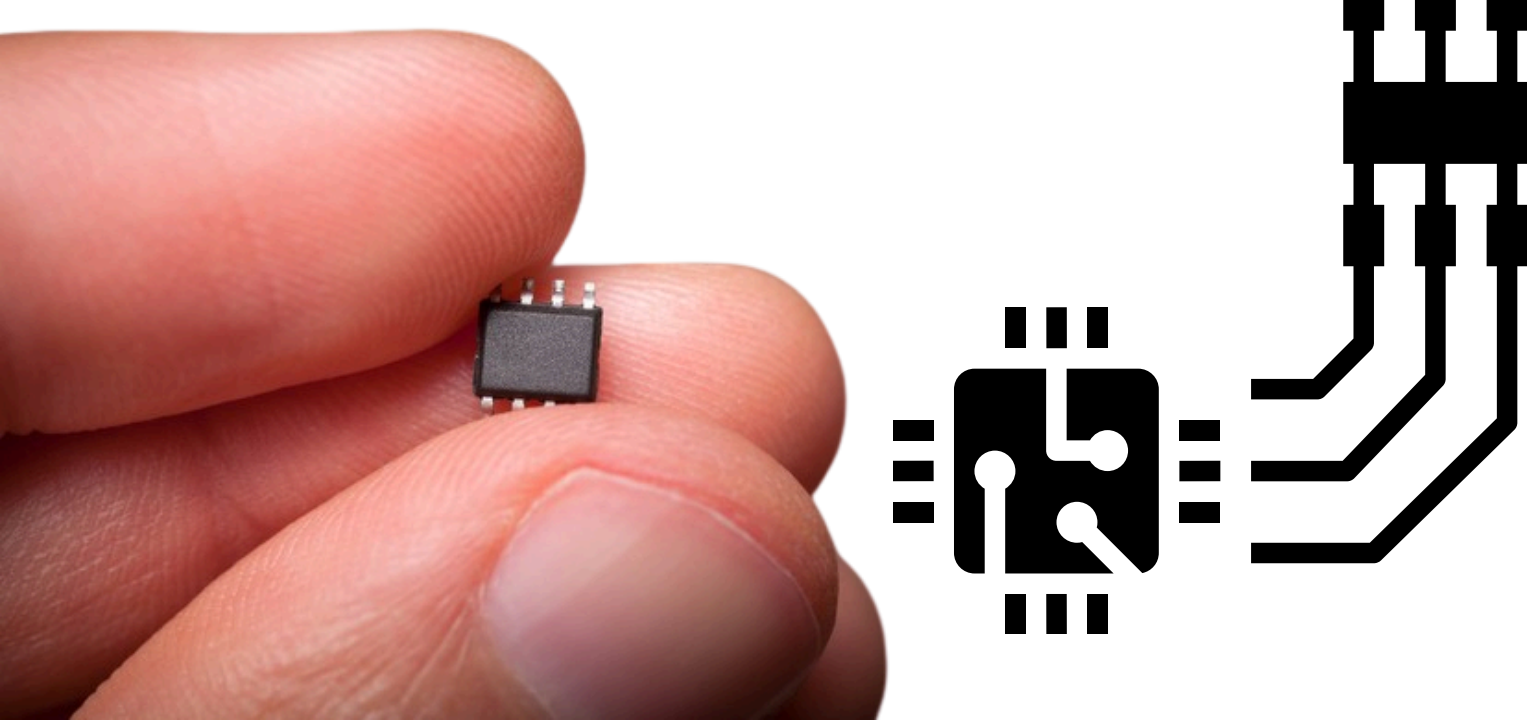
# How is India faring amidst global competition?

India imports a staggering $2.38 billion of semiconductor devices from countries like China, Singapore, Hong Kong, Japan, and the United States. Despite being the global leader in semiconductor chip design, India imports 100% of its semiconductors. However, there is immense scope for growth, as the Indian semiconductor market was valued at $15 billion in 2020 and is expected to reach $63 billion by 2026, which is projected to have a 10% share globally.[44] However, India will require 1.5 million skilled workers and 5 million semi-skilled workers in the semiconductor sector by 2026-27.

