Semicon India 2.0: From capacity creation to ecosystem leadership

September 2026

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Foreword

India Semiconductor Mission (ISM)

The Ministry of Electronics and Information Technology (MeitY) has been leading one of India's most strategically significant industrial transformations: establishing a robust semiconductor ecosystem that strengthens technological self-reliance, enhances global competitiveness, and supports long-term economic growth. Through India Semiconductor Mission (ISM), the Government has adopted a holistic approach that goes beyond attracting individual investments to building the foundational capabilities required for a sustainable semiconductor industry. With an outlay of ₹76,000 crore, Semicon 1.0, the first phase under ISM, has delivered significant progress in a short period of time. As of 2026, 12 semiconductor projects across fabrication, compound semiconductors, and ATMP/OSAT have been approved, with cumulative investments of approximately ₹1.64 lakh crore. Several of these facilities have already commenced commercial production and started exporting, marking a significant step in India's journey towards becoming a trusted and globally competitive semiconductor manufacturing hub.

These developments mark an important first step in establishing India's semiconductor manufacturing base. The progress has extended beyond manufacturing into the semiconductor design, where India already accounts for more than 20% of global design talent. Through the Design Linked Incentive (DLI) Scheme and related initiatives, the Government has supported a growing base of semiconductor design startups and innovators, enabling multiple tape-outs at leading global foundries and contributing to the development of indigenous processor ecosystems. At the same time, expanded access to industry-grade EDA tools across hundreds of academic institutions and tens of thousands of engineers is strengthening the talent pipeline needed to sustain this growth. Together, these efforts are helping translate India's strong design capabilities into greater domestic ownership of semiconductor intellectual property, innovation and technology.

The experience of Semicon 1.0 has also taught us that the long-term competitiveness requires capabilities that extend across the wider semiconductor ecosystem. In this context, the Government launched Semicon 2.0, the second phase under ISM, with an enhanced outlay of ₹1,27,500 crore. Building on the foundation laid by the first phase, Semicon 2.0 seeks to strengthen the complete semiconductor ecosystem through a comprehensive six-pillar approach spanning across Design, Machines and Materials, Fabrication, Packaging, Research and Development, and Talent Development, thereby extending support across the entire semiconductor value chain.A key feature of Semicon 2.0 is the introduction of targeted support for segments that are critical to building domestic value addition. The dedicated incentives have been introduced for manufacturing of semiconductor-grade materials, specialty chemicals, gases, substrates, equipment, and testing infrastructure, creating opportunities for a wider network of suppliers and ecosystem players to participate in India's semiconductor growth story. It further seeks to accelerate innovation through enhanced support for research and development, and talent creation. Support for common design infrastructure, deployment-linked incentives, seed funding and research initiatives is expected to enable startups, MSMEs, research institutions and industry to translate innovation into commercially scalable and globally competitive solutions.

This report, jointly developed by EY and the India Electronics and Semiconductor Association (IESA), chronicles the progress of India's semiconductor ecosystem, assesses the impact of recent policy interventions, and identifies strategic priorities for the next phase of growth. The recommendations presented in this roadmap offer valuable perspectives on strengthening ecosystem capabilities, fostering innovation, and enhancing India's position within global semiconductor value chains.

With sustained policy support, focused execution, and strong stakeholder partnerships, India is well positioned to emerge as a trusted and globally competitive semiconductor ecosystem.

Amitesh Kumar Sinha
CEO, ISM and Additional Secretary, MEITY

India Electronics and Semiconductor Association (IESA)

India's semiconductor journey has entered a defining phase. **Semicon 1.0 (Semicon India program) has transformed intent into tangible outcomes**—with 12 semiconductor manufacturing projects approved, an investment pipeline of approximately 1.64 lakh crore, 23 chip tape-outs completed and three semiconductor units already commencing production and exports and two more production status announced during SEMICON India 2026 event. These milestones have laid the foundation for India's transition from a design-led semiconductor presence to a broader manufacturing ecosystem.

Semicon 2.0 marks the next critical shift—from capacity creation to ecosystem leadership. Its expanded focus on design, manufacturing, advanced packaging, materials, equipment, R&D and talent recognises that sustainable semiconductor leadership is built across the entire value chain.

India now has a unique opportunity to combine its strengths in engineering talent, electronics demand, design capabilities and emerging manufacturing capacity with resilient global supply-chain partnerships. The next phase will be defined by **execution, innovation, technology commercialisation, indigenous IP, specialised talent and ecosystem depth**.

This joint report by **IESA** and **EY** seeks to contribute to that momentum by bringing together industry insight, global benchmarks and actionable perspectives on the opportunities emerging under Semicon 2.0. **By connecting policy, industry, investors, technology providers and the wider ecosystem, IESA and EY can help translate this momentum into sustained capability, investment and global competitiveness for India**.

India has moved beyond semiconductor ambition. **The opportunity now is to build an ecosystem that the world trusts, India owns and the next generation can scale**.

Ashok Chandak
President, India Electronics and Semiconductor Association (IESA)

EY

India's semiconductor sector is at a pivotal moment. The domestic semiconductor market has grown from approximately US$27 billion in 2021 to nearly US$64 billion in 2026 and is projected to reach US$200 billion by 2035*. At the same time, semiconductors have become a critical enabler of economic growth, industrial competitiveness and technological innovation, supporting sectors ranging from consumer electronics and telecommunications to automotive, healthcare, defense, artificial intelligence and advanced manufacturing. Against the backdrop of evolving global supply chains and increasing focus on technology resilience, semiconductors have emerged as a strategic priority for economies worldwide.

India's response to this opportunity has been both timely and ambitious. Through Semicon 1.0, the country initiated a focused effort to establish domestic semiconductor manufacturing capabilities while leveraging its well-established strengths in semiconductor design and engineering talent. The program has contributed to the approval of 12 semiconductor manufacturing projects with investment commitments exceeding INR1.65 lakh crore**. These projects span silicon and compound-semiconductor fabrication, display manufacturing and semiconductor packaging, establishing the foundation of India's domestic semiconductor ecosystem.

Recognizing that long-term competitiveness extends beyond manufacturing capacity alone, Semicon 2.0 marks an important evolution in policy thinking. With an enhanced outlay of INR1,27,500 crore, the program broadens the focus towards semiconductor value chain development by supporting design, fabrication, advanced packaging, materials, equipment, research and development, talent creation and supply-chain resilience***. This wider approach acknowledges an important reality of the semiconductor industry: sustainable success depends on the strength of the entire ecosystem, spanning innovation, infrastructure, suppliers, skills and commercialization capabilities.

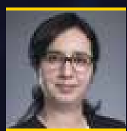
[The significance of these efforts extends beyond the semiconductor sector itself. A vibrant semiconductor ecosystem has the potential to catalyze investments across electronics manufacturing, electric mobility, telecommunications, industrial automation, data centers and emerging technology sectors. It can accelerate innovation, generate high-value employment, strengthen research capabilities and create multiplier effects across a wide network of suppliers, technology providers and ancillary industries. As India continues to expand its digital and manufacturing ambitions, semiconductors are likely to play an increasingly important role in enabling broader economic transformation.

The next phase will be determined by execution. Globally competitive clusters will require reliable infrastructure, skilled personnel and effective coordination between the central government, states and industry. Long-term competitiveness will also depend on research, industry-academia collaboration and technology commercialization. Finally, deeper domestic value addition will require the development of equipment, materials, specialty chemicals, gases and other critical suppliers.

In this context, EY is pleased to collaborate with the India Electronics and Semiconductor Association (IESA) in presenting this report. The report examines the evolution of India's semiconductor ecosystem, assesses the opportunities emerging under Semicon 2.0, and identifies strategic interventions that can support the next phase of industry growth. As India advances from creating manufacturing capacity towards building an integrated semiconductor ecosystem, the collective efforts of government, industry, academia, investors and technology partners will play a defining role in shaping the country's long-term success.

We hope that the insights and recommendations presented in this report contribute meaningfully to policy discussions and support stakeholders across the ecosystem in advancing India's aspiration of becoming a resilient, trusted and globally competitive semiconductor hub.

Bipin Sapra
Partner and Indirect Tax Policy Leader, EY India



Aisha Ali Hussaini
Partner and Semiconductor Tax Leader, EY India

* Future of India's Semiconductor Industry
** Press Release Page | Press Information Bureau
*** Semicon 2.0 - Pillar 1 - Design | India Semiconductor Mission

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For many years, India's semiconductor ambitions were viewed as a future opportunity. Today, they have become an economic and strategic imperative. The domestic semiconductor market has grown from US$27 billion in 2021 to an estimated US$64 billion in 2026 and is projected to reach US$200 billion by 2035*. This rapid expansion reflects the growing importance of semiconductors in powering AI, digital infrastructure, advanced manufacturing, mobility, and the next generation of technology-enabled growth.

Semiconductors now sit at the intersection of industrial competitiveness, technological sovereignty, supply-chain resilience, and national security. As countries seek to secure access to critical technologies and reduce concentration risks across global supply chains, their position within semiconductor value chains will increasingly shape economic competitiveness and strategic influence for decades to come.

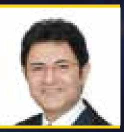
India has responded with ambition. Semicon India 1.0 translated intent into tangible outcomes, with 12 semiconductor manufacturing projects approved, an outlay of US$7.9 billion and the first facilities entering commercial production**. The significance of Semicon India 2.0, however, lies not only in the scale of investment but in the shift in ambition. The agenda has evolved from creating foundational manufacturing capacity to building a comprehensive semiconductor ecosystem spanning design, fabrication, packaging, equipment, materials, R&D and talent.

The next phase will be defined less by the number of facilities announced and more by the depth of the ecosystem created around them. Sustaining momentum will require stronger alignment between central and state policies, reliable infrastructure, deeper materials and equipment capabilities, a skilled workforce, industry-academia collaboration, sustained R&D investment, international partnerships, and long-term policy support. Semiconductor leadership is ultimately built through interconnected capabilities that evolve together, not in isolation.

India's advantage extends beyond incentives. The country combines one of the world's largest concentrations of semiconductor design talent with a rapidly growing domestic market, an expanding electronics manufacturing base, and increasing support for investment, innovation and skills development. These strengths provide a unique foundation for building a resilient and globally competitive semiconductor ecosystem.

Against this backdrop, 'Semicon India 2.0: From capacity creation to ecosystem leadership,' assesses India's progress, benchmarks its policy framework against leading semiconductor economies, identifies remaining ecosystem gaps and outlines the capabilities required across the value chain. It draws on global best practices to highlight what will be needed for India to emerge as a trusted and competitive participant in global semiconductor supply chains.

India has the demand, talent, and policy foundations to succeed. The challenge now is to convert momentum into ecosystem leadership through focused execution, sustained commitment and action at scale.



Nitin Bhatt
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*   Future of India's Semiconductor Industry- NITI Aayog
**   Semicon 1.0 - Semiconductor Fab | India Semiconductor Mission

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Executive summary

India's semiconductor journey reflects a transition from decades of unrealized manufacturing ambition to a structured effort to build a globally competitive and self-reliant ecosystem. While India became a global center for chip design and engineering talent, it remained dependent on imports of applications (such as electronics, automobiles and equipment), functions of which are powered and enabled by the very chip designed by the talent within the country[1].

Over time, India has developed manufacturing capability of end-use electronics, equipment, automobiles and other applications, with back integration of sub-components, parts and materials, but self-reliance in developing and manufacturing core of these applications, i.e., the semiconductor chips, fabricated and packaged within the Country using equipment and materials sourced domestically, remained aspirational, until the introduction of India's semiconductor policy in 2021[2].

Since then, expanding domestic demand, global supply-chain realignment and sustained policy momentum have created a strategic window for India to build capabilities across the semiconductor value chain. Backed by its talent base, growing electronics ecosystem and emerging manufacturing capacity, India is increasingly positioned as a trusted semiconductor player in global supply chains.

ISM 1.0, launched with an outlay of INR76,000 crore (~US$7.9 billion), focused on creating foundational capabilities across semiconductor design, fabrication and packaging[3]. The program has delivered significant outcomes within a short period. India has approved 12 semiconductor manufacturing projects, comprising one silicon fab, two compound semiconductor fabs and nine packaging facilities, attracting cumulative investments of approximately INR1.64 lakh crore (~US$17.1 billion)[4].

Twenty-three chip tape-outs have been successfully completed at foundries, demonstrating India's growing capability to take chip designs from concept to silicon[5], while three semiconductor units have already commenced production and exports. The program has led to the development of indigenous processing technologies such as SHAKTI, VEGA, AJIT, THEJAS and DHRUV64[6], validating domestic design capabilities and creating a roadmap to reduce dependence on imported processor IP. Fiscal and non-fiscal support under the central government and state government policies has attracted substantial investment and generated employment, while IP creation and talent development initiatives have reinforced India's position as a global semiconductor design powerhouse, with nearly 20% of the world's chip design engineers based in the country[7].

These achievements have been accompanied by a strong growth in domestic demand. India's semiconductor market, estimated at approximately US$27 billion in 2021, has grown to around US$64 billion in 2026 and is projected to reach US$200 billion by 2035[8]. This expanding demand, combined with increasing geopolitical focus on resilient supply chains, has created a significant opportunity for India to strengthen its role in the global semiconductor value chain and move beyond design-led participation towards manufacturing and ecosystem leadership.

Building on the foundation created under ISM 1.0, the Government of India launched Semicon India 2.0 in July 2026 with an enhanced outlay of INR1,27,500 crore (~US$13.3 billion)[9]. The program represents a strategic shift from capacity creation to ecosystem development. While ISM 1.0 focused largely on fabs, design and packaging, Semicon 2.0 adopts a comprehensive six-pillar approach covering design, semiconductor materials and equipment, fabrication, advanced packaging, research and development and talent creation.

The benefits of Semicon 2.0 extend across multiple segments of the semiconductor ecosystem[10]:

- For design companies, startups and MSMEs, the scheme provides access to advanced design infrastructure, EDA tools, IP cores, multi-project wafer services, seed funding, equity participation and enhanced deployment-linked incentives, thereby reducing barriers to innovation and commercialization
- For suppliers of semiconductor-grade materials, specialty chemicals, gases, substrates and equipment, the program introduces dedicated fiscal support aimed at building domestic supply-chain capabilities and reducing import dependence

1 orfonline.org/expert-speak/lessons-from-indias-past-for-its-semiconductor-future
2 Press Release Page | Press Information Bureau
3 Semicon 1.0 - Semiconductor Fab | India Semiconductor Mission
4 Press Release Page | Press Information Bureau
5 India's DLI Scheme Backs 24 Startups and 23 Chip Tapeouts | Semicon Hunt
6 Press Note Details: Press Information Bureau
7 futureDESIGN | ISM
8 Future of India's Semiconductor Industry- NITI Aayog
9 Press Release Page | Press Information Bureau
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- For fabrication and packaging projects, continued support for silicon fabs, compound semiconductor fabs and display fabs seeks to strengthen India's manufacturing base, while a dedicated focus on advanced packaging acknowledges the growing importance of chiplets, heterogeneous integration and 2.5D/3D packaging technologies in the next phase of semiconductor innovation
- Support of up to 75% of project costs for R&D and talent development is targeted to accelerate capability creation in emerging technologies and strengthen the semiconductor workforce of the future

The program recognizes that long-term competitiveness depends not only on manufacturing capacity but also on development of indigenous technologies, supply chain, skilled talent and research led future growth. Accordingly, it seeks to build sovereign semiconductor capabilities, deepen domestic intellectual property creation, strengthen participation in global value chains and position India as a globally competitive semiconductor hub.

The assessment in the report establishes that Semicon 2.0 is designed to address ecosystem gaps that remain as India advances toward becoming a globally competitive semiconductor destination. Semicon 1.0 was intentionally structured as a foundation-building program and did not extensively target the broader ecosystem. The initial focus was on establishing front-end manufacturing capabilities, which were considered necessary to attract upstream and downstream ecosystem players.

Semicon 2.0 broadens policy support for manufacturing projects to encompass the surrounding ecosystem of materials, equipment, specialty gases, advanced packaging, design commercialization, research infrastructure and talent development. It also introduces differentiated incentives aligned with technology and strategic priorities, directing greater support towards advanced packaging, R&D and capability-building initiatives. In doing so, India has largely aligned its semiconductor policy framework with global best practices adopted by leading semiconductor nations, while retaining unique strengths such as direct pari-passu support and an emphasis on domestic design ownership.

At the same time, the report identifies incremental opportunities where the government could focus to further strengthen support to India's semiconductor ecosystem. These include:

- Expanding semiconductor-specific fiscal incentives, such as tax credits and lower withholding taxes
- Strengthening and aligning state semiconductor policies with the broader scope of Semicon 2.0
- Simplifying business establishment, export and customs processes for foreign technology companies
- Developing integrated semiconductor manufacturing clusters with common world-class infrastructure
- Introducing dedicated talent certification programs across design, fabrication and advanced packaging segments
- Establishing a national semiconductor research and commercialization platform similar to Taiwan's ITRI[11] or Belgium's IMEC[12]

Such interventions would not only improve project viability and ecosystem depth but also accelerate the development of indigenous technologies, suppliers and intellectual property.

The next phase of India's semiconductor journey should therefore be viewed not through the lens of perceived gaps, but through the government's objective of deepening the ecosystem and its long-term competitiveness and sustainable growth. Future success may be achieved through speedy approvals, effective implementation, industry-academia collaboration, fast-tracked technology commercialization, cluster development, supply chain evolution and adequate talent availability. As global semiconductor supply chains seek diversification and resilience, India is uniquely positioned to emerge as a trusted partner by leveraging its strengths in talent, demand, manufacturing capability, research potential and strategic partnerships.

Overall, India has successfully moved beyond the stage of semiconductor ambition and entered the stage of semiconductor execution. With a projected domestic semiconductor market of US$200 billion by 2035, a combined policy commitment of over INR2 lakh crore (~US$20.8 billion) through ISM 1.0 and Semicon 2.0, a rapidly expanding manufacturing base, global leadership in chip design talent and growing international collaborations, India is well positioned to emerge as a resilient, trusted and globally competitive semiconductor hub. The coming decade may be defined by the country's ability to translate policy momentum into integrated ecosystem capabilities, making execution, innovation, localization and capability development the defining priorities of India's semiconductor transformation.

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Chapter 1

Semiconductors and the evolution of their ecosystem in India

Semiconductors have emerged as the backbone of the digital economy, enabling technological advancements across industries ranging from financial services and telecommunications to healthcare, automotive, manufacturing and defense. Often referred to as the "new oil" of the 21st century, semiconductor chips form the core of virtually every electronic device and digital system, making them indispensable to economic growth, innovation and national security.

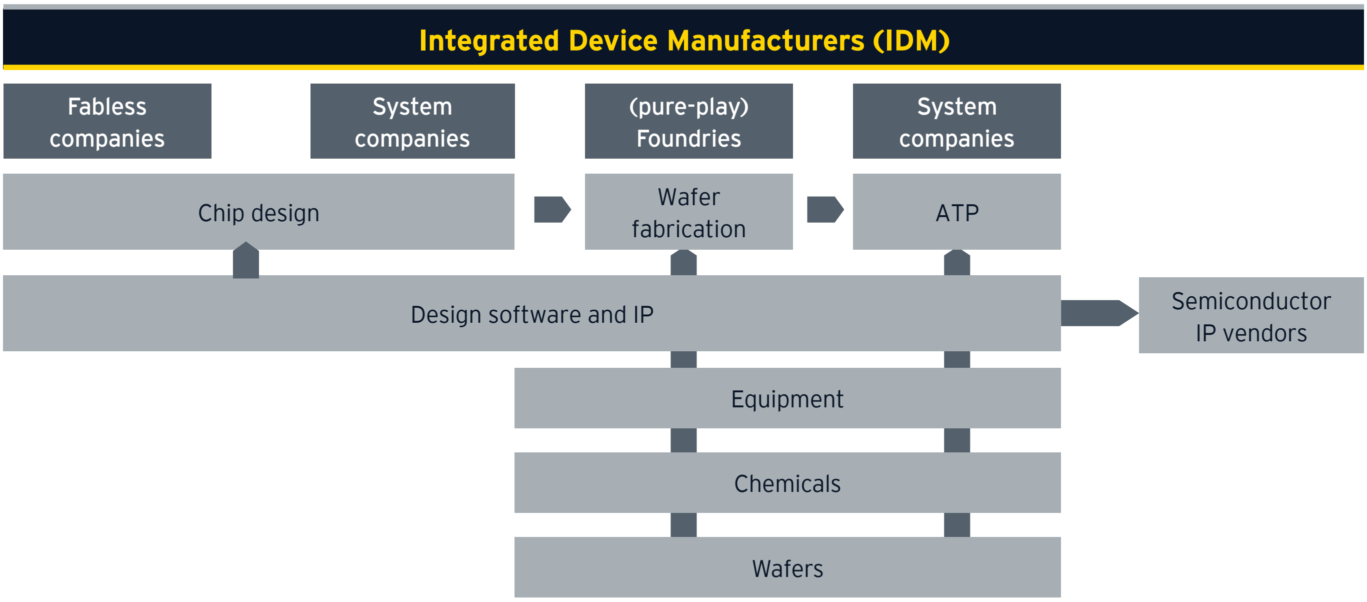
With a growing thrust toward digitization and automation, semiconductors have become crucial for the economic security and independence of a nation, and their growing importance is reflected by India's vision to become a global hub for semiconductor innovation and manufacturing.[13]

13 https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=155130&ModuleId=3&reg=48&lang=2

A semiconductor, most commonly silicon, acts both as a conductor and an insulator. This property of semiconductors helps in controlling the flow of electricity, a desirable factor for electric circuits, thereby making it an essential component in computers, electronic devices, integrated circuits and modern digital technologies. A multitude of semiconductors packed into chips can power countless technologies ranging from a phone call to navigating complex space missions[14]. Based on their application and functionality, various semiconductor chips can be understood as:

- Logic chips for computation and data processing
- Memory chips for data storage and AI workloads
- Sensors & Micro-Electromechanical Systems (MEMS) for sensing and control applications in smartphones, automobiles and industrial systems, etc[15]
- Analog and mixed signals for power magnet chips, amplifiers and data converters to interface real-world signals with digital systems
- Discrete semiconductors and power devices used in EVs and renewable energy application

Semiconductor value chain



The semiconductor value chain comprises a series of interconnected stages that transform a chip concept into a finished semiconductor device. Broadly, the value chain can be divided into three core stages: **Design, Fabrication and ATMP/OSAT**. Each stage requires specialized capabilities, infrastructure, and expertise, and plays a distinct role in the development and production of semiconductor devices.[16]