While 19% of the world's chip designers are in India the country accounts for only 7 percent of chip design facilities. China has 28% of the world's chip designers and 12% of design facilities[45]

In December 2021, India established the India Semiconductor Mission (ISM) to implement federal policies and incentive programs to attract semiconductor-sector investments and



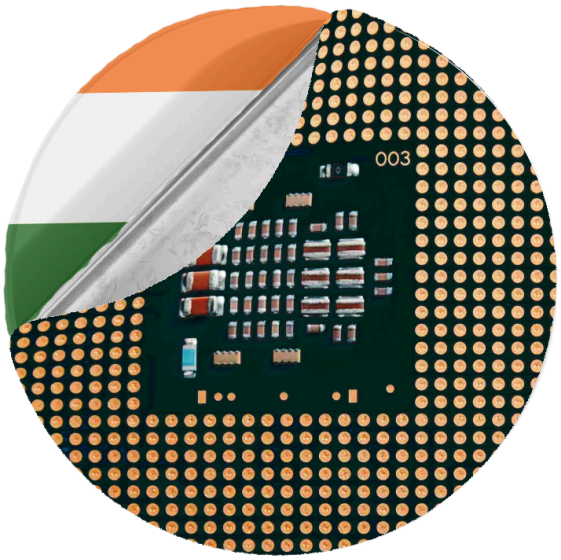


and incentive programs to attract semiconductor-sector investments and incentivise local production across key production phases: design, fabrication, and ATP (assembly, testing, and packaging). Additional incentives like the Indian government would reimburse 50% of the fab cost on a pari passu basis (i.e., extending funds upfront), with a state partner to contribute an additional 20% for a fab worth at least $2.5 billion making[46] 40,000 wafer starts per month (WSPM).[47]

It was launched with a budget of ₹76,000 crores, Rs 65,000 crore for chip manufacturing and packaging units, Rs 10,000 crore for modernising the semiconductor lab at Mohali and Rs 1,000 crore for the design-linked incentive scheme.[48]

The initiative has already attracted ₹1.5 trillion in investments from key industry players such as Micron, Tata Electronics, CG Power, and Kaynes Technology. Under this mission, recently, Tata Electronics pledged an investment of Rs 91,000 crore to establish a semiconductor fabrication unit in the Dholera Special Investment Region (SIR), with a production capacity of 50,000 wafer starts per month (WSPM).[49]