14 https://www.ibm.com/think/topics/semiconductors https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=155130&ModuleId=3&reg=48&lang=2
15 What types of microchips exist? | imec The basics of microchips | ASML
16 Semiconductor Supply Chain, Fabs, Chips & Fab Infrastructure | SemiconductorX

Technology landscape

The semiconductor value chain depends on specialized software, intellectual-property cores, equipment, wafers, chemicals, gases, package substrates, research infrastructure and skilled personnel. [17,18]

The value chain is globally distributed and technically interdependent. A disruption in a specialized input, production stage or geographic concentration can affect downstream chip supply. Emerging technologies do not replace the underlying value chain; they intensify the interaction among design, fabrication, packaging, materials and system development. Chiplet architecture, for example, requires coordinated die and package design, while silicon photonics combines semiconductor processing with optical components.[19,20]

Technology map of the semiconductor value chain

Technology layer	Principal activities	Technology development and emerging capabilities
Design, IP and software	Architecture, logic and circuit design, verification, physical implementation and sign-off	AI-assisted EDA, chip-package co-design, photonic EDA, IP cores, SoCs, AI accelerators, firmware and hardware-software co-design
Wafer fabrication	Material preparation and repeated deposition, lithography, etching, doping, planarization and interconnect processes	Advanced and mature process technologies: SiC, GaN, GaAs, InP and silicon photonics
Assembly, test and packaging	Die separation, electrical connection, protection, inspection, test and reliability validation	Chiplets, heterogeneous integration, 2.5D/3D packaging, advanced substrates and SiP
Displays and optoelectronics	Light emission, modulation or detection; driver and panel integration	OLED, MicroLED and photonic devices
Semiconductor-enabled systems	Integration of compute, memory, connectivity, power, boards and software	AI infrastructure, edge AI and chip-to-system integration

1.1 Semiconductor design, IP and supporting software

Semiconductor design defines the functionality, architecture and physical configuration of an integrated circuit before manufacturing. The process generally begins with system requirements and architectural design and progresses through functional design, logic or circuit implementation, simulation, verification, physical design and sign-off. After verification, the completed layout is transferred to a fabrication facility for production.[21]

a) Electronic design automation

Electronic Design Automation, or EDA, refers to specialized software and computing tools used to design, simulate, verify and prepare integrated circuits and electronic systems for manufacturing. EDA supports activities including architectural exploration, circuit design, functional verification, physical implementation, design-rule checking and preparation of the final manufacturing layout. Emerging EDA developments include AI-assisted workflows, multi-die and 3D-IC design, multiphysics analysis and electronic-photonic co-design.[22]

14 https://www.ibm.com/think/topics/semiconductors https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=155130&ModuleId=3&reg=48&lang=2
15 What types of microchips exist? | imec The basics of microchips | ASML
16 Semiconductor Supply Chain, Fabs, Chips & Fab Infrastructure | SemiconductorX
17 OECD (2025), "Mapping the semiconductor value chain: Working towards identifying dependencies and vulnerabilities", OECD Science, Technology and Industry Policy Papers, No. 182, OECD Publishing, Paris, https://doi.org/10.1787/4154cdbf-en.
18 Ministry of Skill Development and Entrepreneurship, India Semiconductor Ecosystem Workforce Development Strategy Report 2025.
19 OECD (2025), "Mapping the semiconductor value chain: Working towards identifying dependencies and vulnerabilities", OECD Science, Technology and Industry Policy Papers, No. 182, OECD Publishing, Paris, https://doi.org/10.1787/4154cdbf-en.
20 https://www.nist.gov/chips/research-development-programs/national-advanced-packaging-manufacturing-program
21 Ministry of Skill Development and Entrepreneurship, India Semiconductor Ecosystem Workforce
22 hhttps://www.synopsys.com/glossary/what-is-electronic-design-automation.html

b) Semiconductor IP and systems-on-chip

Semiconductor intellectual-property cores are pre-designed functional building blocks that can be incorporated into a chip design. Examples include processors, embedded memories, interfaces, analogue functions, security functions and communications subsystems. An IP core may be reused across multiple products, subject to the applicable technical and licensing arrangements.[23]

A system-on-chip, or SoC, integrates multiple processing or electronic functions into one integrated circuit. Depending on the intended use, an SoC may include processing cores, memories, interfaces, connectivity, security, signal-processing or power-management functions. Semicon 2.0 uses the terms IP cores, chips, SoCs and modules and identifies compute, memory, radio-frequency, power, networking and sensor IP as potential building blocks.[24]

c) AI accelerators and hardware-software co-design

An AI hardware accelerator is a specialised computing architecture designed to perform defined artificial-intelligence operations with higher performance or energy efficiency than a general-purpose processor executing the same operations in software. Accelerator implementations may include graphics processing units, field-programmable gate arrays and application-specific integrated circuits. Accelerators are used in both data-centre systems and power-constrained edge devices.[25,26]

Semiconductor functionality also depends on software. Firmware provides low-level control functions closely linked to the hardware, while device drivers and related software allow the device to interact with operating systems and applications. Hardware-software co-design is the concurrent development of hardware and the software running on it so that system-level objectives, including performance, power, cost and reliability, can be considered together.[27]

23 https://www.synopsys.com/glossary/what-is-electronic-design-automation.html
24 https://www.ism.gov.in/schemes/semicon2.0/index
25 National Institute of Standards and Technology, Hardware Accelerators for Neural Networks. https://www.nist.gov/programs-projects/hardware-accelerators-neural-networks
26 National Institute of Standards and Technology, Hardware Accelerators for Neural Networks. https://www.nist.gov/programs-projects/hardware-accelerators-neural-networks
27 IEEE Technology Navigator, Hardware Software Co-design. https://technav.ieee.org/topic/hardware-software-co-design/

Critical requirements

EDA tools

- These are software tools used throughout the design process.
- These perform key tasks such as circuit simulation, layout design, timing analysis, sign-off, etc.
- These automate design workflows, improve productivity and lessen development time.

IP cores and libraries

- These are pre-designed and verified building blocks used in chip development.
- These provide processor, memory, interface IPs (intellectual property) and standard cell libraries.
- These accelerate development, reduce costs and lower design risk.

Foundry process design kits (PDKs)

- These are foundry-provided technology files required for chip design.
- These include device models, design rules, process parameters and verification decks.
- These enable manufacturable designs and support successful tape-out.

Skilled talent

- Semiconductor design requires a highly skilled workforce, such as register transfer level (RTL) engineers, verification engineers, physical design engineers, design for testability (DFT) engineers and analog/mixed-signal designers.
- Availability of experienced talent is critical for developing complex chips and reducing time-to-market.

Advanced Computing Infrastructure

- Advanced computing infrastructure includes high-performance computing (HPC) clusters, cloud computing resources and large-scale data storage systems.
- These enable efficient execution of electronic design automation (EDA) workloads and accelerate design cycles.

Access to Foundries / MPW and Tape-out Services

- Semiconductor companies require access to manufacturing partners and prototyping services to fabricate and validate their chip designs.
- This includes access to foundries, multi-project wafer (MPW) programs, shuttle runs and tape-out services that enable cost-effective prototyping and production.

Verification and validation infrastructure

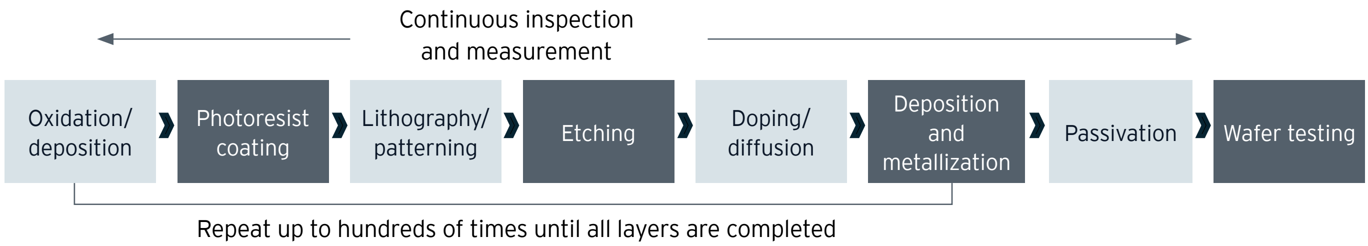
- Strong verification and validation capabilities help minimize costly and time-consuming design errors after tape-out.
- It includes simulation platforms, emulation systems, field-programming gate array (FPGA) prototyping, validation labs and testing tools used throughout the verification process.

Source: OECD Mapping the semiconductor value chain; Ministry of Skill Development and Entrepreneurship: semiconductor strategy report, 2025

1.2 Wafer fabrication

Wafer fabrication creates semiconductor devices through repeated, tightly controlled processes on a silicon wafer. These processes include wafer preparation, material deposition, photolithography, etching, doping or ion implantation, planarization and the formation of electrical interconnections. Fabrication is undertaken in controlled cleanroom environments and depends on specialized equipment, materials, chemicals, gases and process-control systems.[28,29]

Wafer manufacturing (front-end process)



Silicon remains the principal material platform for semiconductor manufacturing and underpins most conventional integrated circuits used in logic, memory, analog, mixed-signal and power applications. Its continued importance arises from the maturity and scalability of silicon-based manufacturing processes, the established global supply chain for silicon wafers and fabrication equipment and silicon's ability to form a stable insulating oxide that enables highly integrated electronic devices. Consequently, silicon-fabrication capability remains fundamental to the development of a broad-based semiconductor ecosystem, even as compound and wide-bandgap materials gain importance in selected high-power, high-frequency, optical and sensing applications.[30]

Other materials are used where their electrical, thermal or optical characteristics are better suited to a particular application.

a) Wide-bandgap semiconductors: SiC and GaN

Wide-bandgap semiconductors have a wider energy bandgap than conventional silicon. Silicon carbide, or SiC, and gallium nitride, or GaN, are important wide-bandgap materials used in power-electronics applications. US Department of Energy sources identify their relevance to more powerful and energy-efficient power-electronic systems used across industrial equipment, data centres, consumer devices and electric vehicles.[31,32]

SiC is used in devices designed for high-voltage, high-power and elevated-temperature operation. A SiC value chain can include substrate production, epitaxial growth, device fabrication, module packaging and testing. GaN is used in power-electronic, high-frequency and optoelectronic applications. These materials require application-specific device structures, manufacturing processes and packaging.[33,34]

b) GaAs (Gallium Arsenide) and InP (Indium Phosphide)

Gallium arsenide, or GaAs, is a III-V compound semiconductor used in selected high-frequency and optoelectronic applications. GaAs-based material systems support devices such as radio-frequency amplifiers, laser diodes, vertical-cavity surface-emitting lasers (VCSELs), photodetectors and selected infrared or red-light-emitting devices. These characteristics make GaAs relevant to wireless communications, optical data transmission, sensing, LiDAR, spectroscopy and selected LED and display applications. India's semiconductor workforce strategy also identifies GaAs as a material relevant to high-frequency and optoelectronic applications.[35,36]

28 Ministry of Skill Development and Entrepreneurship, India Semiconductor Ecosystem Workforce Development Strategy Report 2025.
29 India's Semiconductor Manufacturing Strategy | Jefferies
30 https://www.researchgate.net/publication/393152128_From_Silicon_to_Wide_Bandgap_Semiconductors_Exploration_of_Compound_Semiconductors_in_High_Frequency_and_High_Power_Devices
31 US Department of Energy, PowerAmerica Institute Renewal: Wide-Bandgap Semiconductor Technologies. https://www.energy.gov/cmei/ammto/articles/us-department-energy-extends-commitment-enhanced-semiconductors-through-0
32 US Department of Energy, Wide Bandgap Semiconductors: Pursuing the Promise. https://www1.eere.energy.gov/manufacturing/rd/pdfs/wide_bandgap_semiconductors_factsheet.pdf
33 US Department of Energy, PowerAmerica Institute Renewal: Wide-Bandgap Semiconductor Technologies. https://www.energy.gov/cmei/ammto/articles/us-department-energy-extends-commitment-enhanced-semiconductors-through-0
34 US Department of Energy, Wide Bandgap Semiconductors: Pursuing the Promise. https://www1.eere.energy.gov/manufacturing/rd/pdfs/wide_bandgap_semiconductors_factsheet.pdf
35 https://www.imec-int.com/en/press/first-full-wafer-scale-fabrication-electrically-pumped-gaas-based-nano-ridge-lasers-300-mm
36 https://pubs.aip.org/aip/app/article/9/10/106102/3315287/GaAs-based-photonic-integrated-circuit-platform

Indium phosphide, or InP, is used in high-speed lasers, detectors, modulators and photonic integrated circuits. InP-based devices support optical transmission across telecommunications networks, between data centers and among processors, memory and systems within advanced AI data centers. National Institute of Standards and Technology (NIST) identifies InP photonic devices as enablers of high-speed optical interconnects that can help address data movement and energy efficiency constraints as AI workloads scale.[37]

c) Silicon photonics

Silicon photonics implements optical-system components onto a chip using silicon-compatible semiconductor processes. It can support optical transmission, modulation and detection in telecommunications, data communications and sensing. A silicon-photonics ecosystem may include photonic design, process-design kits, wafer fabrication, integration of optical and electronic components, specialized packaging and optical testing.[38,39]

Based on advanced technologies, the following are the critical requirements:

Critical requirements

Semiconductor manufacturing equipment

- These are specialized tools used to manufacture semiconductor devices on silicon wafers.
- These perform processes such as lithography, deposition, etching, ion implantation, chemical mechanical planarization (CMP) and metrology.
- These enable the fabrication of integrated circuits with high precision and yield.

Wafers and substrates

- These are the base materials on which semiconductor devices are fabricated.
- These include silicon wafers, silicon carbide (SiC) and gallium nitride (GaN) substrates.
- These provide the foundation for transistor formation and circuit manufacturing.

Specialty chemicals

- These are ultra-high-purity materials required during wafer processing.
- These include photoresists, developers, etchants, cleaning chemicals and chemical mechanical planarization (CMP) slurries.
- These enable precise pattern transfer and support high manufacturing yields.

Specialty gases

- These are ultra-high-purity gases used in semiconductor manufacturing.
- These include nitrogen (N), argon (Ar), helium (He), silane (SiH) and ammonia (NH).
- These support deposition, etching, doping and contamination control processes.

Cleanrooms

- These are controlled manufacturing environments designed to minimize contamination.
- These regulate airborne particles, temperature, humidity, and vibration during wafer processing.
- These prevent defects and ensure reliable semiconductor production.

Ultra-pure water (UPW) and utility infrastructure

- These are essential utility systems that support semiconductor fabrication operations.
- Fabrication requires millions of gallons of ultra-pure water (UPW) each day, along with reliable electricity, heating ventilation air conditioning (HVAC) systems and wastewater treatment facilities.

Skilled talent

- These are engineers and technicians required to operate and optimize fabrication facilities.
- These include process, equipment, yield and metrology engineers, as well as cleanroom technicians.
- These enable efficient fabrication operations and continuous process improvement.

Automation and manufacturing IT systems

- These are digital systems used to automate and manage semiconductor manufacturing.
- These include manufacturing execution system (MES), automated material handling system (AMHS) and process control software.
- These improve productivity, traceability and manufacturing yields.

Source: OECD Mapping the semiconductor value chain; Ministry of Skill Development and Entrepreneurship: semiconductor strategy report, 2025

37 https://www.nist.gov/news-events/news/2026/06/department-commerces-chips-program-announces-letter-intent-coherent-50
38 imec, Silicon Photonics: Towards an Accessible Technology for Telecom and Sensing. https://www.imec-int.com/en/articles/silicon-photonics-towards-an-accessible-technology-for-telecom-and-sensing
39 imec, Silicon Photonics Foundry Services. https://www.imec-int.com/en/what-we-offer/development/photonics

1.3 Assembly, testing and packaging

After wafer fabrication, semiconductor dies are separated from the wafer, electrically connected, packaged and tested. Packaging protects the die, provides electrical and mechanical connections to the electronic system, supports heat dissipation and enables handling and assembly. Inspection and testing identify manufacturing defects and verify functional, electrical and reliability requirements.[40]

Outsourced Semiconductor Assembly and Test (OSAT)/ Assembly, Testing, Marking and Packaging (ATMP)

Wafer dicing ❯ Die attach ❯ Die bonding ❯ Wire bonding ❯ Package molding ❯ Package testing ❯ Packaged semiconductor device

All digital progress is built on semiconductor technology

Depending on the package architecture and level of integration required, Outsourced Semiconductor Assembly Test (OSAT) operations can be broadly categorized into traditional and advanced packaging technologies.

1. **Traditional packaging**: Conventional packaging technologies based on wire bonding and lead-frame packages. Conventional packaging uses established architectures such as wire bonding, lead frames and flip-chip attachment.
2. **Advanced packaging:** Next-generation packaging technologies such as flip-chip, wafer-level packaging, 2.5D/3D integration and chiplet-based packaging that enable higher performance and greater integration. Advanced packaging involves the close assembly of multiple chips with diverse functions on a substrate in two or three dimensions. It is intended to provide tighter integration and improvements in system function, performance or power relative to conventionally packaged chips on a printed circuit board.[41]

a) Chiplets and heterogeneous integration

A chiplet is a semiconductor die designed to operate with other dies as part of a larger packaged system. Instead of placing every function on one monolithic die, a chiplet architecture divides selected functions across multiple dies and connects them through package-level interconnections. Chiplet-based systems integrate dies of different technologies and levels of complexity using interposers, bridges and other advanced interconnects.[42]

Heterogeneous integration combines components with different functions, materials or process technologies within a packaged system. The integrated components may include logic, memory, analog, radio-frequency, sensing or photonic dies.[43]

b) 2.5D, 3D, SiP and fan-out packaging

In 2.5D integration, multiple dies are generally placed beside one another and connected through an interposer or another high-density interconnect structure. In 3D integration, dies or device layers are stacked vertically. Through-silicon vias may provide vertical electrical connections through a die or silicon interposer.[44,45]

A system-in-package, or SiP, integrates multiple integrated circuits and may also incorporate passive components in one package. Fan-out packaging redistributes electrical connections beyond the original die area to enable additional input/output connections and compact package structures.[46]

Advanced packaging depends on package architecture, interconnect design, substrates, thermal management, precision assembly, inspection, testing and reliability. Power delivery, heat dissipation, testing, repair and reliability are among the key technical challenges associated with tightly integrated advanced packages.[47,48]

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40 Ministry of Skill Development and Entrepreneurship, India Semiconductor Ecosystem Workforce Development Strategy Report 2025.
41 National Institute of Standards and Technology, Hardware Accelerators for Neural Networks. https://www.nist.gov/programs-projects/hardware-accelerators-neural-networks
42 IEEE Electronics Packaging Society, Chiplet Technology and Heterogeneous Integration. https://eps.ieee.org/wp-content/uploads/2026/03/EDMS-TC-Chiplet-Technology-and-Heterogenous-Integration.pdf
43 IEEE Electronics Packaging Society, Chiplet Technology and Heterogeneous Integration. https://eps.ieee.org/wp-content/uploads/2026/03/EDMS-TC-Chiplet-Technology-and-Heterogenous-Integration.pdf
44 Ministry of Skill Development and Entrepreneurship, India Semiconductor Ecosystem Workforce Development Strategy Report 2025.
45 IEEE Electronics Packaging Society, Heterogeneous Integration and Chiplet Assembly: All Between 2D and 3D. https://eps.ieee.org/wp-content/uploads/2025/11/EPS_Newsletter_Paper_Ramm_201111_Pascal_Vivet_Phil_Garrou_Paul_Franzon_Ravi_Swaminathan_Mustafa_Badaroglu_final_1.pdf
46 Ministry of Skill Development and Entrepreneurship, India Semiconductor Ecosystem Workforce Development Strategy Report 2025.
47 National Institute of Standards and Technology, National Advanced Packaging Manufacturing Program. https://www.nist.gov/chips/research-development-programs/national-advanced-packaging-manufacturing-program
48 NIST, Material Needs and Measurement Challenges for Advanced Semiconductor Packaging. https://tsapps.nist.gov/publication/get_pdf.cfm?pub_id=959970

Basis the advanced technologies, below are the critical requirements:

Critical requirements

Packaging and test equipment

- These are specialized tools used for semiconductor assembly, packaging, inspection and testing.
- These include die attach, wire bonding, flip-chip, molding, singulation, wafer probers, burn-in systems and automated test equipment (ATE).
- These enable chips to be packaged, tested and qualified for end-use applications.

Packaging materials

- These are materials required to assemble and protect semiconductor devices.
- These include lead frames, substrates, bonding wires, molding compounds, solder balls and underfill materials.
- These provide mechanical protection, electrical connectivity and heat dissipation for packaged chips.

Cleanrooms

- These are controlled environments required for semiconductor assembly and testing.
- These maintain strict control over particles, temperature and humidity during packaging operations. These prevent contamination and ensure high product quality and reliability.

Skilled talent

- These are engineers and technicians required for packaging, test engineering, process integration, reliability and equipment maintenance. These support process optimization, yield improvement and advanced packaging development. These are critical for scaling sophisticated packaging technologies.

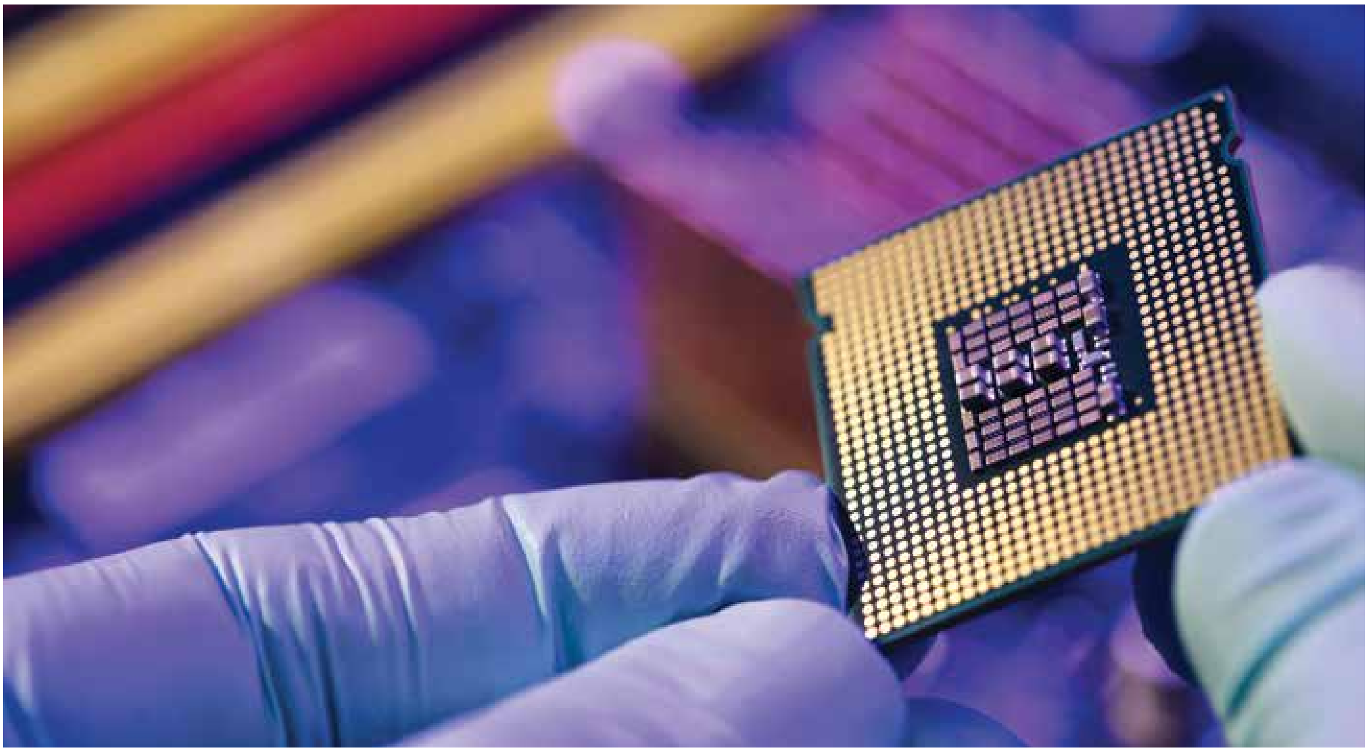
Automation and manufacturing IT systems

- These are digital systems used to automate, monitor and manage outsourced semiconductor assembly and test (OSAT) operations.
- These include Manufacturing execution system (MES), equipment monitoring, traceability and yield management software.
- These improve productivity, quality control and traceability.

Verification and validation infrastructure

- These are essential utility systems that support outsourced semiconductor assembly and test (OSAT) operations.
- Advanced packaging and testing facilities require reliable electricity, compressed air, process cooling water and heating ventilation air conditioning (HVAC) systems.

Source: OECD Mapping the semiconductor value chain; Ministry of Skill Development and Entrepreneurship: semiconductor strategy report, 2025



1.4 Display semiconductor and emerging display technologies

Display systems combine a light-emitting or light-modulating layer with a semiconductor backplane, display-driver ICs and power-management components. Thin-film transistors, or TFTs, control individual pixels and may use hydrogenated amorphous silicon, low-temperature polycrystalline silicon or oxide semiconductors such as indium gallium zinc oxide, or IGZO. TFT is therefore a backplane technology used across LCD, OLED and certain MicroLED displays rather than a separate display-light source.

TFT-LCD displays use a liquid-crystal layer to regulate light from a separate LED backlight. The backlight is located behind the panel and may be edge-lit, directly lit or configured as a mini-LED array for local dimming. Blue GaN-based LEDs are commonly combined with phosphors or semiconductor quantum dots to produce the required illumination spectrum. The image is then formed as the TFT-controlled liquid-crystal layer modulates this light through red, green and blue filters.

OLED displays are self-emissive and therefore do not require a separate backlight. They use thin organic-semiconductor emissive and charge-transport layers between electrodes, with a TFT backplane controlling the current to each pixel. OLED manufacturing combines semiconductor-backplane fabrication with organic-material deposition, encapsulation, driver ICs and panel testing.

MicroLED displays use microscopic inorganic compound-semiconductor LEDs as directly emissive pixels. Blue and green emitters commonly use InGaN/GaN material systems, while red emitters may use AlGaInP. Manufacturing can involve epitaxial growth, LED-chip fabrication, integration onto a TFT or CMOS backplane, bonding, testing and panel assembly. In a mass-transfer process, large numbers of microscopic LED dies are transferred from donor wafers and bonded onto the display backplane. This differs from mini-LED technology, in which small LEDs serve as the backlight behind an LCD panel.

From a semiconductor perspective, display manufacturing encompasses TFT-backplane fabrication, compound-semiconductor LED production, display-driver and power-management ICs, emitter integration, bonding, inspection and testing.[49,50]

1.5 Semiconductor-enabled systems and AI infrastructure

The performance of a semiconductor product is ultimately determined within a wider electronic system. A complete system may integrate processors, accelerators, memory, connectivity devices, power-management semiconductors, sensors, packages, printed circuit boards, firmware and application software.

For this report, AI infrastructure refers to the computing hardware and associated system components used to develop or deploy artificial-intelligence workloads. At the semiconductor level, these components may include general-purpose processors, specialized accelerators, memory, data-interconnect and networking devices and power-management components. The precise composition depends on the application and system architecture.

Edge AI performs AI computation within or close to the device generating or using the data rather than relying exclusively on a remote data center. Energy efficiency is particularly important for edge applications, where computing devices may operate under constrained power availability.[51]

1.6 Cross-cutting enablers

Research and development, specialized equipment, materials, infrastructure and talent cut across all stages of the value chain. Research addresses device materials, fabrication processes, circuits, packaging and system applications. Equipment and materials requirements vary by process, product and technology. Talent requirements span materials science, device engineering, architecture, design, verification, manufacturing, packaging, testing, firmware and systems engineering.

Recognizing these requirements, India has adopted a multi-pronged approach comprising support under the India Semiconductor Mission, state-level incentives and infrastructure, strategic collaborations and other enabling measures. The foundations of these policy efforts are rooted in a semiconductor journey that began decades ago and has evolved through phases of ambition, setbacks and renewed momentum.

49 Behrman, K. and Kymissis, I., Micro Light-Emitting Diodes, Nature Electronics. https://www.nature.com/articles/s41928-022-00828-5

50 Wu, T. et al., Mini-LED, Micro-LED and OLED Displays: Present Status and Future Perspectives, Light: Science & Applications. https://www.nature.com/articles/s41377-020-0341-9

51 National Institute of Standards and Technology, Hardware for AI. https://www.nist.gov/hardware-ai

52 OECD, Mapping the Semiconductor Value Chain, OECD Science, Technology and Industry Policy Papers. https://www.oecd.org/en/publications/mapping-the-semiconductor-value-chain_4154cdbf-en.html

53 Ministry of Skill Development and Entrepreneurship, India Semiconductor Ecosystem Workforce Development Strategy Report 2025. Internal supporting report provided with this study.

Evolution of India's semiconductor ecosystem

Semiconductors are the backbone of modern electronics, enabling technologies ranging from smartphones and automobiles to artificial intelligence and defense systems. Recognizing their strategic importance early, India began investing in semiconductor capabilities in the 1960s, well before semiconductors emerged as a global geopolitical priority. India is therefore not a new entrant to the semiconductor industry. The country's engagement with semiconductor manufacturing dates back more than five decades, placing it among the early cohort of nations that attempted indigenous chip fabrication.

India's semiconductor journey reflects a mix of early technological ambition, missed opportunities and a renewed push to establish itself as a significant participant in the global semiconductor value chain.

The evolution of India's semiconductor industry

1980s — Early Manufacturing Vision

- India's first fabrication facility was established in Mohali for applications in defense, space, telecom, etc.
- India's first multinational R&D center established in Bengaluru.
- India's semiconductor ambitions predate those of several Asian economies that later emerged as global chip leaders.

India enters semiconductor manufacturing before the foundry era begins.

1990s — Inflection & Re-orientation

- Devastating fire disrupts fabrication momentum.
- Global fabrication scale rapidly and India pivots during economic reforms.

Manufacturing slows; India's talent base fuels its design ambitions.

2000s — Design Becomes the Anchor

- Enactment of the Semiconductor Integrated Circuits Layout-Design Act, 2000, protecting design intellectual property rights.
- Global firms establish design centers in India.
- Indian IT majors enter very-large-scale-integration (VLSI) and verification.
- India becomes a key hub for global chip design.

Design strength becomes India's semiconductor identity.

2010s — Demand & Strategic Realization

- Electronics have become a top import commodity.
- Mobile manufacturing scales rapidly.
- Semiconductors are seen as strategic infrastructure.
- Government launches National Policy on Electronics (NPE) and Phase Manufacturing Program (PMP).

Import dependence drives a strategic reset.

2020s — Ecosystem Build-Out

- Production Linked Incentive (PLI) scheme injected ~US$5 billion in electronics and related sectors.
- India Semiconductor Mission (2021), a US$10 billion program targeted fabrication, ATMP, design and packaging.
- Mobile production increased 16 times between FY15 and FY24.
- Electronics exports increased fourfold.
- Semicon 2.0 was launched with an outlay of US$15 billion.

India renews its manufacturing ambitions through policy support and investment flows.

India: An early contender in the chip race

India's strategic interest in electronics and semiconductor capability was already visible in the 1960s, when a handful of Indian companies were producing basic semiconductor components domestically alongside early collaborations with pioneering global semiconductor firms.

This commitment culminated in 1984, when the Indian government established a public sector semiconductor fabrication facility in Mohali, Punjab, through technology licensing arrangements with American and Japanese semiconductor companies.[55] In parallel, the government invited bids for a National Silicon Facility, drawing interest from firms in the United States and East Germany. A dedicated polysilicon production unit was subsequently set up in Tamil Nadu with support from a state-owned defense electronics enterprise.[56]

Notably, India's public fabrication facility in Mohali predated the founding of the Taiwanese company that would go on to become the world's largest contract chip manufacturer, which was established in 1987.[57] This placed India among a small set of countries attempting end-to-end chip fabrication at a time when the field was concentrated in a handful of nations. By the late 1980s, the Mohali-based fabrication facility had advanced from 5-micron to 0.8-micron process technology, reflecting India's early progress in semiconductor manufacturing capabilities.[58]

Missed opportunities and loss of momentum

Despite this early start, the growth of India's semiconductor sector progressed at a measured pace due to factors such as evolving technology access, infrastructure readiness and the need for sustained long-term investments. At the same time, India demonstrated strong capabilities in building complex technology ecosystems, as evidenced by its achievements in areas such as nuclear energy and space exploration. A further challenge emerged in 1989, when a major fire destroyed a significant part of the Mohali facility's infrastructure at a critical juncture.[59]

Although efforts were subsequently made to rebuild operations, the interruption occurred at a critical stage when global competitors were rapidly expanding capacity, investing in newer technologies and integrating into international supply chains. As a result, India was unable to fully capitalize on its early initiatives, while other countries strengthened their positions within global semiconductor value chains.

Several multinational semiconductor firms from the United States explored opportunities in India for manufacturing, packaging, research or design operations.[60] During this period, many countries in East and Southeast Asia adopted targeted industrial policies, including substantial funding support, strategic procurement programs and government-backed technology development initiatives to attract semiconductor investments. Consequently, a significant share of global semiconductor manufacturing capacity was established in these locations, while India's role remained concentrated in select areas of the value chain.

Transition from manufacturing to design

As manufacturing ambitions stalled, India gradually emerged in the field of semiconductor design and engineering services. Economic reforms in the 1990s, combined with the growth of the information technology sector, enabled the country to leverage its large pool of engineering talent. By the early 2000s, India had emerged as a destination for semiconductor design and engineering services, supported by the growing presence of multinational design centers and the expansion of domestic firms in VLSI design, chip verification, embedded systems and electronics R&D.[61]

Over time, India developed one of the world's largest concentrations of semiconductor design talent. However, this success did not translate into comparable manufacturing capabilities. While India became deeply integrated into the design segment of the value chain, it remained heavily dependent on imports for fabrication, advanced packaging, semiconductor materials and manufacturing equipment.

54 Lessons from India's past for its semiconductor future
57 SCL | Semi-Conductor Laboratory
56 Lessons from India's past for its semiconductor future
57 About TSMC - Taiwan Semiconductor Manufacturing Company Limited
58 India Started its Semiconductor Journey with SCL in 1984, even before TSMC was set up – What went Wrong?
59 Press Release Page | Press Information Bureau
60 Lessons from India's past for its semiconductor future
61 Sixsense.ai

Renewed ambitions: Push for semiconductor ecosystem development

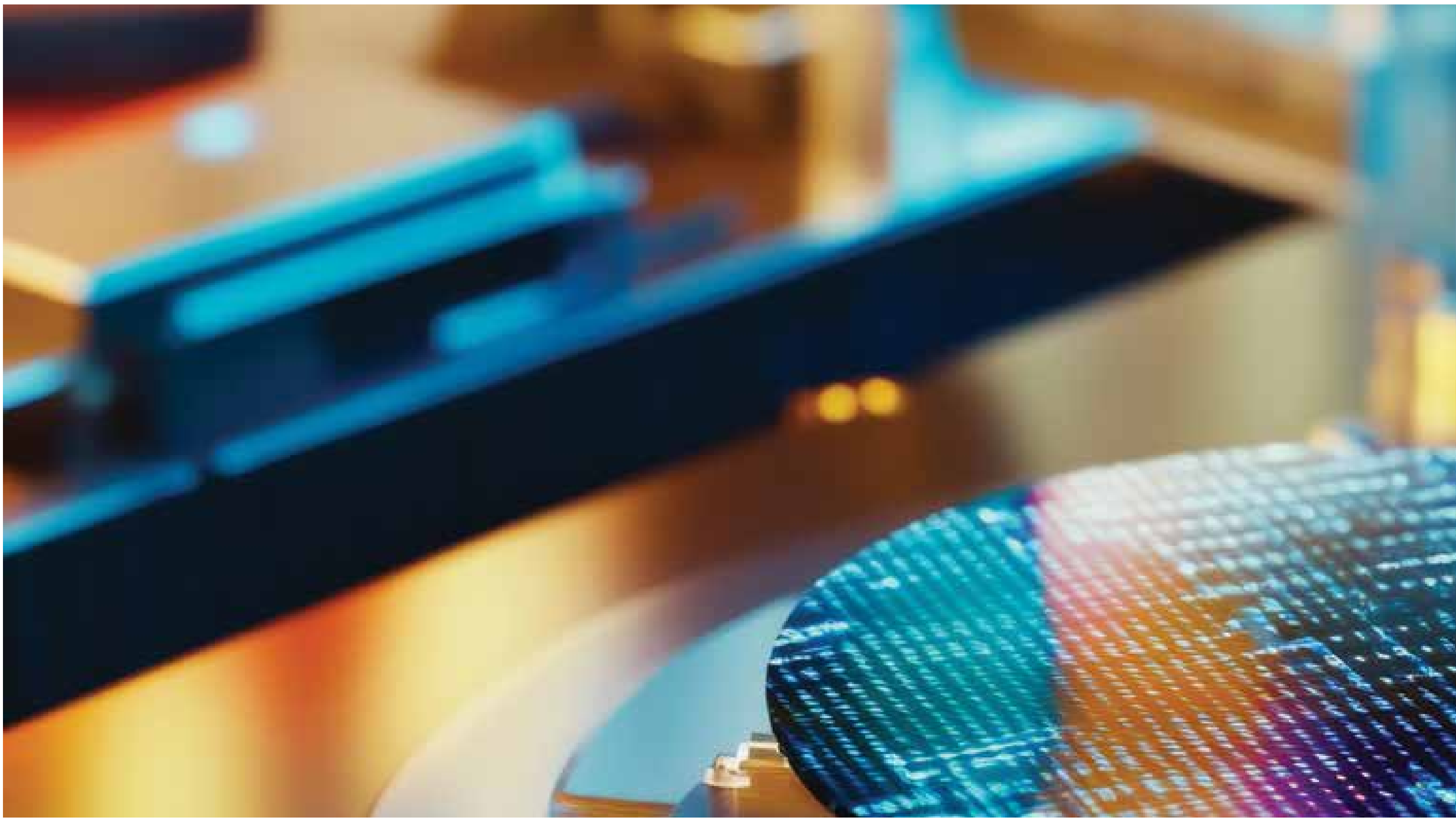
Growing geopolitical considerations, global supply chain disruptions, the global race to secure critical resources and technologies and the increasing strategic importance of semiconductors have renewed India's focus on developing domestic semiconductor manufacturing capabilities.

In recent years, the government has pursued a coordinated push through Production-Linked Incentive (PLI) schemes and the India Semiconductor Mission (ISM). This strategic intervention has catalyzed significant progress across the semiconductor value chain, including:

- Large domestic conglomerates and global chipmakers announcing fabrication, assembly and packaging investments across India, reflecting the emergence of a geographically diverse semiconductor manufacturing ecosystem.[62]
- Government incentive frameworks and international collaborations, including semiconductor supply chain agreements with the United States[63], Taiwan[64], Singapore[65] and other strategic economies, aimed at integrating India into resilient and diversified global supply chains.
- A strategic shift from India's traditional strength in chip design toward building a comprehensive semiconductor ecosystem. While Semicon 1.0 focused on establishing foundational manufacturing capabilities through support for fabs, ATMP/OSAT, compound semiconductors and design, Semicon 2.0 expands the focus to include semiconductor materials, specialty chemicals and gases, equipment manufacturing, R&D, talent development and resilient domestic supply chains.[66]

For India, strengthening domestic semiconductor capabilities is no longer merely an industrial objective but a strategic imperative. The domestic semiconductor market is projected to exceed US$200 billion by 2035, with a significant share of demand still being met through imports. This presents

62 Press Release Page | Press Information Bureau
63 New Partnership with India to Explore Semiconductor Supply Chain Opportunities - United States Department of State
64 Beyond the Strait: Taiwan's Role in India's Semiconductor Rise | Global Taiwan Institute
65 MTI-press-release-on-India-Singapore-Semiconductor-Ecosystem-Partnership-MOU.pdf
66 Press Release Page | Press Information Bureau
67 Semicon 2.0 - Pillar 1 - Design | India Semiconductor Mission

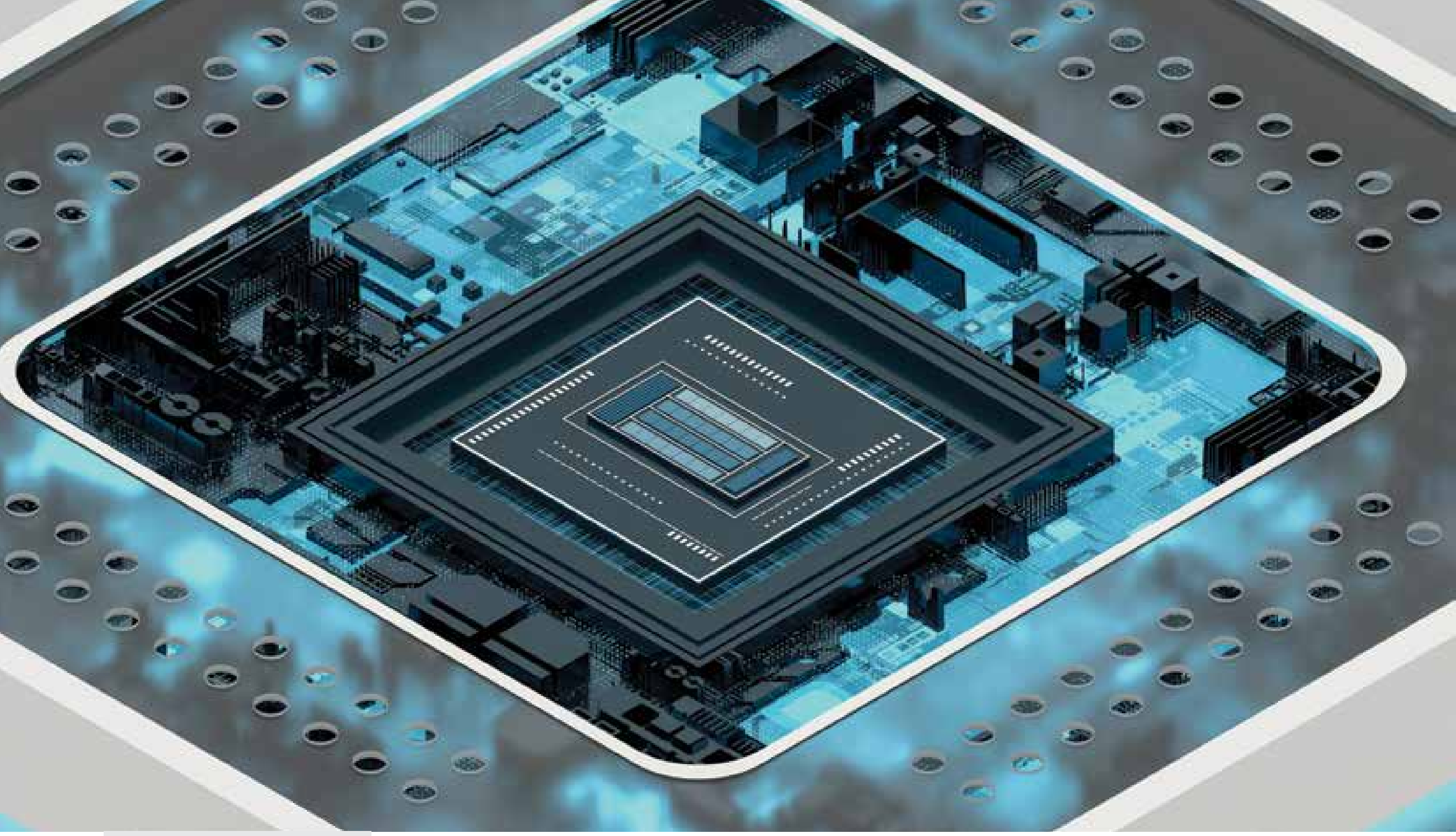


a critical opportunity to translate growing domestic consumption into domestic manufacturing, innovation and supply-chain resilience. Given the sector's central role in powering digital infrastructure, advanced manufacturing, telecommunications, artificial intelligence, defense systems and other emerging technologies, building a robust semiconductor ecosystem is essential for India's long-term economic and technological competitiveness.

India's semiconductor journey has entered a critical phase with the launch of Semicon 2.0, a comprehensive policy framework designed to move beyond chip design and basic manufacturing into a full-fledged ecosystem. The government has introduced targeted incentives and forged global collaborations to attract investment and strengthen supply chain resilience.[67] Together, these initiatives mark a deliberate shift from incremental progress to a coordinated national strategy – one that positions India to seize the current opportune moment and establish itself as a trusted hub for semiconductor innovation, manufacturing and supply chain resilience.

India's semiconductor journey demonstrates that technical capability alone is insufficient to build a globally competitive industry. The experience underscores the importance of timely decision-making, reliable infrastructure and long-term industry support alongside technological knowledge. With renewed policy focus and lessons drawn from past challenges, India is now better positioned to build a more integrated and resilient semiconductor ecosystem spanning design, manufacturing and innovation.