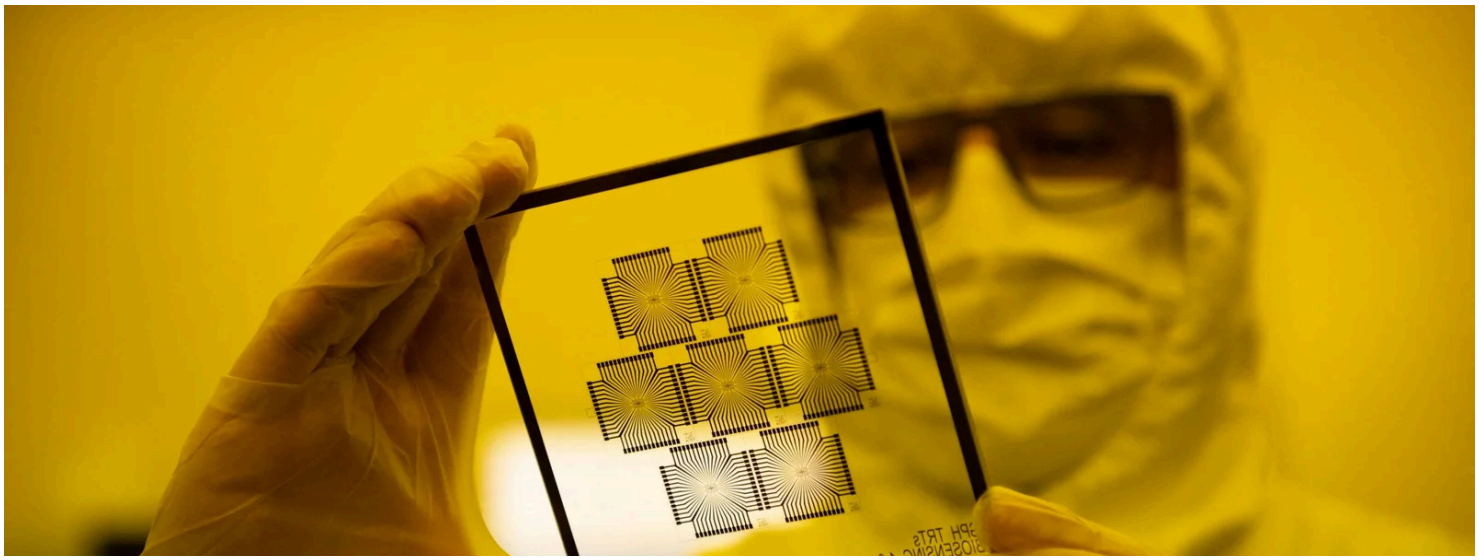
# Recent Approvals and Partnerships



India signed an MoU with Singapore to establish a partnership in the semiconductor industry in September 2024. Within a few weeks, there was an agreement with the US to establish a joint semiconductor fabrication plant in India.[50]

Maharashtra's government approved a semiconductor fabrication unit to be established jointly by the Adani Group and Israel-based Tower Semiconductor for an investment of about Rs 83,947 crore ($10 billion). The unit in the first phase will see an investment of Rs 58,763 crore and produce 40,000 semiconductor wafers monthly and an investment of Rs 25,184 crore, and a production capacity of 80,000 wafers per month in the second phase.[51]

The Union Cabinet approved setting up an Outsourced Semiconductor Assembly and Test (OSAT) facility in Sanand, Gujarat, by Kaynes Semicon, with an investment of ₹3,307 crore. This facility will have a daily production capacity of 63 lakh chips.[52] Taiwan's Powerchip Semiconductor Manufacturing Corporation (PSMC) and Tata Electronics in March 2024 launched Dholera Semiconductor Fab to build a 28 nm fab plant. India's first semiconductor fab in 30 years.



The Indian government funds 70% of the investment, while Tata Group covers the rest. PSMC oversees technology transfer and employee training.[53]

Apple is in talks with Micron, the Tata Group, and other Indian semiconductor manufacturers to source its devices' $12 billion worth of components.[54]

The Taiwanese Company Hon Hai Precision Industry Company Ltd, also known as Foxconn, is the world's biggest contract electronics manufacturer and a principal assembler of Apple iPhones. Both companies seek to diversify away from China, where much of their manufacturing is based and manufacture in India with Plants in Bengaluru, Chennai and Hyderabad. [55]

FOXCONN and Hindustan Computers Limited (HCL) Group are planning a joint venture to set up a Semiconductor outsourced assembly and testing unit to ensure supply-chain resilience even after the completion of the project.[56]

A research firm, Elara Securities, reported that Japan is training Indian workers, while Taiwan invests in Southeast Asian semiconductor clusters. Strengthening such collaborations could provide the much-needed expertise and investment to bolster India's semiconductor ecosystem. [57]

India can be a key supplier of talent and know-how to produce the scientists, engineers, and technicians. Recently, the Union Minister of Electronics and IT, signed an MoU with Purdue University for capacity building, research and development, and industry participation.[58]

Global chipmaker AMD recently opened its largest global design centre in Bengaluru, which is a part of its $400 million investment in India.[59]

## Challenges and Limitations of Chip Manufacturing in India

Building new fabs has enormous costs of building new fabs. In 1983, constructing a bleeding-edge semiconductor fab cost about $200 million. By the early 2020s, that price rose to $20 billion. The enormous investments required for the "fab model" seem risky for India as the prospect of achieving technological sovereignty in semiconductor fabs cannot be guaranteed.[60] The fabrication process is highly resource-intensive, requiring a steady power supply and vast amounts of "ultrapure water" to clean silicon chips. A typical facility today can consume up to 10 million gallons of ultrapure water daily. This could put more pressure on India's already stressed water systems, and the power supply demand could impede the national mandates on net-zero targets.[61]