Against this backdrop, the report focuses on India's journey to build semiconductor capabilities across design, manufacturing, ATMP/OSAT, materials, equipment and related segments by extending support and collaboration to the industry. It also highlights global best practices within the semiconductor ecosystem, India's value proposition for investment and an assessment of the further support required, followed by recommendations.



Chapter 2

Building the foundation: Government reforms, demand-side PLIs and private sector momentum

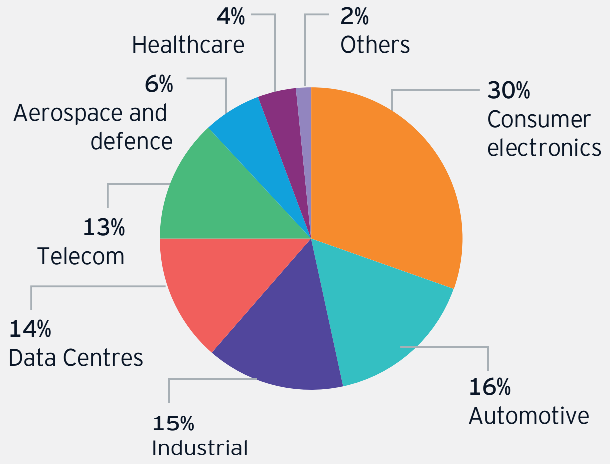
India is not a new entrant to the semiconductor sector. By the early 2020s, recognizing the strategic importance of semiconductors, India initially focused on creating a demand ecosystem for the industry by incentivizing end-use industries such as electronics, telecommunications, data centers and automotive manufacturing which require semiconductors as an important input. This growing domestic demand laid the foundation for subsequent policy interventions aimed at building a competitive and resilient semiconductor ecosystem.

India's demand for semiconductors

According to industry estimates, the Indian semiconductor market was valued at approximately US$27 billion in 2021, growing to US$64 billion in 2026 and projected to reach US$200 billion by 2035, at a CAGR of 15.4%.[68]

The Indian semiconductor demand is dominated by consumer electronics, which accounts for a 30% market share, driven by the growth of mobile manufacturing in India, followed by the automotive industry (16%) and the industrial sector (15%).[69] The increasing demand across each sector is driven by government polices as explained in the table below:

Indian semiconductor market share by end-user (2025)



Sector	Products	Government policy	Impact
Consumer electronics	Smartphones	1. 1PLI for Large Scale Electronics Manufacturing, 2020[70] 2. Modified Electronics Manufacturing Clusters (EMC 2.0) Scheme, 2020[71] 3. Mobile Phone Manufacturing Scheme, 2026[72]	1. An increase in production by 142% to INR11.61 lakh crore (~US$12.09 billion) and exports by 132% to INR6 lakh crore (~US$6.25 billion) over a period of 5 years (2021-26)[73] 2. Investment commitment of INR1,46,846 crore (~US$15.3 billion) under the scheme[74] 3. Electronics manufacturing grew 7 times and exports grew 11 times since FY2014-15 to current levels[75]
	Electronic components - sub-assemblies, modules	Electronic Components Manufacturing Scheme, 2025[76]	Electronics production increased six-fold from INR1.9 lakh crore (~US$2 billion) in 2014-15 to INR11.3 lakh crore (~US$11.77 billion) in 2024-25 at a CAGR of 21.91%[77]
	Laptops, tablets, PCs	PLI Scheme for IT Hardware, 2023[78]	Expected incremental production of INR3.35 lakh crore (~US$3.5 billion) over a period of 6 years from 2023 [79]
	Wearables	Ayushman Bharat Digital Mission, 2021[80]	Vision of creation of state-of-the art digital health systems in India[81]
	Home appliances: Air conditioners	PLI Scheme for White Goods, 2021[82]	Increase in domestic value addition from 15% to 20% to 75%-80% over the scheme tenure from FY22 to FY29[83]

68 Future of India's Semiconductor Industry- NITI Aayog
69 India Semiconductor Market Size, Share & Trends | Report 2034
70 854bea0fa5bf3c3eca352e4968ac1a72.pdf
71 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2205046&reg=3&lang=2
72 Press Release Page | Press Information Bureau
73 https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=2291171&reg=48&lang=2
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76 ECMS Notification notified on 08.04.2025.pdf
77 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2222519&reg=48&lang=2
78 https://www.pib.gov.in/PressReleaseIframePage.aspx?PRID=1939553&reg=48&lang=2
79 Press Release:Press Information Bureau
80 https://abdm.gov.in/abdm
81 https://abdm.gov.in/abdm
82 Production Linked Incentive (PLI) Scheme for White Goods | Department for Promotion of Industry and Internal Trade
83 Production Linked Incentive (PLI) Scheme for White Goods | Department for Promotion of Industry and Internal Trade

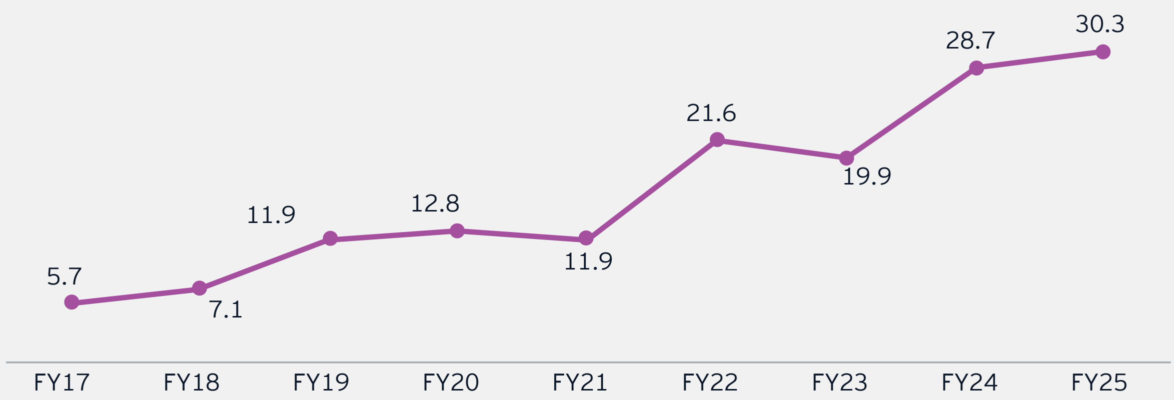
Sector	Products	Government policy	Impact
Automotive industry	Electric two-wheelers and three-wheelers	PM E-Drive Scheme, 2024, 2022[84]	Increase in sales by 20 times from 0.9 million in 2016 to 18.78 million in 2024[85]
	Automobiles and auto components	PLI Scheme for Automobile and Auto Components Industry, 2021[86]	Incremental production of INR42,500 crore (~US$4.4 billion) over a period of five years from 2024[87]
Industrial sector	Industrial robots and automated production systems	SAMARTH Scheme, 2017[88]	Development of factories, advanced smart machines, manufacturing technologies[89]
Data centers	AI servers and GPU-based computing	IndiaAI Mission, 2024[90]	More than INR10,300 crore allocated over five years for IndiaAI Mission, with 38,000 GPUs deployed[91]
Defense and aerospace	Drones and unmanned aerial systems	SAMVITA and PMFBY[92]	Wider adoption of drones in agriculture, mapping, inspection, logistics and defense[93]

The growth in these sectors further increased the demand for semiconductors in India. Rising consumption translated into a sustained increase in imports of semiconductors. India's imports of semiconductor products witnessed a continuous increase from US$5.7 billion in FY17 to US$30.3 billion in FY25 at a CAGR of 23%.[94]

The reliable availability of semiconductors became critical to a nation's economic security and strategic autonomy, given their indispensable role in powering essential systems and infrastructure.[95]

However, in recent times, the world witnessed a shortage of supply in semiconductor sector, leading to concerns over supply-chain resilience, economic security and dependence on a limited number of manufacturing hubs.

India's import of semiconductor products (US$ billion)



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86 Press Release Page | Press Information Bureau
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88 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2117289&reg=48&lang=2 https://samarth-textiles.gov.in/
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94 Future of India's Semiconductor Industry
95 https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=154968&ModuleId=3&reg=3&lang=2

Global semiconductors supply related challenges

Following the COVID-19 pandemic, the world was exposed to several semiconductor supply chain shocks, as elaborated below:

Strategic Technology Control

The semiconductor ecosystem is highly concentrated, with a few countries controlling critical technologies, intellectual property, manufacturing equipment and advanced fabrication capabilities. This concentration limits access to frontier technologies and constraints technological advancement. Semiconductors are the foundational input for emerging technologies such as AI, 5G/6G, electric vehicles, Industry 4.0, cloud computing and advanced electronics. Strengthening domestic semiconductor ecosystem capabilities is critical for enhancing India's manufacturing competitiveness and technological leadership

National Security Imperatives

Semiconductors have increasingly become a tool of strategic influence, with countries using export controls on advanced chips, manufacturing equipment and critical materials to advance national security objectives. Examples include US restrictions on advanced semiconductor technologies and equipment exports as well as China's restrictions on critical minerals and materials used in semiconductor supply chains, underscoring the importance of building domestic capabilities and reducing strategic dependencies.

Global supply chain disruptions, rising geopolitical uncertainties and the race to secure critical technologies exposed the risks of overdependence on external suppliers. At the same time, Indian market for semiconductors is expected to expand significantly driven by digital era. Nations that act decisively now can secure long-term strategic advantages. The simultaneous growth in domestic semiconductor consumption and exposure to global supply disruptions has strengthened the case for developing domestic capabilities. India now has an opportunity to connect the scale created in downstream electronics and technology sectors with investments in semiconductor design, fabrication, packaging and supplier development.

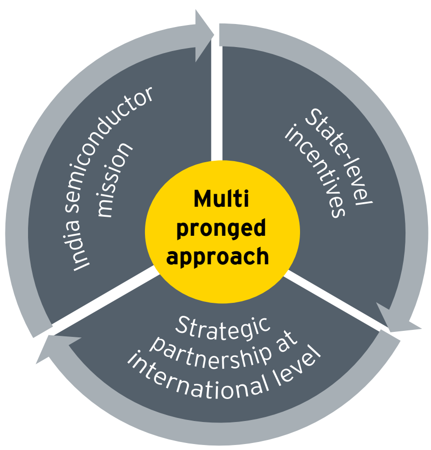
As a result, the government planned to launch dedicated policy interventions covering the entire semiconductor manufacturing supply chain. As an initial step, the primary focus was on building capabilities across design, manufacturing/fabrication and OSAT/ATMP by understanding the critical requirements in each segment.[96]

Semiconductor policies at the central level

India Semiconductor Mission 1.0

Recognizing the rapid expansion of India's semiconductor market, valued at approximately US$22.7 billion in 2019[97], the government launched the India Semiconductor Mission (ISM) as an umbrella program to develop a robust domestic semiconductor ecosystem.

The Mission initially focused on attracting investments and establishing foundational capabilities across the semiconductor value chain through incentives for semiconductor and display fabs, OSAT/ATMP facilities, compound semiconductors and sensors and semiconductor design.[98]



96 https://www.pib.gov.in/PressNoteDetails.aspx?NoteId=155130&ModuleId=3&reg=48&lang=2 Press Release Page | Press Information Bureau
97 India's Promising Semiconductor Manufacturing Trajectory
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Central schemes for the semiconductor ecosystem

ISM 1.0 (Semicon 1.0, 2021-26[99]): The project was approved with a financial outlay of INR76,000 crore

	Scheme name	Eligibility	Tenure	Incentives
Design	Design Linked Incentive (DLI) Scheme[100]	Companies/consortia/joint ventures proposing to set up a silicon CMOS-based semiconductor fab in India for manufacturing logic/memory/digital ICs/ analog ICs/mixed signal ICs/ SoCs[101]	Applications invited for three years from 2022	**Product design-linked incentive**: Reimbursement of 50% of eligible expenditure, capped at INR15 crore (~US$1.56 million) per application **Deployment-linked incentive**: Reimbursement of 6% to 4% of net sales over five years, capped at INR30 crore (~US$3.13 million) per application
Manufacturing fabs	Scheme for Setting Up Semiconductor Fabs[102]	▪ **Technology**: Wafer size of 300 mm ▪ **Installed capacity**: Minimum 40,000 WSPM* ▪ **Minimum capital investment**: INR20,000 crore (US$2.08 billion) ▪ **Revenue threshold**: INR7,500 crore (~US$0.78 billion) in any three preceding financial years	Six years (2021-27)	Incentives are as follows: ▪ **Fiscal support**: Up to 50% of project cost ▪ **R&D support**: Up to 2.5% of the scheme's outlay is earmarked for R&D, skill development and training requirements
Manufacturing fabs	Scheme for Setting up Display Fabs[103]	▪ **Technology**: Generation 8 or above for TFT LCD and Generation 6 or above for AMOLED ▪ **Installed capacity**: Minimum 60,000 panels/ month for TFT and 30,000 panels/month for AMOLED ▪ **Minimum capital investment**: INR10,000 crore (US$1.04 billion) ▪ **Revenue threshold**: INR7,500 crore (~US$0.78 billion) in any three preceding financial years	Six years (2021-27)	Incentives are as follows: ▪ **Fiscal support**: Up to 50% of project cost ▪ **R&D support**: Up to 2.5% of the scheme's outlay is earmarked for R&D, skill development and training requirements
Manufacturing fabs	Scheme for Setting Up Compound Semiconductors/ Silicon Photonics/ Sensors Fab and Semiconductor Assembly, Testing, Marking and Packaging (ATMP)/OSAT facilities[104]	▪ **Technology**: Generation 150/200 mm or more ▪ **Installed capacity**: Minimum 500 WSPM* (100 mm equivalent) ▪ **Minimum capital investment**: INR100 crore (US$0.0104 billion)	Applications invited till 31.12.2024	Incentives are as follows: ▪ **Fiscal support**: Up to 50% of project cost ▪ **R&D support**: Up to 2.5% of the scheme's outlay is earmarked for R&D, skill development and training requirements
ATMP/OSAT	Scheme for Setting Up Compound Semiconductors/ Silicon Photonics/ Sensors Fab and Semiconductor Assembly, Testing, Marking and Packaging (ATMP)/OSAT facilities[105]	▪ Minimum capital investment: INR50 crore for ATMP/OSAT	Applications invited till 31.12.2024	Incentives are as follows: ▪ Fiscal support: Up to 50% of project cost ▪ R&D support: Up to 2.5% of the scheme's outlay is earmarked for R&D, skill development and training requirements

*WSPM- Wafer Starts Per Month

97 India's Promising Semiconductor Manufacturing Trajectory
98 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2284806&reg=3&lang=1
99 Semiconductor Fab | India Semiconductor Mission
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101 Design Linked Incentive Scheme | ISM
102 1665119978_Notification_Modified_Scheme_for_Semiconductor_Fabs.pdf
103 1665120088_Notification_Modified_Scheme_for_Display_Fabs.pdf
104 1665120229_Notification_Modified_Scheme_for_Compound_Semiconductor_ATMP.pdf
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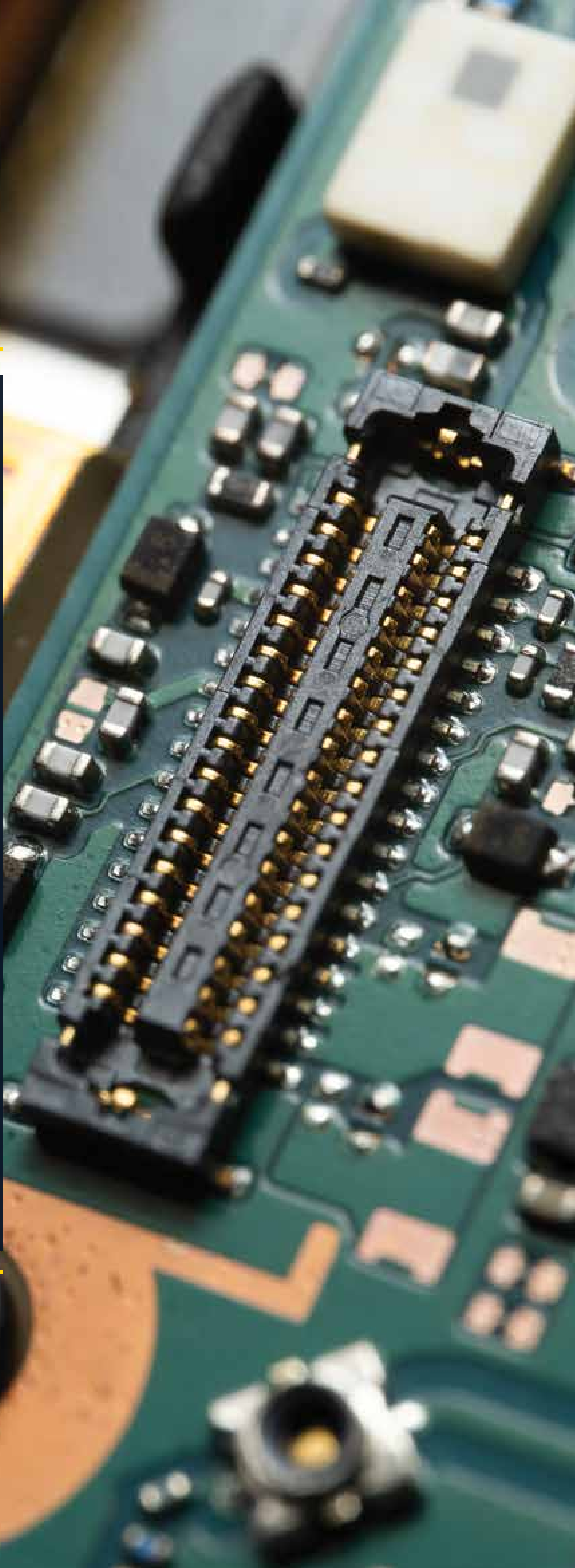
Snapshot of achievements of Semicon 1.0

- Twelve (12) semiconductor manufacturing projects have been approved, including 1 silicon fab, 2 compound semiconductor fabs, 9 packaging facilities and 24 design startups, with a cumulative investment pipeline of approximately INR1.64 lakh crore (~US$17.1 billion).
- As of August 2026, 23 chip tape-outs have been completed at foundries, demonstrating India's growing capability to take chip designs from concept to silicon.
- As of August 2026, three semiconductor units have commenced production and exports.
- Development of indigenous RISC-V* processor families such as SHAKTI, VEGA, AJIT, THEJAS and DHRUV64 has created a domestic processor ecosystem, reducing dependence on imported processor IP.
- Launch of the Digital India RISC-V (DIR-V) ecosystem under C2S has enabled students, startups and researchers to build solutions on indigenous VEGA and SHAKTI processor platforms.
- The government's timely facilitation of incentives and implementation from approvals to on-ground execution has strengthened investor confidence and enabled tangible progress.

*RISC-V (Reduced Instruction Set Computer-V): An open-source processor Instruction Set Architecture (ISA) that enables the design of customizable and royalty-free processors.



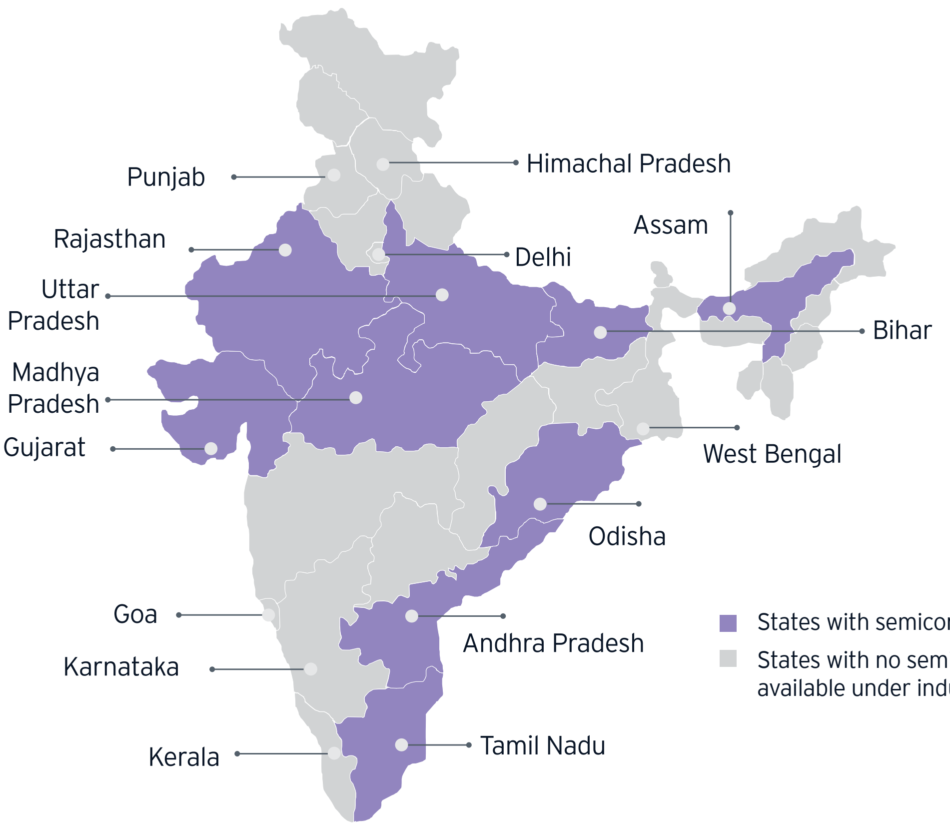
India's complementary schemes across the value chain

Incentives in India for the raw material stage: Pursuant to the National Critical Mineral Mission and the thrust of the government upon strengthening the recycling capabilities for India, a INR1,500 crore Incentive Scheme for Recycling of Critical Minerals was approved by the Ministry of Mines in September 2025, to secure critical mineral needs in India.[106]				
Raw materials	Incentive Scheme for Promotion of Critical Minerals Recycling[107]	The scheme covers important critical minerals required in the semiconductor supply chain such as gallium, cobalt and titanium	Six years: FY 2025-26 to FY 2030-31	▪ Capital subsidy: 14% to 20% for new capacity or expansion; or ▪ Opex subsidy: Incentive on incremental sales over FY26; or ▪ Hybrid of capex and opex subsidy: A mix of both with capping

Semiconductor policies across Indian states

To complement the capital support provided by the central government under the Semicon India Programme, several state governments have introduced dedicated semiconductor policies offering additional fiscal and non-fiscal incentives to attract investments and support ecosystem development.

Across states, semiconductor policies combine capital support with incentives related to land, financing, utilities, SGST, skilling and innovation. The table below provides an indicative overview of the incentive ranges commonly offered to semiconductor projects.