As the fab model expands, the talent and skills gap is also a concern. The 2022 National Skill Development Corporation (NSDC) report finds the supply of skilled workers needed to operate the semiconductor manufacturing plants falling short of the demand. Another report by Team Lease Degree Apprenticeship projects India to

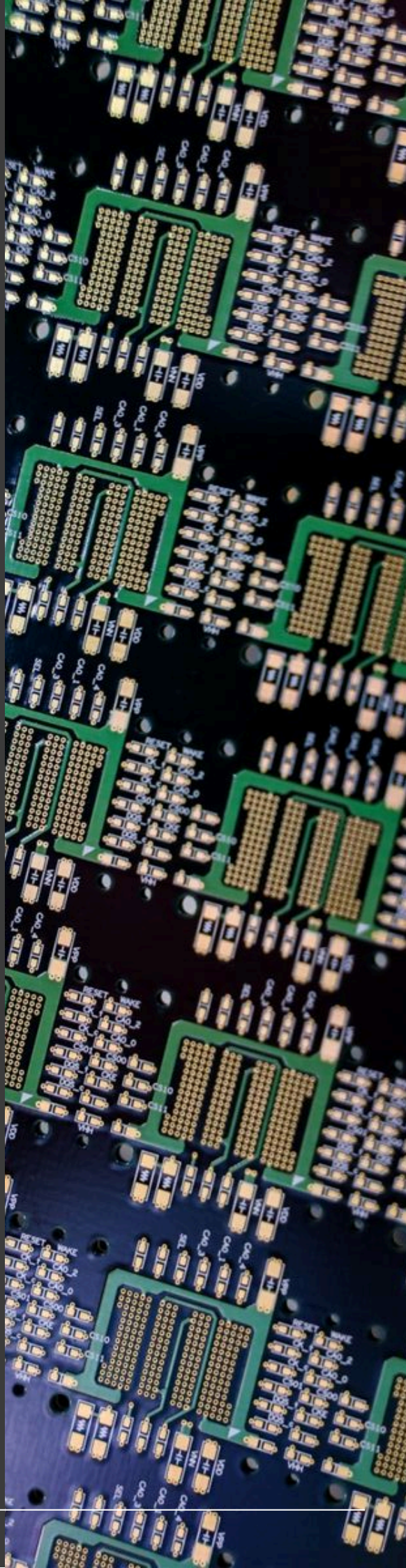
encounter a shortage of 250,000 to 300,000 professionals in the semiconductor industry by 2027.[62] India's over-reliance on imports, particularly from China, for critical minerals essential for chip manufacturing, including Rare Earth Elements (REEs) is another concern. India has only utilized 10-20 % of its exploration capacity for critical minerals.[63]

## Way Ahead:

The trade war has provided India the best alternative to China, providing incentives as well as the country's cost advantage, making it an attractive destination for firms looking to diversify their supply chains. India, which has friendly relations with most countries, is already leveraging its relationships with them to attract more investments. India could adopt a more feasible semiconductor strategy by focusing on the back-end manufacturing stage of ATP, which transforms silicon wafers from front-end fabs into finished chips ready for



electronic devices. ATP is a relatively easier segment to enter for India due to lesser capital but more labour-intensive requirements than front-end production. MNCs set up ATP facilities to a larger extent in developing countries. As Chris Miller, author of Chip Wars, noted, Korea, Taiwan, and Singapore initially entered the chip industry through ATP advancing to fabrication. There has been some progress in this direction, such as the government recently approving Tata's Rs 27,000 crore investment for a greenfield facility in Assam that will focus on the assembly and testing of semiconductor chips. Electronics manufacturers that have shifted production to India are already taking advantage of this ATP focus. Apple, for instance, is in talks with Micron, the Tata Group, and other chip manufacturers establishing facilities in India to source $12 billion worth of components for its devices[64] and is expected to produce one-quarter of its smartphones in India by 2025, demonstrating India's growing ability to attract major manufacturers like Foxconn and produce high-value ICT goods.[65]



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