■ States with semiconductor policy
■ States with no semiconductor policy (incentives may be available under industrial/electronics policies)

106 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2163454&reg=3&lang=2
107 68bfbdede93491757396461.pdf

Type of incentive	Quantum of incentive (indicative range)
Capital subsidy	▪ For projects approved under ISM: 40% to 60% of the subsidy provided by the Centre under ISM ▪ For projects not approved under ISM: 5% to 40% of project capex
Land-related incentives	▪ Land price subsidy of 5% to 75%
Interest subsidy	▪ Interest subsidy of 5% to 6% p.a. on term loans for five to seven years
SGST reimbursement	▪ 50% to 100% reimbursement of SGST
Stamp duty exemption	▪ 100% exemption on stamp duty
Utilities incentives	▪ 20% to 50% of capex subsidy for establishing solar power projects, water-treatment plants, Zero Liquid Discharge (ZLD) plants, etc. ▪ 100% electricity duty exemption ▪ Subsidized power tariff ranging from INR2-INR5/unit ▪ Subsidized water tariff ranging from INR4-INR12/cubic meter
Employment benefits	▪ 20% to 30% payroll subsidy for hiring local state residents
Skilling incentives	▪ 50% to 100% reimbursement of cost of training/skilling ▪ 50% to 100% reimbursement of cost of quality certification, capped at INR10 lakh–INR1 crore/unit
Patent filing assistance	▪ 50% to 100% reimbursement of patent fee, capped at INR10 lakh–INR1 crore
R&D support	▪ 25% to 50% capital subsidy for establishing R&D centers and Centre of Excellence (CoE), capped at INR10-INR25 crore

While central support under ISM is primarily focused on capital expenditure and R&D expenses, state policies provide additional incentives covering land procurement, interest subvention, utilities, tax reimbursements, employment generation, skilling and ecosystem development. These incentives typically target semiconductor fabrication facilities, display fabs, OSAT/ATMP units, compound semiconductor projects, design companies and R&D centers, with the objective of improving project viability and accelerating ecosystem development across states. Some of the achievements of state-level policies are highlighted below:[108]

Snapshot of achievements of state industrial policies

- Under the Gujarat Semiconductor Policy 2022-27, Gujarat has attracted significant investments worth INR1.24 lakh crore (~US$13 billion), which are expected to create 53,000 jobs.
- The Gujarat Semiconductor Policy facilitated investments of over INR22,500 crore (~US$2.34 billion) for the establishment of a cutting-edge ATMP facility in Sansad, Gujarat.
- The Uttar Pradesh Semiconductor Policy 2024 facilitated investment of a major OSAT plant, strengthening the state's position as an attractive destination for semiconductor-related investments.
- Approval of landmark semiconductor projects under the state government with a cumulative investment of INR23,000 crore (~US$2.4 billion) and generation of more than 3,500 high-value jobs across Karnataka.

108 Gujarat - Gujarat becomes India's first state to implement a dedicated semiconductor policy | DD News Gujarat govt unveils Semiconductor Policy (2022 | Akashvani News Uttar Pradesh - Semiconductors in Uttar Pradesh | Official Website of Invest UP, Government of Uttar Pradesh, India Karnataka - egov.eletsonline.com/2025/05/karnataka-approves-23000-crore-semiconductor-projects-strengthens-bid-to-become-global-chip-hub/

In addition to fiscal incentives, several states have proactively developed dedicated semiconductor manufacturing facilities, industrial parks and cluster-based infrastructure to attract investments across the semiconductor value chain.

State and cluster name	Focus area	Key project description
Gujarat – Dholera Semiconductor Cluster	Silicon wafer fabrication; compound semiconductor (GaN) fab and ATMP	▪ India's first commercial semiconductor fab at Dholera Special Investment Region, an INR91,000 crore (~US$2.35 billion), 300 mm facility for logic and analog ICs (28-110 nm nodes) with a capacity of up to 50,000 wafer starts per month, approved 29 February 2024.[109] ▪ In May 2026, the Cabinet also approved an integrated compound-semiconductor fab and ATMP unit at Dholera for Mini/Micro-LED display modules and GaN epitaxy on 6-inch wafers.[110]
Gujarat – Sanand Semiconductor Cluster	ATMP/ OSAT – memory, discrete and logic packaging	▪ ATMP (memory packaging) unit, INR22,516 crore (~US$2.35 billion), was the first project approved under the India Semiconductor Mission (June 2023) and began commercial production in February 2026.[111] ▪ INR7,600 crore (~US$ 791 million) OSAT facility approved on 29 February 2024.[112] ▪ INR3,300 crore (~US$343 million) OSAT unit was approved on 2 September 2024.[113] ▪ OSAT facility for discrete semiconductors was approved on 5 May 2026.[114]
Assam – Morigaon (Jagiroad) Semiconductor Cluster	ATMP – assembly, test, marking and packaging	▪ Semiconductor assembly and INR27,000 crore (~US$2.8 billion) ATMP facility at Jagiroad, Morigaon district, India's first semiconductor unit in the Northeast was approved on 29 February 2024. It is designed for 48 million chips per day for automotive, EV, consumer electronics and telecom applications.[115]
Uttar Pradesh – YEIDA (Jewar) Semiconductor Cluster	Display driver IC (DDIC) manufacturing	▪ A joint venture approved on 14 May 2025 (INR3,700 crore, ~US$385 million) is building a display-driver-chip plant near Jewar airport under the Yamuna Expressway Industrial Development Authority (YEIDA). The facility is designed for 20,000 wafers per month and 36 million units per month and is the first ISM-approved project outside the Gujarat-Assam corridor.[116]
Odisha – Bhubaneswar (Info Valley) Semiconductor Cluster	Compound semiconductor (SiC) fab; advanced glass-substrate packaging	▪ India's first commercial silicon carbide compound-semiconductor fab at Info Valley, Bhubaneswar (60,000 wafers/year; 96 million packaged units/year). ▪ An embedded glass-substrate and interposer packaging unit (approximately 69,600 glass panel substrates, 50 million assembled units and 13,200 3DHI modules per annum).[117]
Andhra Pradesh[118]	ATMP – assembly, test, marking and packaging	▪ Setting up of semiconductor manufacturing unit with technology tie up with a leading global semiconductor company. ▪ Manufactured products to find application in mobile phones, set-top boxes, automobiles and electronics.
Punjab[119]	High-power discrete and compound semiconductor	▪ Brownfield expansion of the existing facility to manufacture diodes, transistors among other products using silicon and silicon carbide serving automobile industry, renewable energy and other industry requirements.

109 Press Information Bureau, "Cabinet approves setting up of three more semiconductor units in India," 29 February 2024. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2010135

110 Press Information Bureau, "Cabinet approves two more semiconductor manufacturing units with cumulative investment of more than Rs. 3,900 crore," 5 May 2026. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2258116

111 Press Information Bureau, "PM inaugurates Micron Technology's ATMP facility in Sanand, Gujarat," 28 February 2026 (approval originally announced June 2023). https://www.pib.gov.in/PressReleasePage.aspx?PRID=2233998

112 Press Information Bureau, "Cabinet approves setting up of three more semiconductor units in India," 29 February 2024. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2010135

113 Government of India, All India Radio News (newsonair.gov.in), "Cabinet approves proposal of Kaynes Semicon to setup a semiconductor unit in Gujarat," 2 September 2024. https://www.newsonair.gov.in/cabinet-approves-proposal-of-kaynes-semicon-to-setup-a-semiconductor-unit-in-sanand-gujarat

114 Press Information Bureau, "Cabinet approves two more semiconductor manufacturing units with cumulative investment of more than Rs. 3,900 crore," 5 May 2026. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2258116

115 Press Information Bureau, "Cabinet approves setting up of three more semiconductor units in India," 29 February 2024. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2010135

116 Press Information Bureau, "Cabinet approves semiconductor unit in Uttar Pradesh," 14 May 2025. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2128605

117 Press Information Bureau, "Cabinet approves semiconductor manufacturing units in Odisha, Punjab and Andhra Pradesh with an outlay of Rs. 4,600 crore," 12 August 2025. https://www.pib.gov.in/PressReleasePage.aspx?PRID=2155459

118 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2155456&reg=48&lang=2

119 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2155456&reg=48&lang=2

India's strategic collaborations

Foreign Trade Agreements (FTAs)	▪ India has actively expanded its network of FTA's including engagements with the EU, New Zealand and Oman ▪ These FTA's are envisioned to boost investment and strengthen manufacturing of semiconductors in India.
Memorandum of Understandings (MoUs)	▪ India Japan Digital Partnership 2.0: Agreement to advance cooperation in advanced technological fields including semiconductors ▪ India-ROK industrial cooperation committee: Commitment to Unlock opportunities for collaboration in sectors such as semiconductors ▪ India and Chile MoU on critical minerals: Exploration on deeper collaboration of critical minerals like copper and lithium ▪ India Japan Memorandum of Cooperation in mineral resources: Joint investment in exploration, mining and exchange of information
Strategic partnerships	▪ India US partnership under ISM: Exploration of opportunities to diversify global semiconductor ecosystem under CHIPS Fund and establishing a semiconductor ▪ India Singapore partnership: Policy exchanges, B2B forums promoting cooperation on supply-chain resilience and workforce development ▪ India Taiwan partnership: Proposed private sector investments in wafer fabs, OSAT and collaboration in skill development, R&D activities

India's semiconductor collaborations demonstrate that global cooperation remains central to its semiconductor ambitions, including its goal of becoming an alternative to other countries in the semiconductor sector and reducing supply chains risks for both domestic and global economies. Certain achievements and potential outcomes resulting from these collaborations are described below:

Snapshot of achievements of strategic collaborations

- A joint venture between Indian and Taiwanese companies is expected to create more than 20,000 job opportunities and build India's first 12-inch wafer fab.[121]
- AICTE-facilitated MoUs between Indian and Taiwanese institutions have enabled over 128 colleges to adopt new curricula and are expected to add nearly 8,000 skilled professionals to India's semiconductor workforce.[122]
- Japan invited officials from the Indian government and faculty members from universities to visit semiconductor human resource development centers in Japan to train personnel for semiconductor manufacturing in India.[123]

120 FTA https://www.facebook.com/MoRTHIndia/posts/indiaeu-fta-accelerating-growth-in-the-electronics-sector-the-indiaeu-free-trade/1196524159305927/ Japan MoU - Press Release Page | Press Information Bureau https://mines.gov.in/admin/download/68b54184a65e41756709252.pdf Korea - Joint Strategic Vision for India-ROK Special Strategic Partnership | Prime Minister of India US - https://2021-2025.state.gov/new-partnership-with-india-to-explore-semiconductor-supply-chain-opportunities/ https://invest.up.gov.in/wp-content/uploads/2024/09/India_280924.pdf Singapore - https://isomer-user-content.by.gov.sg/166/bfbe25ae-e74a-42dc-b286-0ac4f78011f7/MTI-press-release-on-India-Singapore-Semiconductor-Ecosystem-Partnership-MOU.pdf Taiwan - https://globaltaiwan.org/2024/11/beyond-the-strait-taiwan-india-semiconductor/ Japan - 101054354.pdf

121 Press Releases | PSMC

122 Indian Higher Education Delegation visits Taiwan to Establish Semiconductor Related Training Collaboration -Ministry of Education Republic of China (Taiwan)

123 Press Release Page | Press Information Bureau

Further, in addition to the above, the Indian government has recognized the importance of talent in development of a comprehensive semiconductor value chain in the country. India's talent and research foundation forms one component of the wider policy and investment environment supporting the semiconductor ecosystem. The following sections examine the contribution of private companies, states and strategic international collaborations to this broader foundation.

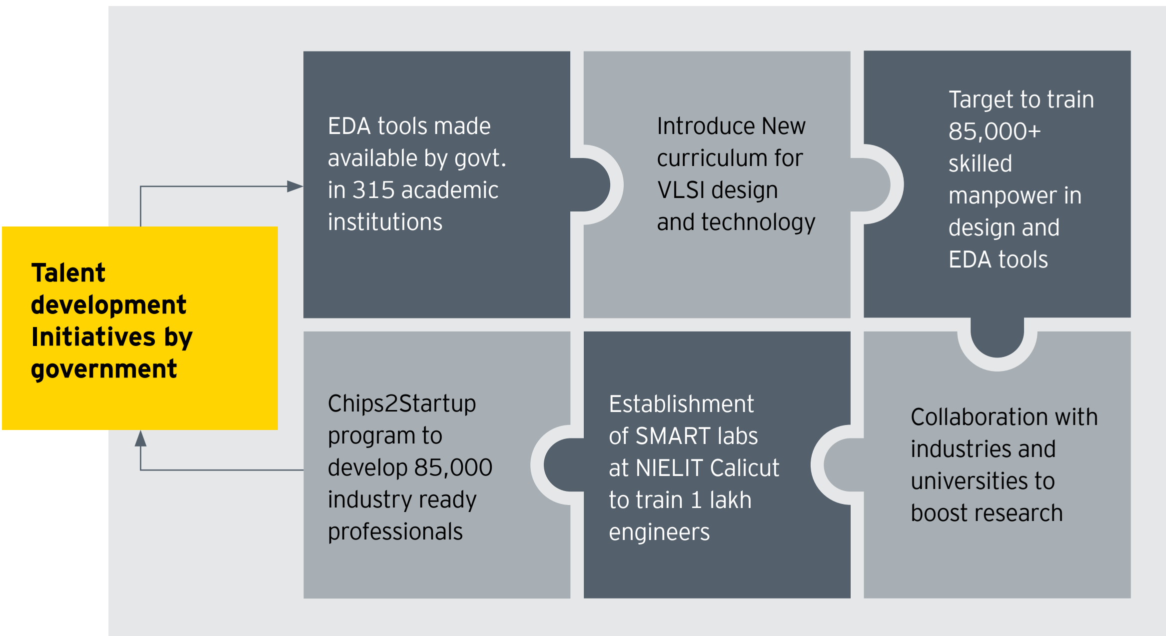
India's evolving semiconductor talent and research foundation[124]

India's semiconductor talent base has developed principally around integrated-circuit design, verification, embedded systems and engineering services. In terms of semiconductor manufacturing, India's strength lies in its large pool of engineers and technology professionals. The government has also launched several initiatives to enhance the depth and quality of talent pool through funding and Chips to Start-up (C2S Programme).[125,126,127]

India's semiconductor progress has been driven not only by government policy and financial support but also by the active participation of private companies, startups and researchers. This includes hosting major global design centers[128] and expansion of Indian semiconductor GCCs.[129]

The government has adopted a proactive approach to semiconductor talent development through a combination of curriculum reforms, industry-academia collaboration, research support and large-scale skilling initiatives. Programs such as Chips2Startup (C2S), the provision of Electronic Design Automation (EDA) tools to academic institutions, and targeted training efforts under the National Institute of Electronics and Information Technology (NIELIT) are helping build a pipeline of industry-ready professionals. These initiatives are expected to strengthen India's talent base, support domestic semiconductor manufacturing and design capabilities and enhance the country's competitiveness across the semiconductor value chain.

India has also developed qualifications relevant to semiconductor manufacturing and packaging. The National Qualifications Register includes programs covering semiconductor fabrication technology, cleanroom operations and safety, photolithography, etching, thin-film technology, device characterization, process-equipment maintenance, assembly, testing, packaging, production quality and industrial safety. These qualifications provide a starting point for developing technicians and manufacturing personnel across fabrication and ATMP/ OSAT operations.



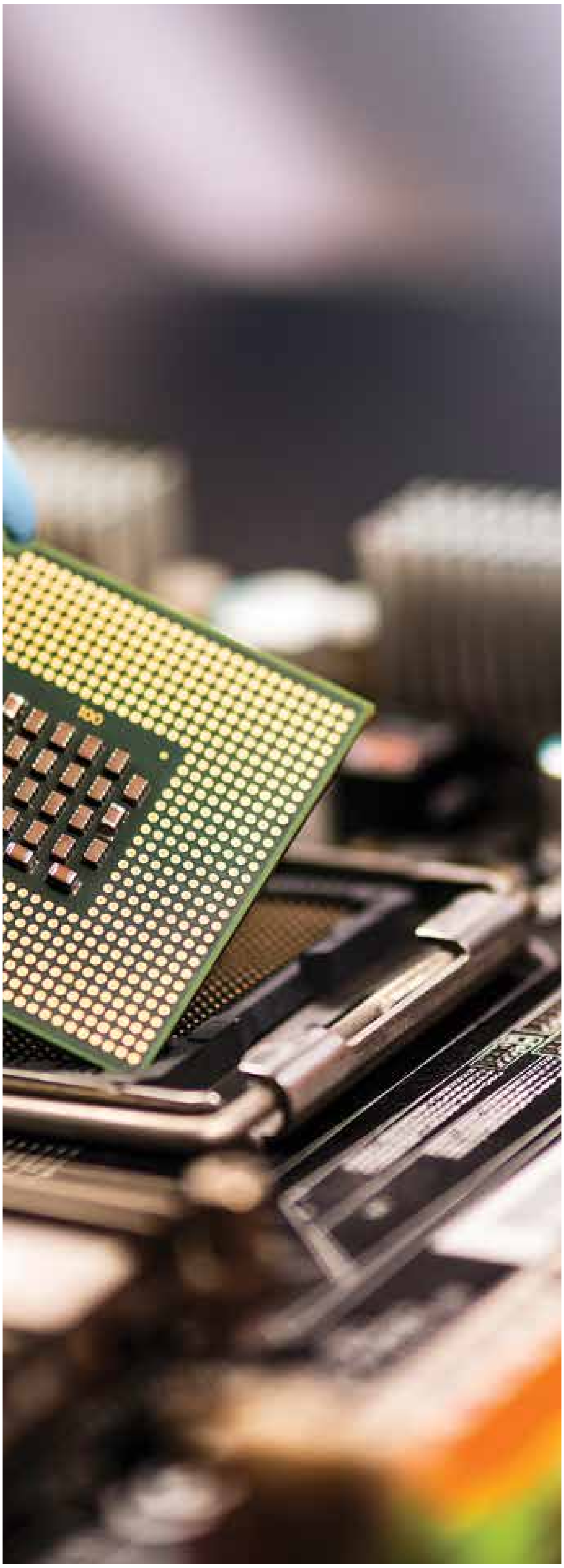
124 Ministry of Skill Development and Entrepreneurship, India Semiconductor Ecosystem Workforce Development Strategy Report 2025.
125 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2236290&reg=3&lang=1 Press Release Page | Press Information Bureau
126 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2148393&reg=48&lang=2
127 https://c2s.gov.in/chipin.jsp
128 AMD Inaugurates Technostar Campus in Bengaluru
129 India Semiconductor - Industry Players

These initiatives provide an important foundation. However, India's next-stage requirement is to move from the availability of courses and training programs toward measurable manufacturing readiness, experienced faculty and trainers, practical exposure to semiconductor processes and equipment and shared research platforms capable of supporting technology development, validation and commercialization. The next phase of ecosystem development may require this design capability to be complemented by skills across fabrication, assembly, testing, packaging, equipment, materials, facilities engineering and research. Semiconductor manufacturing depends on a multidisciplinary workforce comprising researchers, device and process engineers, equipment engineers, packaging and test specialists, technicians, cleanroom personnel, quality and reliability professionals, and utility, safety and environmental specialists.

Semiconductor manufacturing requires competencies that differ significantly from those required for chip design. Fab operations require capabilities in process control, equipment operation and maintenance, metrology, contamination control, chemical and gas handling, yield improvement, quality assurance and emergency response. Assembly and packaging require capabilities in die attach, wire bonding, flip-chip attachment, molding, inspection, automated testing, reliability and failure analysis. Accordingly, workforce-development programs need to be aligned with the operating requirements of the facilities being established rather than treating semiconductor talent as a single homogeneous category.

Faculty and trainer readiness is another component of workforce development. The India Semiconductor Ecosystem Workforce Development Strategy Report recommends a structured Training of Trainers and Assessors program for faculty and instructors from engineering institutions, polytechnics, ITIs and other training providers. The proposed areas include photolithography, chemical mechanical planarization, wafer inspection, bonding, packaging, functional testing, EDA tools and cleanroom protocols, supported by simulation, industry exposure and assessment-based certification.

Research and training capacity also depends on access to specialized infrastructure. Relevant facilities include EDA tools, simulation and high-performance computing, cleanrooms, deposition, lithography and etching equipment, metrology and inspection systems, assembly and bonding equipment, semiconductor-test facilities, reliability laboratories and prototype-development infrastructure. The workforce strategy also identifies the role of joint research centers, incubation facilities, virtual cleanrooms and industry-academia collaboration in expanding access to such infrastructure. The next section examines the global semiconductor landscape, highlighting manufacturing concentration across key geographies and identifying key lessons and best practices that may help further strengthen India's semiconductor ecosystem.



Chapter 3

Global semiconductor outlook: Capacity, concentration and incentives support

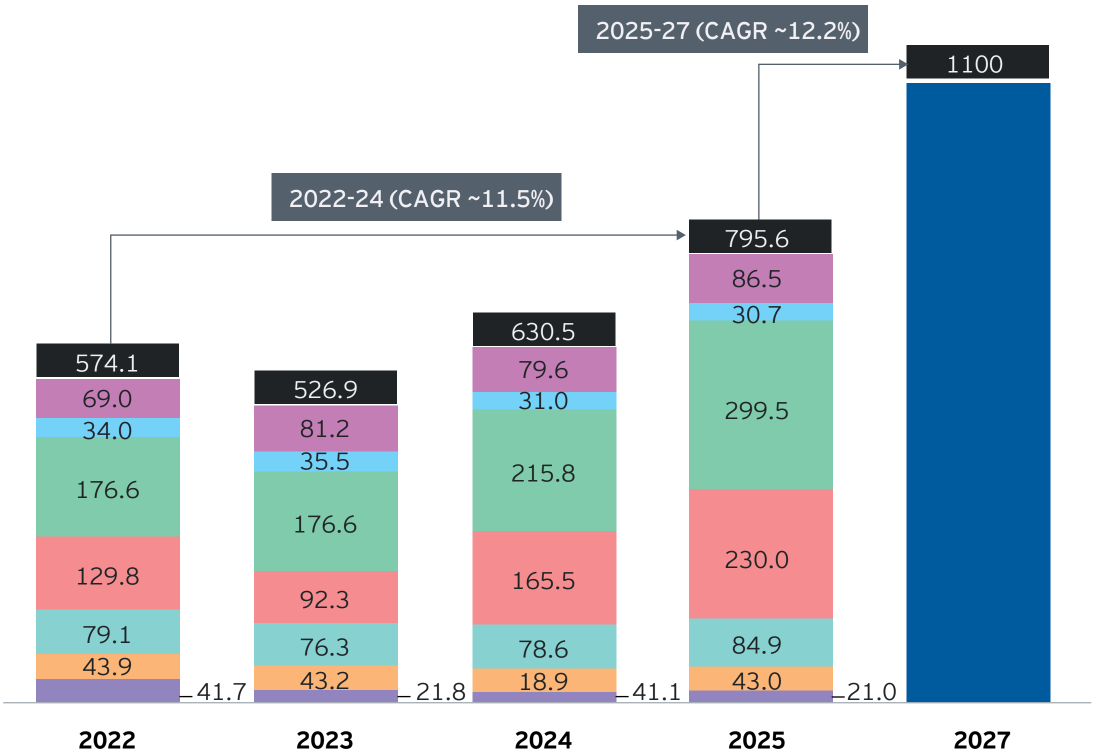
Semiconductors are widely regarded as the fourth most traded commodity worldwide, after crude oil, refined petroleum products and automobiles, underscoring their strategic economic importance[130]. The global semiconductor industry is witnessing strong growth driven by AI, EVs, 5G/6G, data centers and industrial automation. However, key manufacturing capacity, equipment, materials and chemicals remain concentrated in a few countries, creating supply chain risks and intensifying policy-driven investments worldwide. Examining the strategies of leading semiconductor economies, such as Taiwan, Japan, South Korea, the US, EU, Malaysia and Singapore, provides important lessons for India on ecosystem development, supplier depth, R&D, workforce creation and long-term policy support.

130 Strengthening the Global Semiconductor Supply Chain | BCG

Global market size

The semiconductor market is witnessing a strong rebound alongside long-term structural growth, positioning it for sustained expansion driven by both technological demand and continued investment.

Semiconductor products market size (US$ billion)



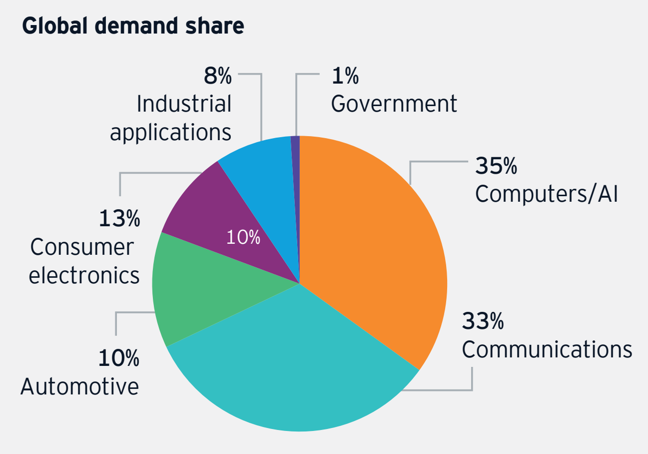
Source: World Semiconductor Trade Statistics (WSTS)

- Global semiconductor market reached a record US$795.6 billion in 2025, an increase of 26.18% compared to 2024, driven by demand from artificial intelligence, data centers and advanced electronics.[131]
- The market is estimated to grow further and reach ~US$1 trillion by 2027 at a CAGR of ~12.1%, indicating strong long-term demand.[132]
- Highest year-on-year growth was witnessed in logic and memory devices.[133]
- CAPEX investment in the industry amounted to ~US$160 billion in 2025, highlighting ongoing capacity expansion and focus on advanced manufacturing.[134]

130 Strengthening the Global Semiconductor Supply Chain | BCG
131 WSTS-Q4-Release-2025_-_06-Mar-2026.pdf
132 ESIA_WSTS_PR_AuFc2025.pdf
133 WSTS-Q4-Release-2025_-_06-Mar-2026.pdf
134 Semiconductor CapEx Down in 2024, up in 2025 - SC-IQ: Semiconductor Intelligence

Global end-users of semiconductors

To better understand the demand dynamics of the semiconductor industry, it is essential to look at the diverse set of end-users that ultimately drive consumption.[135]

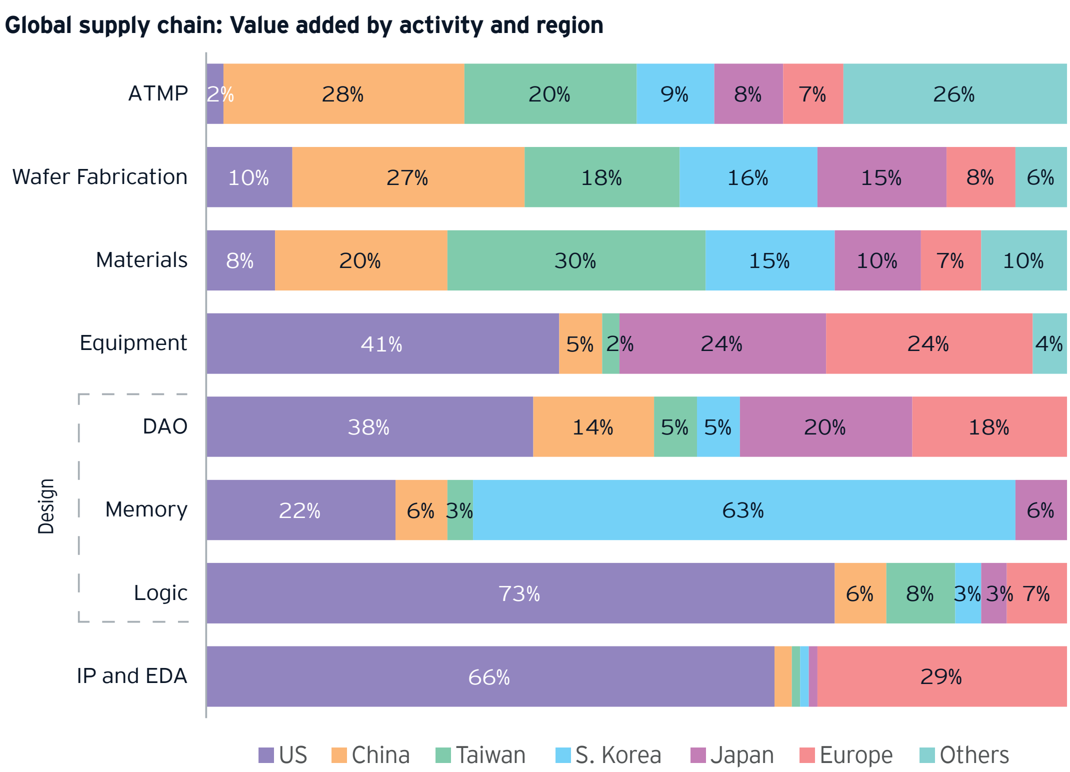


- Communications (~33%) and computing (~35%) account for the largest share of semiconductor usage, showing a strong dependence on smartphones, data processing and digital infrastructure.
- Automotive (~13%) and industrial (8%) segments are growing steadily, reflecting increased adoption of semiconductors in vehicles and automation systems.
- Consumer electronics contributes ~13%, while government and military usage remain minimal at 1% but strategically important.[136]

The distribution indicates both heavy reliance on digital technologies and expanding applications across emerging sectors.

Global manufacturing concentration: Value added by activity and region[137]

The semiconductor supply chain is globalized and complex with production process diversified across countries. The graph below depicts production concentration of various segments of semiconductor supply chain such as materials (wafers, chemicals, gases, lead frames, substances) design, equipment manufacturing, wafer fabrication and OSAT/ATMP globally.[138,139]



135 2025-SIA-Factbook-FINAL-1.pdf
136 SIA-State-of-the-Industry-Report-2025.pdf
137 SIA-State-of-the-Industry-Report-2025.pdf
138 Mapping the semiconductor value chain | OECD
139 SIA-State-of-the-Industry-Report-2025.pdf

- **IP and EDA**: The United States dominates semiconductor design-related activities, accounting for 66% of IP and EDA, 73% of logic and 38% of discrete, analog and other chips (DAO) , highlighting its leadership in high-value intellectual property and chip design. South Korea is another country leading 63% of the total design for memory chips.
- **Materials**: Taiwan is the leading manufacturer of raw materials used in the semiconductor industry (30%) followed by China (20%) and South Korea (15%).
  - Taiwan is a top producer of silicon wafers, hosting leading wafer companies across the globe.[141]
  - China leads in the production of critical minerals required for semiconductor production, such as gallium and germanium.[142]
  - Korea is a leader in specialty gases for semiconductors such as nitrogen trifluoride, tungsten hexafluoride, etc.[143]
- **Equipment**: Semiconductor equipment production is highly concentrated in the US and Europe, with the US accounting for 41% and Europe 24%, together representing nearly two-thirds of global equipment value added.
- **Wafer fabrication**: Manufacturing is concentrated in Asia, with Taiwan leading materials (30%) and holding significant shares in wafer fabrication (18%) and ATMP (20%).
  - Taiwan's manufacturing reflects its central role in the global semiconductor supply chain.
  - South Korea dominates memory manufacturing, contributing 63% of global value added, making it the most geographically concentrated semiconductor segment.
- **OSAT/ ATMP**: ATMP (Assembly, Testing, Marking and Packaging) is the most geographically diversified segment, with meaningful contributions from China (28%), Taiwan (20%), the US (2%), South Korea (9%), Japan (8%), Europe (7%) and others (26%), indicating a relatively distributed manufacturing footprint.

Technology transitions are reshaping semiconductor value creation

The next phase of semiconductor growth is being shaped not only by increasing chip volumes but also by changes in system architecture, computing requirements and energy constraints. Artificial intelligence, data centers, electric mobility, telecommunications, connected devices and industrial automation are increasing demand for specialized compute, memory, networking, sensing and power-management technologies. The semiconductor workforce strategy identifies AI, IoT, robotics, 5G and rising data-processing requirements as important drivers of global and Indian semiconductor demand.

At the same time, continued performance improvement through transistor scaling has become increasingly complex and costly. This increases the strategic importance of complementary approaches, including specialized accelerators, chiplets, heterogeneous integration, advanced packaging, wide-bandgap materials and optical interconnects. These technologies shift part of semiconductor value creation from the individual monolithic die towards the integrated package and complete electronic system.

AI infrastructure illustrates this transition. Its semiconductor requirements extend beyond an accelerator to include memory, high-speed data movement, networking, power management, advanced packaging, thermal management, firmware and software. Similarly, electric vehicles and energy systems create demand for power semiconductors and modules, while expanding data traffic strengthens the relevance of photonic technologies and advanced interconnects. Consequently, countries are increasingly treating design IP, packaging, compound semiconductors, photonics, software and research infrastructure as strategic capabilities alongside wafer-fabrication capacity.

The restructuring of semiconductor supply chains and the emergence of new technology segments create an entry window for countries that do not yet possess large-scale conventional fabrication capacity. India can participate selectively by combining its design and software capabilities with emerging strengths in advanced packaging, compound semiconductors, photonics, AI accelerators and chip-to-system integration. This provides a pathway to develop differentiated positions while the wider domestic manufacturing ecosystem matures.

140 DAO refers to discrete analog and other chips
141 Group Profile - GlobalWafers Co., Ltd. All rights reserved. Top 10 Global Silicon Wafer Manufacturers 2026
142 https://rareearthexchanges.com/news/silicons-hidden-dependency-why-gallium-and-germanium-expose-a-fragile-supply-chain/
143 eng.sk.com/companies/info/sk-ecoplant-materials

Investment and strategic focus areas across leading semiconductor nations[144]

The current distribution of semiconductor manufacturing capabilities across geographies is closely linked to the strategic priorities and technological strengths of leading nations. The following table describes the recent trends in key technology focus areas and investment priorities across major semiconductor economies:

Country	Segment	Emerging technologies/focus areas
US	IP and EDA	▪ Companies in the US are advancing and collaborating to bring AI-driven tools within EDA tools such as: ▪ Utilizing AI in manufacturing 2 nm semiconductor chips, automatic verification design of chips, etc. (collaboration between the top three companies in the US and Taiwan[145]) ▪ Developing a multi-block, multi-user chip design tool that empowers a single engineer to design multiple blocks. This accelerates chip delivery time by 10x.[146]
China	Raw materials- critical minerals such as gallium and germanium	▪ Key extraction and purification technologies such as ion-exchange or resin method to separate gallium metal from host ores like bauxite and zinc. ▪ Exploration of cost-efficient methods of extracting these metals.[147]
EU	Equipment manufacturing	▪ Commercialization of extreme ultraviolet ('EUV') optical columns (precise optical systems) for next gen EUV lithography machines in Germany. These generate, direct and shape EUV light in a lithography machine to print intricate patterns on semiconductor wafers. ▪ These machines are essential in the production of leading-edge chips needed in computing or autonomous driving ▪ Deployment of advanced Extreme Ultraviolet lithography machines for the design and manufacture of chips using technology beyond 2 nm.[148]
Taiwan	Wafer fabrication and ATMP	▪ Taiwan commenced volume production of 3 nm chips in 2022 and is the world's leading manufacturer of advanced-node semiconductors.[149] ▪ Taiwan's 1.6 nm process to be ready for commercial production in the second half of 2026.[150] ▪ Taiwan's Chip-on-Wafer-on-Substrate (CoWoS) technology combines multiple chips, such as processors and high-bandwidth memory as one integrated system for advanced packaging.[151]

Given the respective technological strengths, leading semiconductor nations have introduced targeted policy measures to attract investment and strengthen domestic capabilities. This section focuses on the worldwide incentives provided by major nations in various sectors.

144 TSMC Advanced Packaging Bottleneck: Why CoWoS Controls AI Chip Supply
3nm Technology - Taiwan Semiconductor Manufacturing Company Limited – Taiwan https://www.trade.gov/country-commercial-guides/japan-semiconductors - Japan
https://www.blackridgeresearch.com/blog/latest-list-of-largest-new-semiconductor-fabs-foundries-in-the-us-united-states?srsltid=AfmBOoo0pZ6DPbO7aNJgfQXh8gqJU9smAXucMsCizPuD9eiUx8Jj58nh - US UMC unveils new fab expansion in Singapore in grand opening ceremony | Singapore EDB - SingaporeTSMC Advanced Packaging Bottleneck: Why CoWoS Controls AI Chip Supply
3nm Technology - Taiwan Semiconductor Manufacturing Company Limited – Taiwan https://www.trade.gov/country-commercial-guides/japan-semiconductors - Japan
https://www.blackridgeresearch.com/blog/latest-list-of-largest-new-semiconductor-fabs-foundries-in-the-us-united-states?srsltid=AfmBOoo0pZ6DPbO7aNJgfQXh8gqJU9smAXucMsCizPuD9eiUx8Jj58nh - US UMC unveils new fab expansion in Singapore in grand opening ceremony | Singapore EDB - Singapore

145 AI and Chiplets Prominent at TSMC OIP 2025

146 https://www.cadence.com/en_US/home/tools/digital-design-and-signoff/soc-implementation-and-floorplanning/cadence-cerebrus-ai-studio.html

147 https://www.csis.org/analysis/beyond-rare-earths-chinas-growing-threat-gallium-supply-chains

148 EU invests €700 million in newly opened NanoIC, Europe's largest Chips Act pilot line | Shaping Europe's digital future

149 3nm Technology - Taiwan Semiconductor Manufacturing Company Limited

150 https://globaltaiwan.org/2026/06/taiwans-semiconductor-success-more-than-tsmc/

151 TSMC Advanced Packaging Bottleneck: Why CoWoS Controls AI Chip Supply

Global best practices[152]

Global leaders have adopted semiconductor incentive frameworks that extend beyond manufacturing subsidies to cover the wider value chain, including materials, equipment, fabs, packaging, design, R&D, talent and prototyping infrastructure. This section benchmarks key global policy and financial support measures that have enabled countries to scale their semiconductor ecosystems. It further includes the historical development of the industry, role of the government in enabling so, current market position along with the challenges that may persists in global jurisdictions to present a comprehensive analysis.

1. United States of America (USA)[153]

The United States pioneered the semiconductor industry and for decades-maintained leadership across the value chain, including chip design, manufacturing equipment and innovation. However, while US firms continued to account for 45% to 50% of global semiconductor sales, manufacturing gradually shifted to Asia as Taiwan, South Korea, Singapore and China aggressively supported domestic fabrication through grants, tax benefits and ecosystem development. As a result, the US share of global semiconductor manufacturing capacity declined from 37% in 1990 to 12% in 2020, raising concerns over supply chain resilience, national security and long-term technology leadership.

Key bottlenecks that emerged:

1. US fab production costs were **30% to 50% highe**r than competing Asian locations.
2. **40% to 70% of the cost gap** was attributable to lower government incentives.
3. Growth of the **fabless model** encouraged outsourcing of manufacturing to foreign foundries.
4. Strong semiconductor clusters in East Asia created self-reinforcing advantages in talent, suppliers and infrastructure.

Recognizing the strategic importance of semiconductor manufacturing, the US began evaluating targeted government support to restore competitiveness and attract a greater share of future investments.

152 Future of India's Semiconductor Industry
153 Summary of development from https://www.semiconductors.org/wp-content/uploads/2020/09/Government-Incentives-and-US-Competitiveness-in-Semiconductor-Manufacturing-Sep-2020.pdf and https://www.semiconductors.org/wp-content/uploads/2026/07/SIA_2026_State-of-the-Semiconductor-Industry.pdf

Targeted government interventions

The CHIPS and Science Act, signed in 2022, provides various incentives for semiconductors. Till date, direct funding of US$39,000 million and US$75,000 of credit has been granted to various companies as detailed below:

	Particulars	Incentives as on date
Raw materials	Production cost tax credit	▪ 45X advanced manufacturing production credit, which provides direct payments or credit transfers to produce critical minerals.[154] ▪ Direct payments: Direct cash payments equivalent to 12 energy tax credits. ▪ Credit transfers: Enables buying and selling of IRA tax credits in exchange for cash.
Manufacturing fabs	Manufacturing incentives	▪ US$39 billion in incentives designed for companies undertaking semiconductor facility and equipment projects: ▪ Benefits in the form of – direct grants or loan funding ▪ About 19 companies with 40 projects were selected with funds amounting to US$30.9 billion for construction, expansion and modernizing semiconductor facilities, of which 32 are for wafer / chip manufacturing ▪ Award/grant ranging from 4.6% to 38.8% of capital expenditures with a median of 14.2% ▪ Funding is disbursed basis achievement of milestones as submitted by the beneficiaries ▪ 100% of such projects are scheduled to complete investment by 2033, with more than 50% by 2028[155]
	Tax credit through the CHIPS Act	▪ 35% tax credit of qualified investment in the taxable year for chip manufacturing facilities.[156] ▪ The benefit is applicable to projects with construction occurring after the enactment of the CHIPS and Science Act on 9 August 2022.[157]
Equipment	Tax credit through the CHIPS Act	▪ 35% tax credit of qualified investment in the taxable year for semiconductor manufacturing equipment.[158] ▪ The benefit is applicable to projects with construction occurring after the enactment of the CHIPS and Science Act on 9 August 2022.[159]
ATMP/ OSAT	Funding	▪ Plan to invest US$3 billion in CHIPS Act funds to enhance the US advanced packaging capability ▪ US$300 million in award funding for establishing an advanced packaging industry[160]
Design and R&D	Funding	▪ US$500 million Chips R&D Award for coordination with international partners on AI-driven semiconductor materials discovery and innovation activities[161] ▪ The grant will be spread over a period of five years from FY2023-27 with $100 million funding per year[162]
	Funding towards R&D and workforce development	▪ US$11 billion towards R&D programs such as the National Semiconductor Technology Centre (NSTC) over five years[163] ▪ US$2 billion to fund microelectronics research, fabrication and workforce training over five years[164] ▪ US$200 million towards semiconductor workforce growth and education over five years[165]
	Defence Advanced Research Projects Agency (DARPA)	▪ The DARPA's VLSI (Very Large-Scale Integration) program in the 1970s and 1980s funded universities and companies to develop chip design architecture, computer-aided designs to create design-centric ecosystem[166] ▪ The MOSIS multi-project wafer allowed many chip designs to share a single wafer. MOSIS 2.0 offers end-to-end support such as rapid prototyping, design assistance, fabrication services and testing[167]

154 IF12809.1pdf
155 https://www.gao.gov/assets/gao-26-107882.pdf
156 https://www.semiconductors.org/wp-content/uploads/2026/05/SIA-48D-2-Pager.pdf
157 U.S. Department of the Treasury Releases Final Rules to Strengthen U.S. Semiconductor Industry | U.S. Department of the Treasury
158 https://www.semiconductors.org/wp-content/uploads/2026/05/SIA-48D-2-Pager.pdf
159 U.S. Department of the Treasury Releases Final Rules to Strengthen U.S. Semiconductor Industry | U.S. Department of the Treasury
160 National Advanced Packaging Manufacturing Program | NIST
161 https://www.nist.gov/news-events/news/2026/06/department-commerce-announces-definitive-agreement-sandboxaq-500-million
162 The U.S. Department of State International Technology Security and Innovation Fund - United States Department of State
163 FACT SHEET: Biden-Harris Administration Announces Over $5 Billion from the CHIPS and Science Act for Research, Development, and Workforce | The White House
164 CHIPS for America: Federal Programs Supporting the U.S. Semiconductor Supply Chain and Workforce
165 https://www.gao.gov/assets/gao-26-107882.pdf
166 VLSILayoutfinal.pdf
167 https://www.mosis2.com/about-us

With timely government intervention and support provided to the industry, the market share of the US gradually started to stabilize with the key achievements being:[168]

- **US-headquartered companies generated US$425 billion in semiconductor sales in 2025**, accounting for **53.4% of global semiconductor revenues**, the highest US market share since 1984.
- **Global semiconductor sales reached a record US$795.6 billion in 2025** and are projected to exceed **US$1.5 trillion in 2026**, driven largely by AI and advanced computing demand.
- US semiconductor companies invested a record **US$76.8 billion in R&D during 2025**, reinforcing leadership in next-generation chip technologies.
- Since 2020, companies announced over **US$770 billion in private investments across 160 projects in 30 states**, spanning fabs, packaging, equipment, materials and research facilities.

2. European Union (EU)[169]

Europe remains a critical participant in the global semiconductor value chain, with world-leading capabilities in semiconductor research and equipment manufacturing, including unique position in advanced lithography equipment. However, Europe's share of global chip revenues declined from around 20% in the 1990s to approximately 10% by 2022, while less than 10% of global semiconductor production took place in the region and was largely concentrated in chips of 22 nm and above. European manufacturers retained strength in automotive and industrial semiconductors, accounting for approximately 37% and 17% of the respective global markets. At the same time, the region remained dependent on East Asia for leading-edge fabrication, assembly, testing and packaging and on US-owned chip-design tools. This combination positioned Europe as an important provider of research, equipment and specialized chips, but without an end-to-end semiconductor value chain or a comparable presence in advanced manufacturing.

Key bottlenecks that emerged

1 Dependence on critical raw materials wherein China accounts for 99% of global primary gallium production and about 68% of refined indium production

2 Limited domestic leading-edge fabrication capacity resulting in dependence on Asia for advanced-node manufacturing

3 Microchip factories also require supply of skilled workers and low energy costs which are not available across the European Union

4 Significant assembly and packaging capacity had shifted to East Asia particularly China meaning that chips fabricated in Europe could still need to be sent abroad for further processing.

168 2026 State of the Industry Report: Historic Growth Amid Intensifying Global Competition - Semiconductor Industry Association

169 Summary from https://www.europarl.europa.eu/RegData/etudes/BRIE/2022/733585/EPRS_BRI%282022%29733585_EN.pdf , https://sciencebusiness.net/news/semiconductors/chips-act-spurs-semiconductor-investments-europe , https://www.europeaneconomics.com/en/secteurs/semiconductors/

Targeted government interventions

The EU launched the European Chips Act, mobilizing €43 billion (~US$49 billion) to strengthen semiconductor R&D, pilot lines, advanced manufacturing, packaging, talent development and supply-chain resilience. The Act also supports first-of-a-kind fabs, pilot production facilities and research-commercialization platforms.

	Particulars	Incentives as on date[170]

Manufacturing fabs	Support for advanced chip production in Europe	▪ EU public funding towards vertically integrated manufacturing centers, production of chips designed by others for third parties:
		  ▪ In Italy, a silicon carbide wafer plant was given a direct grant/aid of 40% of the investment cost. [171]
		  ▪ State aid measure of 40% of a direct grant of the total investment in SiC power devices. The project is planned to operate at full capacity in 2032.[172]
		▪ Financial support from the EU and member states for a fund of US$30 billion to support new facilities.[173]

Equipment	State aid	▪ US$86.64 million aid approved by European Commission for supporting a facility to produce semiconductor testing equipment in Munich, which is around 50% of the project cost.[174] ▪ The facility will include advanced metrology and inspection systems.[175]
Design and R&D	Joint undertaking (public-private collaboration)	▪ Joint undertakings worth US$12.54 billion from 2023-2030.[176] ▪ Developing advanced chip technology, semiconductor research, pilot lines, standards, certification for energy efficiency and security of chips, skills and networking of semiconductor research centers.
ATMP/ OSAT	Funding	▪ Direct grant covering 40% of the total investment for a plant offering advanced packaging solutions for chiplet integration. The plant is expected to reach full capacity by 2033.[177]

These interventions have reinforced Europe's position in critical semiconductor technologies while strengthening its long-term industrial competitiveness. Key achievements include:

- The EU houses the world's sole supplier of Extreme Ultraviolet (EUV) lithography systems, a critical technology required for manufacturing leading-edge semiconductor chips[178]. This makes Europe indispensable to the production of leading-edge chips globally.
- It has established multiple advanced pilot lines to accelerate commercialization of next-generation technologies[179].

3. Japan[180]

Japan was a global semiconductor powerhouse in the 1980s, accounting for over **50% of the global semiconductor market**. Rising manufacturing costs, intensifying competition from South Korea in memory chips, and the relocation of electronics manufacturing to other parts of Asia gradually eroded Japan's position in semiconductor manufacturing. While leadership in leading-edge manufacturing shifted to Taiwan and memory production became dominated by South Korea, Japan retained strong competitive advantages in semiconductor materials, silicon wafers, photoresists and manufacturing equipment, which continue to underpin global semiconductor supply chains. Supported by substantial government funding, the country is now pursuing a semiconductor revival strategy centered on advanced chip manufacturing, through initiatives and partnerships with global technology leaders strengthening its position in the current global market.

170 European Chips Act | Shaping Europe's digital future
171 State aid
172 €2 billion Italian State aid
173 Future of India's Semiconductor Industry
174 EU clears €76 million German state aid for QuantumDiamonds
175 Commission approves €76 million German State aid
176 IP_23_6167_EN.pdf
177 Italian State aid
178 EUV lithography systems - Products | ASML
179 The European Chips Act
180 Summary from https://www.trade.gov/country-commercial-guides/japan-semiconductors

Targeted government interventions

Japan government has invested US$23.79 billion[181] from the years 2021-2023 for semiconductor industry.

	Particulars	Incentives as on date
Raw material	Raw materials	▪ Policy on Measures to Secure a stable supply of critical minerals- Grant of 50% of applicant's share of costs including 36 minerals for activities such as exploration, mine development, smelting and refining and technology development.[182]
Manufacturing fabs	Specified Semiconductor Funding Program	▪ The New Energy and Industrial Technology Development Organization (NEDO) Act provides a subsidy of @50% for the cost of civil engineering, construction work and purchase of plant and machinery for development of high-performing semiconductors.[183] ▪ The fund program period would be FY2022-FY2030.[184]
	Specified Semiconductor Interest Subsidy Project	▪ Interest subsidy on loans for specified semiconductor production facilities. The scale of subsidies will vary according to financial requirements. ▪ The policy period would be FY2022-FY2030.[185]
Design and R&D	Research and development funding	▪ US$0.27 billion funding on Leading-Edge Semiconductor Technology Centre (LSTC) for Research & Development costs for a period of five years.[186]

With the support of the Japanese government within strategic areas, the country is now a leading economy in semiconductor equipment and materials, with growth driven by:

- Japan's semiconductor market is estimated to reach **US$51.9 billion in 2025**, driven by growth in AI chips, logic ICs and memory ICs.
- The government allocated approximately **US$25.7 billion (0.71% of GDP)** over three years to support the semiconductor sector, one of the highest levels of support among advanced economies.
- Japan remains a global leader in semiconductor equipment and materials:
  - **88% global market share** in semiconductor coater/developers
  - **53% market share** in silicon wafers
  - **50% market share** in photoresists
  - Key Japanese firms account for approximately 90% of the global silicon wafer market and **90% of the global photoresist market**.
- Through its initiatives, Japan aims to mass-produce **2 nm chips by 2027**, backed by more than **US$6.1 billion** in government funding.

180 Summary from https://www.trade.gov/country-commercial-guides/japan-semiconductors
181 Exchange rate of 1 JPY = 0.0061 US$0.0061
182 Critical Minerals Subsidy Program - Policies - IEA
183 Section3. Amended NEDO Act | Chapter3. Recent Government Policies - JETRO Invest Japan Report 2022 - Reports - Why Invest - Investing in Japan - Japan External Trade Organization - JETRO
184 Subsidy Services for Specified Semiconductor Production Facility Development, etc. | Business | NEDO
185 Subsidy Services for Specified Semiconductor Production Facility Development, etc. | Business | NEDO
186 METI to Provide up to ¥45 bil. for Development of Cutting-Edge Chips; Subsidizing Research and Development Costs - The Japan News Japan to spend $300m on public sector chip R&D centre

4. Taiwan

Taiwan transformed itself from an economy focused on low-value manufacturing in the 1970s into the world's leading semiconductor hub through sustained government support, technology acquisition, talent development and ecosystem creation. The establishment of ITRI and technology transfer from the then leading semiconductor company, creation of Hsinchu Science Park and the emergence of pure-play foundry model enabled Taiwan to build a globally dominant semiconductor manufacturing ecosystem. The same was not without the support provided by the government in terms of:

Targeted government interventions

Taiwan has various funding mechanisms for the semiconductor industry. It has a proposed budget of US$5.46 billion to support semiconductors, AI and other strategic industries.[187]

	Particulars	Incentives as on date[188]
Manufacturing fabs	Skilling	▪ US$1.085 billion scholarships and hands-on training for chip experts. Scholarship award amounts include: ▪ US$620 per month for doctoral students ▪ US$465 per month for master's students ▪ US$310 per month for undergraduate students ▪ Each scholarship will be provided for one year[189]
Design & R&D	R&D funding	▪ Under the Taiwan Industry Innovation Platform Program, 40% to 50% of funding for developing/ innovating high-value products.[190]
	R&D tax deduction	▪ 25% R&D tax deduction, which can be offset against the amount payable for the current year in profit-seeking enterprise income tax. This is available for a period from 1 January 2023 to 31 December 2029.[191] ▪ 5% tax credits for new machinery purchased to be used in advanced manufacturing processes against income tax payable. This incentive is available for a period from 1 January 2023 to 31 December 2029.[192]
	R&D funding	▪ Chip-based Industrial Innovation Program of US$9.3 billion for industry-academia collaboration, AI chips, R&D, infra development. The program will be implemented between 2024-2033.
	Establishment of R&D center for semiconductors	▪ Establishment of an advanced semiconductor R&D center, supported by Taiwan's Ministry of Economic Affairs, to provide R&D and pilot production services, helping IC design firms and startups accelerate commercialization and reduce verification costs.[193]

The strategic interventions by the government in targeted areas resulted in Taiwan being a market leader wherein it:

- Produces over 90% of the world's most advanced semiconductor chips
- Accounts for approximately 64% of global foundry output, making it the world's leading semiconductor manufacturing location
- Hosts a highly integrated ecosystem where design, fabrication, packaging, suppliers and universities operate within a closely connected cluster
- Maintains strong industry support (discussed in the succeeding section)
- Home to globally leading semiconductor companies, which emerged from technology and research capabilities developed in the initial phases of development

187 Science council proposes 13% tech budget hike - Taipei Times Exchange rate at 1 taiwan = US$0.031
188 ICOS – Semiconductor Ecosystem TAIWAN
189 Microsoft Word - Semiconductor International Talent Cultivation Scholarship Implementation Guidelines v5(final)
190 Invest Taiwan_Why Taiwan_Incentives_Subsidies for R&D Expenditures
191 Amendments to the Statute for Industrial Innovation (Executive Yuan, R.O.C. (Taiwan)-Major Policies Detail)
192 Amendments to the Statute for Industrial Innovation (Executive Yuan, R.O.C. (Taiwan)-Major Policies Detail)
193 Building Taiwan's Next Semiconductor Launchpad - ITRI TODAY 124

5. South Korea

South Korea built its semiconductor industry around a **domestic champion model**, with the government backing large national firms rather than relying primarily on foreign investment. The turning point came in **1983**, when one of the leading companies entered the DRAM market with strong state support.

Targeted government interventions

Semiconductor Ecosystem Support Package was announced in South Korea in June 2026 with the aim of enhancing the competitiveness of the entire semiconductor ecosystem.[194]

	Particulars	Incentives as on date
Manufacturing fabs	Credit financing	▪ Preferential interest rates for semiconductor companies starting July 2024-2027: ▪ Interest subsidies of 0.8-1% for large corporations ▪ Interest subsidies of 1.2-1.5% for middle market enterprises[195]
	Infrastructure support	▪ Public funding of KRW 2.4 trillion (~US$1.8 billion) for roads, water and power infrastructure in semiconductor clusters in 2025.[196]
	Skilling	▪ Nurturing 150,000 semiconductor talents over 10 years from 2022-2032.[197]
Equipment	Funding	▪ KRW 204 million (~US$0.14 million) fund 2025 for semiconductor ecosystem for equity investments in materials, parts, equipment and fabless companies starting July.[198]
Design & R&D	R&D tax credit	▪ R&D tax credits on detailed technologies, national strategic technologies and new growth/ fundamental technologies :[199] ▪ Small and medium enterprises: 30% to 40% tax credit ▪ Middle market enterprises: 20-30% tax credit ▪ Major company: 20% to 30% tax credit
	Commercial support	▪ An allocation of US$22.84 million to provide support to AI semiconductor companies. Practical support through vouchers, consulting and technical support will be given to support AI semiconductor commercialization. [200]

Through sustained investment across technology cycles and a focus on memory semiconductors, South Korea established itself as one of the world's leading semiconductor producers and currently:

- Accounts for approximately **65% of global memory production**, making it the world's dominant memory semiconductor hub.
- **Two of the major South Korean companies produce around 70% of global DRAM output**, a segment increasingly driven by AI and data-center demand.
- South Korea represents about **17% of global wafer fabrication capacity**, making it one of the largest manufacturing bases globally.
- The government continues to support industry expansion through the **K-Chips Act**, with an estimated **US$40 billion** equivalent support package focused on foundries, memory, HBM and advanced packaging.
- Remains a critical supplier to the AI ecosystem, where demand for high-bandwidth memory (HBM) is growing rapidly.

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194 Press Releases Exchange rate 1 won = US$0.00068
195 Press Releases
196 Korean Government to Spend 8.8 Tril. Won to Support Semiconductor Industry in 2025 - Businesskorea
197 Gov't pushing to nurture 150,000 semiconductor talents over next 10 yrs | Yonhap News Agency
198 Press Releases
199 Press Releases
200 Press Rele ases - >

6. China

The National Integrated Circuit Industry Investment Fund (Big Fund) of US$100 billion provides a mechanism for granting incentives to the semiconductor industry.

	Particulars	Incentives as on date
Manufacturing fabs	Tax incentives	▪ Corporate income tax exemptions offered for integrated circuits:[201] ▪ 100% corporate income tax exemption for 10 years for projects with circuit lines with width less than 28 nm and an operating period of more than 15 years. ▪ 100% corporate income tax exemption for five years followed by a 50% reduction in the statutory CIT rate for the next five years for projects with circuit lines with width less than 65 nm. ▪ 100% corporate income tax exemption in the first two years followed by a 50% reduction in the statutory CIT rate for the next three years for projects with integrated circuit lines with width less than 130 nm. Allowance to carry forward losses (if incurred) to maximum transfer period of 10 years.
	Credit financing	▪ The government is encouraging local governments to support and improve financial services for medium and long-term loans to commercial financial institutions.[202] ▪ Qualified integrated circuit companies to be supported to list and raise funds at home and abroad.[203]
	Procurement preferences	▪ Chinese data centers have been provided a 50% subsidy on electricity bills with the condition that they use approved Chinese semiconductors.[204]
Equipment manufacturing	Funding	▪ Big fund of China also focuses on semiconductor equipment and materials. The first phase of the fund was established in 2014 with a capital of US$18 billion, followed by a second phase in 2019 with a capital of US$27 billion.[205]
	Tax incentives	▪ 100% corporate income tax exemption for enterprises engaged in equipment in the first two years and 50% for the next three years.[206]

201 Notice of the State Council on Issuing Several Policies to Promote High-Quality Development of the Integrated Circuit and Software Industries in the New Era _ Information Industry (Including Telecommunications) _ China Government Website
202 China stresses high-quality development in integrated circuits and software
203 China stresses high-quality development in integrated circuits and software
204 China cuts data centre energy costs to rev up homegrown chip adoption
205 China sets up third fund with $47.5 bln to boost semiconductor sector | Reuters
206 Notice of the State Council on Issuing Several Policies to Promote High-Quality Development of the Integrated Circuit and Software Industries in the New Era _ Information Industry (Including Telecommunications) _ China Government Website Exchange rate at 1 yuan = US$0.031

7. Malaysia

Malaysia's National Semiconductor Strategy (NSS) worth US$5.3 billion provides fiscal support to the semiconductor industry in Malaysia, which will be launched in three phases, supporting the entire ecosystem of semiconductors.[207]

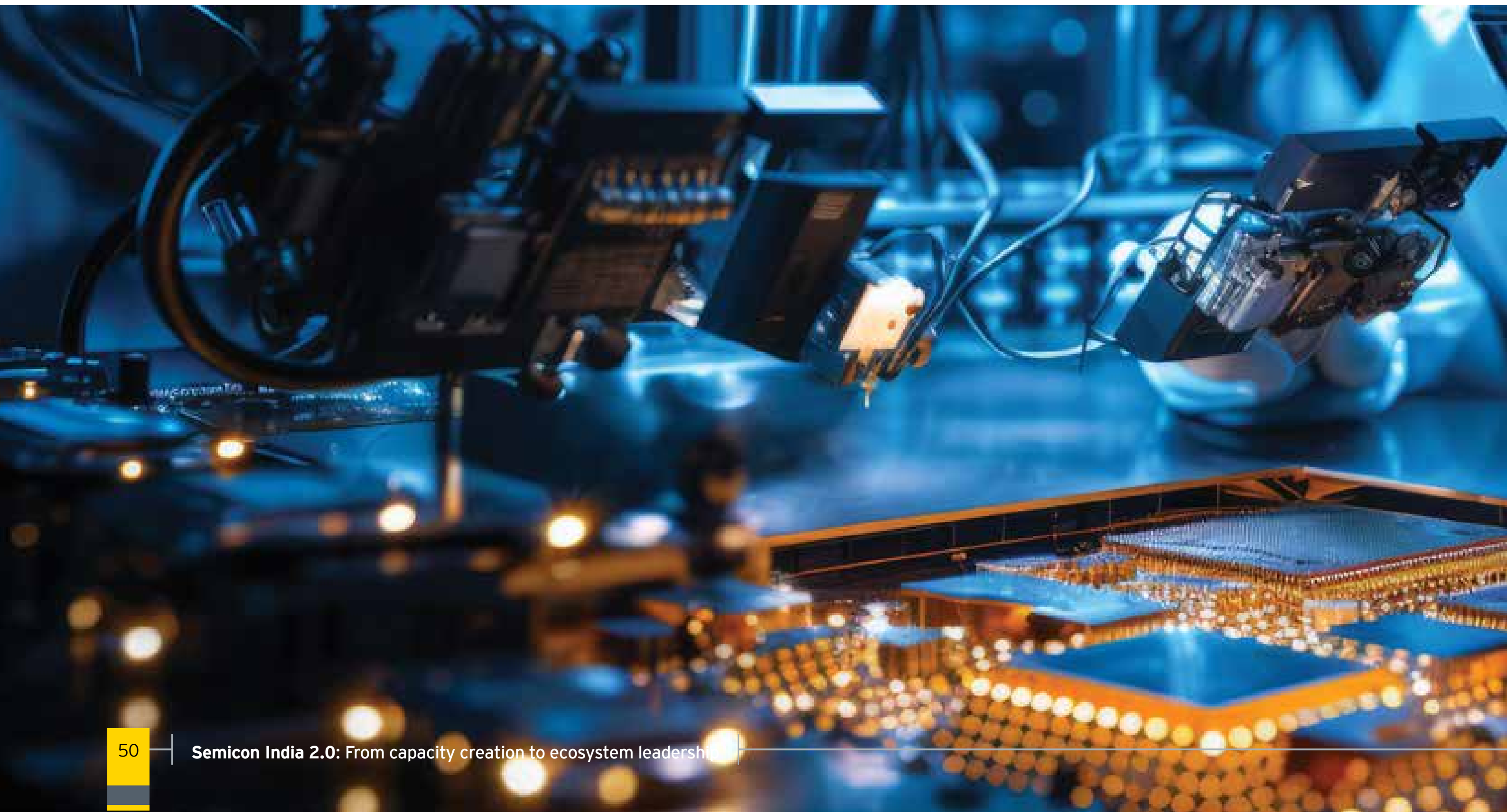
	Particulars	Incentives as on date
Manufacturing fabs	Tax incentive	▪ A reinvestment allowance can be taken equivalent to 60% of the capital expenditure incurred in the base year. This allowance can be offset against 70% of the statutory income earned over the years, as any unutilized RA can be carried forward to future years.[208]
	Investment tax credit	▪ Semiconductor industry, including wafer fabrication, has been granted pioneer status, eligible for investment tax credit.[209] ▪ This incentive provides a five-year partial exemption from income tax, under which the company is required to pay tax on only 30% of its statutory income.[210] ▪ Alternatively, a company may also apply for an investment tax allowance (ITA) of 60% on qualifying expenditure.[212]
Design and R&D	Skilling	▪ Training and upskilling of 60,000 high-skilled engineers with a funding of US$4800 per engineer.

Drawing from global incentive frameworks, several key learnings emerge in terms of the strengths of respective nations in the semiconductor ecosystem:[213]

207 Malaysia to allocate $5.3B funding to operationalize the National Semiconductor Strategy - TNGlobal 1MR = US$0.24
208 Foreign Investors' Guide To Semiconductor Investment In Malaysia - Inward/ Foreign Investment - Malaysia
209 20200425150812_Appendix20I20General.pdf
210 Incentives - MIDA | Malaysian Investment Development Authority
211 Incentives - MIDA | Malaysian Investment Development Authority
212 National Semiconductor Strategy to guide industry up value chain - MIDA | Malaysian Investment Development Authority
213 Japan - The VLSI Research Project, 1976-1980 (Chapter 3) - The Market and Beyond, China - https://www.semiconductors.org/wp-content/uploads/2021/07/Taking-Stock-of-China%E2%80%99s-Semiconductor-Industry_final.pdf https://www.kenresearch.com/china-semiconductor-device-market Taiwan -https://www.researchgate.net/publication/397578171_Structural_Adjustment_of_the_Semiconductor_Industry_in_the_Taiwan_Region_Historical_Evolution_and_Global_Supply_Chain_Shifts https://theconversation.com/how-taiwan-came-to-dominate-the-global-chip-industry-276939 https://www.trade.gov/country-commercial-guides/taiwan-semiconductors-including-chip-design-ai Malaysia - Nomura coverage of Kaynes report

Based on the analysis of global semiconductor ecosystems, a common theme emerges: the most successful jurisdictions have not relied on isolated manufacturing subsidies, but on sustained, ecosystem-wide interventions spanning raw materials, equipment, fabrication, advanced packaging, design, R&D, workforce development, infrastructure and commercialization support. Countries such as the United States, Taiwan, Japan, South Korea and the European Union have demonstrated that well-designed policy measures can influence global supply chain configurations, attract large-scale private investments and strengthen strategic capabilities across critical segments of the semiconductor value chain. Evidence from these jurisdictions suggests that targeted incentives have been effective in expanding domestic capacity, catalyzing significant private sector participation and building technology leadership in niche areas such as advanced manufacturing, semiconductor equipment, materials and chip design.

The comparative assessment further indicates that ecosystem maturity, rather than the quantum of incentives alone, is a decisive determinant of long-term success. Jurisdictions that have developed deep supplier networks, specialized research institutions, strong academia-industry linkages, skilled talent pools and integrated industrial clusters have been able to create self-reinforcing competitive advantages that sustain growth over multiple technology cycles. At the same time, even the most advanced ecosystems continue to grapple with strategic bottlenecks relating to workforce availability, supply chain concentration risks, technology access, geopolitical dependencies and the escalating capital intensity associated with next-generation nodes. For policymakers, the key implication is that semiconductor competitiveness requires a long-term, coordinated and holistic approach that combines fiscal incentives with investments in innovation, talent, infrastructure and ecosystem development. As countries increasingly view semiconductors through the lens of economic security and technological sovereignty, the effectiveness of future interventions will be determined not merely by their ability to attract investments, but by their success in creating resilient, globally competitive and innovation-led ecosystems capable of adapting to evolving technological and geopolitical realities. Similarly, to seize the opportunity presented by the evolving policy landscape in India, it is imperative to take timely action to create a support system aligned with global best practices. One such example is the formulation and launch of Semicon 2.0, which is discussed in detail in the subsequent chapter.



USA

Extensive subsidization for design R&D

The US benefitted from a strong ecosystem of universities, research institutions and a skilled workforce.

Taiwan

Talent-led ecosystem development

Taiwan has built an integrated semiconductor ecosystem by combining talent development with strong foundry, packaging and testing capabilities.

Japan

Support public-private partnerships

Public-private initiatives support next-gen technologies like 2nm chips, backed by strategic R&D funding.

Malaysia

Product diversification

Malaysia's OSAT success is driven by building industry-linkages and focused product diversification.

China

Promoting domestic technologies

Focuses on building its manufacturing capabilities and investing in R&D to develop homegrown technologies.

South Korea

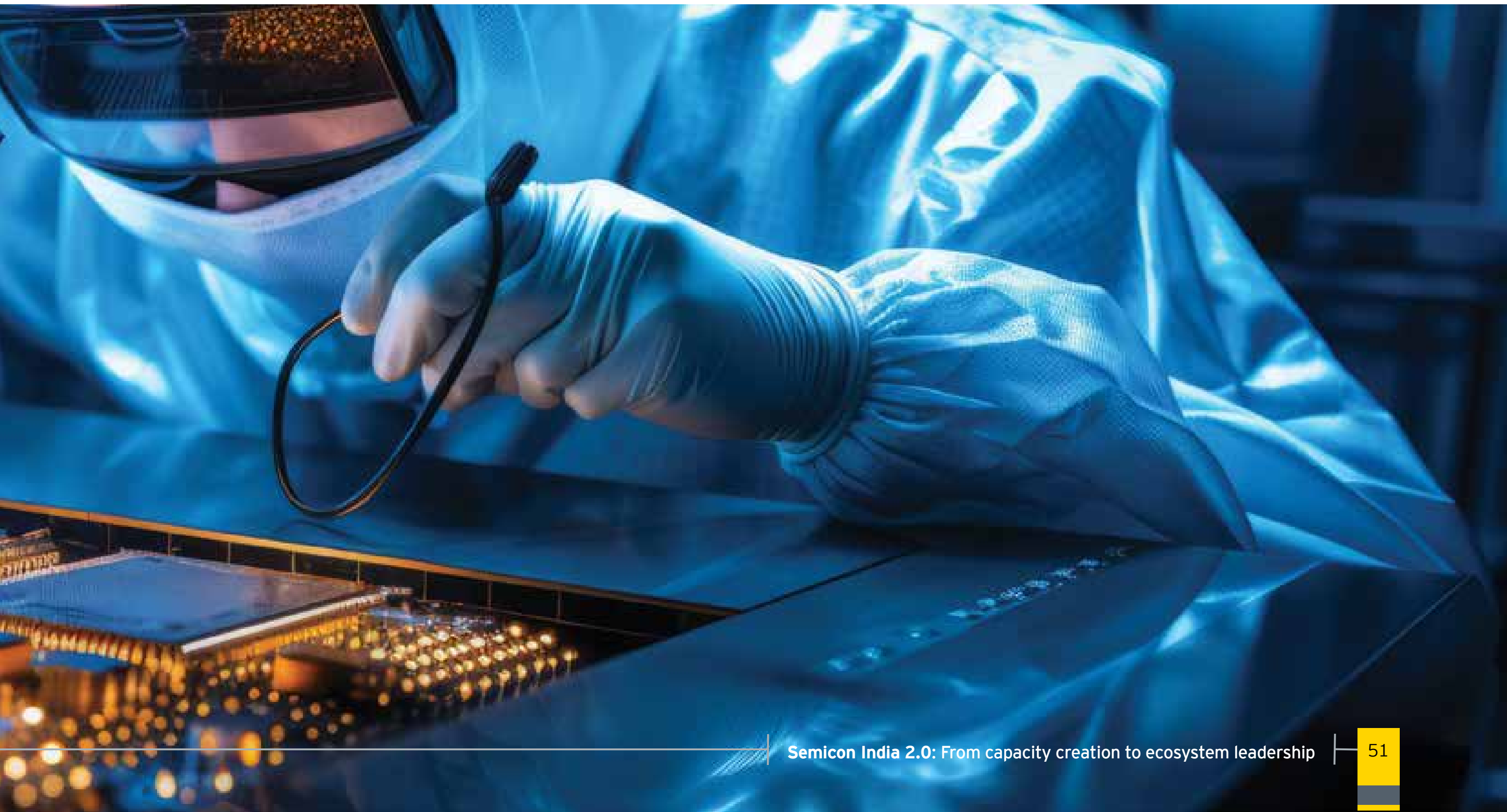
Building national cluster

Korea offers tax incentives, R&D subsidies and infrastructure support for semiconductor investment and cluster development.

European Union

Coordinated funding across the value chain

The EU aligns public investment, industry consortia and R&D to build integrated chip capacity.



Chapter 4

Semicon 2.0: India's shift from manufacturing incentives to ecosystem development

Semicon 1.0 marked a significant step in establishing India's semiconductor ecosystem by catalyzing investments across manufacturing, design and innovation. Through a combination of strategic incentives and timely implementation, the program has translated policy intent into tangible industry outcomes.

Upon achieving the right environment for design, manufacturing and OSAT through Semicon 1.0 (as discussed in the previous sections), India is now focused on developing a comprehensive domestic ecosystem. As of 2026, the semiconductor market size was valued at US$64 billion and is projected to increase to US$200 billion by 2035 at a CAGR of 15.4%.[214] Given this opportunity of growing demand in the coming years, strengthening policy support beyond manufacturing, enhancing greater alignment between central and state initiatives and accelerating the implementation of Semicon 2.0 may be critical to building a globally competitive, resilient and self-sustaining semiconductor ecosystem in India.

214 Future of India's Semiconductor Industry- NITI Aayog

Semicon 2.0: Scheme for the development of semiconductor design and manufacturing ecosystem in India

The government announced Semicon 2.0 in July 2026 with a fiscal outlay of INR1,27,500 crore (~US$13.3 billion) to support six pillars to boost domestic semiconductor manufacturing. Semicon 2.0 is expected to support economic growth across all sectors, strengthen national security through enhanced supply chain resilience and help establish technological leadership in critical sectors. The approach of building the complete ecosystem will catalyze semiconductor design and manufacturing in India.8 The main foundational objectives of the scheme are:

- Semicon 2.0 is centered on five elements: Pioneering, Policy and Investment, Production, People and Partnership, each serving as a key enabler of advancement.
- It aims to build trusted and sovereign semiconductor capabilities by strengthening domestic chip design, innovation, IP creation and technology deployment, while positioning India as a globally competitive hub for semiconductor design and product development.
- Promote participation in the global electronics value chain for the semiconductor manufacturing ecosystem.

The policy is divided into 6 segments:

Six pillars of Semicon 2.0

01

Design

Chip design, IP creation and embedded engineering capabilities

02

Machines and Materials

Equipment, tools, gases, wafers and specialty input ecosystem

03

Setting up more fabs

Capital-intensive fabrication capacity supported by infrastructure and incentives

04

ATMP / OSAT industry

Assembly, testing, marking and packaging capabilities for back-end manufacturing

05

Research and Development

Applied research, prototyping platforms and industry-academia collaboration

06

Talent development

Skilled manpower for design, fabs, OSAT, equipment and materials

First pillar: Design –Three categories

- Aims to deepen and strengthen India's semiconductor design ecosystem through development of building blocks (compute, memory, RF, power, networking, sensors) for designing identical chips and supporting startups, MSMEs, companies owned by Indian citizens or Overseas Citizen of India (OCIs).
- Startups/MSMEs will receive seed funding and EDA tools/IPs as support and companies will get deployment-linked incentives to offset higher costs of tape-outs.

Overview	Category 1	Category 2	Category 3
Target segments	Design of semiconductor IPs, chips, System-on-Chips (SoCs) and modules for National Importance and Strategic Priorities	Design of semiconductor IPs, chips and SoCs for electronics products for the commercial sector	Deployment-Linked Incentive (DLI) for semiconductor IPs/chips/SoCs
Eligible applicants	▪ Companies incorporated and headquartered in India, owned and controlled by Indian citizens ▪ Significant operational and manpower presence in India ▪ Consortiums allowed with global companies, R&D organization, academic institutions, etc.	▪ Companies incorporated and headquartered in India, owned and controlled by Indian citizens or OCIs ▪ Significant operational and manpower presence in India ▪ Consortiums allowed with global companies, R&D organizations and academic institutions	▪ Eligible applicants under categories 1 and 2

	▪ Fiscal and chip design infrastructure support provided to selected bidders based on competitive evaluation of technical and financial parameters	▪ Design Infrastructure Support (DIS) offered to eligible applicants in the form of:
		  ▪ Access to national EDA tools grid
		  ▪ IP cores, compute sub-systems
		  ▪ Access to Multi-project Wafer (MPW) fabrication services
		  ▪ Access to post-silicon validation services
		▪ Product Design Linked Incentive (P-DLI) offered to eligible startups and MSMEs in the form of:
		  ▪ Seed funding up to 50% of the project cost or INR15 crore (US$1.56 million), whichever is lower
		  ▪ Equity co-investment for companies that secure private equity (PE)/venture capital (VC) funding (beyond INR15 crore)
			▪ Reimbursement of 9% on net sales for 5 years, capped at INR30 crore (US$3.13 million) per application and INR120 crore (US$12.5 million) per company (including group companies) across multiple products within the target segments

Overview	Category 1	Category 2	Category 3
Incentives		▪ Product Design Linked Incentive (P-DLI) offered to eligible companies (other than startups and MSMEs) in the form of: ▪ Royalty financing on a co-investment basis, with company paying 5% of net revenue until 1.5 times of the financial support is recovered ▪ Equity co-investment for companies that secure PE/VC funding ▪ Benefits may also be claimed under Research, Development and Innovation (RDI) scheme[215]: ▪ Long-term loans at nil or low interest rates ▪ Equity infusion, especially for startups ▪ Contributions to Deep-Tech Funds of Funds ▪ Funding support for up to 50% of eligible R&D project costs	
Conditions	▪ The IP rights will be co-owned by the applicant company and Centre for Development of Advanced Computing (C-DAC) ▪ C-DAC will not exercise commercial rights over the IP unless the applicant defaults on its contractual obligations	▪ The IP rights and all associated design and development files must be retained within India	As per category 1 and 2
Exit mechanism	▪ Not applicable	▪ Seed funding/equity co-investment - exit by paying an amount equivalent to seed funding provided and the prevailing market value of government-held equity, or 1.5 times the total financial support provided (whichever is higher) ▪ Royalty financing - exit by paying 1.5 times (if exit within 4 years) or 2 times (if exit beyond 4 years) of the financial support received, from the last disbursement	Not applicable

215 Research, Development, and Innovation (RDI) Cell | Department Of Science & Technology

Second Pillar: Machines and materials

Category 4: Semiconductor manufacturing ecosystem

- To build self-reliant and globally competitive semiconductor manufacturing ecosystem and enable participation in global electronic value chains.
- Aims to strengthen India's semiconductor supply chain by incentivizing R&D and manufacturing of equipment, semiconductor-grade chemicals, gases and materials.
- This would enhance sustainable growth, develop precision manufacturing industry and place India in the global supply chain.
- The applicants are expected to own or possess licensed technologies for the proposed unit, except for test and characterization facilities.

Target segments	Minimum capital investment threshold	Minimum revenue threshold	Fiscal support
R&D facilities for equipment	INR300 crore (US$31.25 million)	INR120 crore (US$12.5 million)	
Manufacturing facilities for raw materials (wafer, photo mask, photoresist, substrate, chemicals, gases, glass for display fab, etc.)	INR50 crore (US$5.21 million)	INR20 crore (US$2.08 million)	30% of capex on pari-passu basis
Test and characterization facilities	INR100 crore (US$10.42 million)	INR40 crore (US$4.17 million)	
Manufacturing/ assembly of equipment/ refurbishing equipment, components, etc., for packaging and fabrication facilities	INR300 crore (US$31.25 million)	INR120 crore (US$12.5 million)	▪ 30% of capex on pari-passu basis ▪ Production Linked Incentive (PLI) of 10% / 8% / 6% / 4% / 2% of BoM value sourced from domestic manufacturers for 5 years starting FY 2028-29 (The overall support is capped at 50% of eligible capex)

Third pillar: Setting up more fabs – 2 categories

- To build globally competitive semiconductor manufacturing facility across different technologies.
- With the commissioning of first fab facility in 2028, focus will be on attracting more investors to come to India and set up fabs for manufacture of chips.
- The applicants must own or possess production grade licensed technologies for proposed technology process. Additional eligibility requirements and fiscal support provided across categories 5, 6 and 7 are as follows:

Category 5: Silicon semiconductor wafer fabs		
Technology	Wafer size	Installed capacity
	300 mm	40,000 wafer starts/month or more
Minimum capital threshold	INR20,000 crore (US$2.08 billion)	
Minimum revenue threshold	INR7,500 crore in any of the 3 financial years preceding the year of application submission	
Fiscal support	40% of eligible capital expenditure on pari-passu basis	

Category 6: Compound semiconductors/photonics/sensors (including MEMS) fab/discrete semiconductors fab		
Technology	200 mm or more	Sensor (including MEMS) fabs
	150 mm or more	Compound semiconductors, discrete fab
	100 mm or more	Fabs for photonics applications
Capacity	500 wafer starts/month or more	
Minimum capital threshold	INR500 crore (US$52.08 million)	
Minimum revenue threshold	INR200 crore (US$20.83 million) in any of the 3 financial years preceding the year of application submission	
Fiscal support	35% of eligible capital expenditure on pari-passu basis	

Category 7: Display fabs			
Technology	**OLED (Gen 6 or above)**	**Micro LED**	**LCD (Gen 8 or above)**
Capacity	30,000 panels/month or more	Panel area of 500 sqm/month or more	60,000 panels/month or more
Minimum capital threshold	INR10,000 crore (US$1.04 billion)	INR1,500 crore (US$156.25 million)	INR10,000 crore (US$1.04 billion)
Minimum revenue threshold	INR5,000 crore (US$520.8 million) in any of the 3 financial years preceding the year of application submission	INR600 crore (US$62.5 million) in any of the 3 financial years preceding the year of application submission	INR5,000 crore (US$520.83 million) in any of the 3 financial years preceding the year of application submission
Fiscal support	35% of eligible capital expenditure on pari-passu basis		

Fourth pillar: Further strengthening the ATMP/ OSAT industry: Category 8

- Encourage capacity addition to get most advanced packaging technologies in India and make India an alternative hub for packaging of chips.
- The applicants must own or possess production grade licensed technologies for proposed technology process. Additional eligibility requirements and fiscal support provided is as follows:

Category	Advanced packaging (2.5D/3D packaging, wafer-level chip scale packaging, heterogenous integration) and advanced substrate	Legacy packaging
Minimum capital threshold	INR1,000 crore (US$104.17 million)	
Minimum revenue threshold	INR200 crore (US$20.83 million) in any of the 3 financial years preceding the year of application submission	
Fiscal support	35% of eligible capital expenditure on pari-passu basis	25% of eligible capital expenditure on pari-passu basis

Fifth pillar: Research and development (R&D): Category 9: R&D for advanced semiconductor technologies

- Strengthen India's R&D capabilities in semiconductor and display manufacturing technologies.
- Transition from legacy and mature nodes (28nm-110nm) to advanced semiconductor process technologies.
- Increase collaboration with leading R&D centers within and outside India.

Criteria	Incentive scheme
Eligibility	Semiconductor companies, either on their own or in a consortium with academic institutions or R&D organizations, etc.
Target segment	Advanced process technologies for CMOS-based fabrication, silicon photonics, display fabrication, chiplet-based technologies for advanced packaging or any other advanced technologies related to semiconductors.
Incentives	Up to 75% (including state incentives) of the total project cost (eligible capex and opex), including applicable state incentives.

Sixth pillar: Talent development: Category 10

- Nurture skilled professional across design, fabrication and packaging domains.
- Inclusion of more institutes/colleges to provide holistic experience for students from chip design to fabrication and packaging of chips.
- Active engagement in deepening of clean room, fab construction and other ecosystem training.

Criteria	Incentive scheme
Eligibility	Indian academic institutions, R&D organizations and laboratories, scientific societies, domestic training institutions/organizations.
Target segment	Design: Access to advanced chip design tools, MPW fabrication services, post-silicon validation tools and capacity-building initiatives. Manufacturing: Development of training infrastructure and hands-on industry training through nanofabrication and process laboratories.
Incentives	Up to 75% (including state incentive) of the project cost (eligible capex and opex).

With the help of the above pillars, India is positioning itself as a hub for conventional and advanced packaging, legacy fabs and compound semiconductor fabs. India also aims to take leadership in advanced display technologies such as micro-LEDs. Today, the world has a shortage of 1 million semiconductor professionals and India is expected to address this talent gap by skilling more manpower for domestic as well as global needs.[216]

Semicon 2.0 aims to enhance various support measures that were not sufficiently covered under Semicon 1.0. The next section prsents a comparative analysis of the two missions to provide a comprehensive overview of the changes envisaged, based on information available in the public domain, inputs from industry stakeholders and statements from government stakeholders.

Comparative analysis of Semicon 1.0 and Semicon 2.0

Parameter	ISM 1.0	ISM 2.0[217]
Time period	The initial program outlay structured over a period of six years.[218] Individual application windows and incentive periods varied by scheme.	The duration of projects supported under the scheme would be up to six years and applications would be initially open for three years.
Outlay	Total financial outlay of the scheme was INR76,000 crore (~US$7.9 billion)	Total financial outlay of ISM 2.0 is INR1,27,500 crore (~US$13.3 billion)
Coverage	ISM 1.0 covered semiconductor fabs, display fabs, compound semiconductor, ATMP/ OSAT and Design	ISM 2.0 will cover entire ecosystem, including equipment makers, materials, chemicals, gas producers, IP and design, R&D and talent
Incentives	**Manufacturing fabs** ▪ Fiscal support: Financial support of 50% of the eligible project cost on pari-passu basis for manufacturing projects	**Manufacturing fabs:** ▪ Fiscal support: 35% to 40% of capital expenditure on pari-passu basis

	Design:
	▪ Product Design Linked Incentive: 50% of eligible expenditure with cap of INR15 crore per project
	▪ Deployment Linked Incentive: 4% to 6% of net sales over 5 years with capping of INR30 crore per project
		Design:
		▪ Product Design Linked Incentive (P-DLI)
		  ▪ Seed funding of 50% of the project cost or INR15 crore, whichever is lower. Additionally, equity co-investment permissible beyond INR15 crore (MSMEs and startups)
		  ▪ Royalty co-investment financing with 5% royalty on net revenue until 1.5 times of the funding amount is recovered. Additionally, equity co-investment permissible (other than MSMEs and startups)
		▪ Deployment Linked Incentive: Reimbursement at 9% on net sales with a cap of INR30 crore per applicant or INR120 crores per company (across multiple segments) for a period of 5 years

		Machines and materials manufacturing: ▪ Fiscal support: 30% of the capital expenditure on pari-passu basis ▪ Production Linked Incentive: 10%/8%/6%/4%/2% of the BoM value sourced from domestic manufacturers, subject to an overall ceiling of 50% of eligible capex, for a period of 5 years
	ATMP/ OSAT: ▪ Fiscal support: Up to 50% of the project cost ▪ R&D support: Up to 2.5% of the scheme's outlay is earmarked for R&D, skill development and training requirements	**ATMP/ OSAT:** ▪ Fiscal support: 25% to 35% of the eligible capital expenditure on pari-passu basis **Research and development:** ▪ Fiscal support: 75% of the project cost (including state incentives), covering eligible capital and operational expenditures
		Talent development: ▪ Fiscal support: 75% of the project cost (including state incentives), covering eligible capital and operational expenditures

216 The global semiconductor talent shortage | Deloitte Global https://manufacturing.economictimes.indiatimes.com/news/hi-tech/indias-semiconductor-sector-faces-1-million-global-talent-gap-vaishnaw/132343140

217 https://d2p5j06zete1i7.cloudfront.net/Cms/admin/post/18/1788158248.pdf

218 https://ism.gov.in/schemes/semicon1.0/semiconductor-fab

Assessment of the notified Semicon 2.0 framework

Semicon 2.0 represents a substantive change in India's semiconductor industrial policy. The significance of the program lies not merely in the expansion of financial outlay, but in the widening of policy coverage from selected manufacturing and design projects to the broader ecosystem required to sustain semiconductor activity.

In our assessment, the notified framework contains five important strategic shifts: from anchor projects to ecosystem depth; from uniform subsidy support to differentiated incentives; from design prototyping to commercial deployment; from conventional packaging to advanced packaging; and from general skilling to semiconductor-specific manufacturing capability development. These changes broadly align India's policy architecture with the direction adopted by major semiconductor economies, while retaining a distinct emphasis on milestone-linked capital support and domestic design ownership.

From project viability to ecosystem economics

Under Semicon 1.0, the immediate policy priority was to overcome the high entry cost associated with establishing fabrication and packaging facilities. Semicon 2.0 continues to support anchor manufacturing projects but additionally recognizes equipment, sub-assemblies, materials, process chemicals, specialty gases, test and characterization, R&D and talent infrastructure as investible segments.

This is strategically important because the economic competitiveness of a semiconductor facility is influenced not only by its initial capital cost, but also by the availability, quality, lead time and cost of operating inputs over its entire life. A fab that depends extensively on imported materials, spares, technical services and equipment support may increase domestic output without creating equivalent domestic value addition or supply-chain resilience.

The machinery and materials pillar can therefore be viewed as an attempt to improve the economics and durability of the wider manufacturing cluster. Its success should be measured through the development of qualified domestic suppliers, reduction in input lead times, localization of technical services, exports and the participation of Indian companies in global equipment and materials supply chains.

Differentiated incentives indicate policy prioritization

Semicon 2.0 does not apply one incentive rate across the semiconductor value chain. Silicon fabs are eligible for 40% of the eligible capital expenditure, compound semiconductor and specified display fabs for 35%, advanced packaging for 35%, legacy packaging for 25% and eligible equipment and materials projects for 30%. R&D and talent projects may receive support of up to 75% of the project cost, including state incentives.

In our view, this differentiation signals an attempt to direct public resources toward activities with distinct capital requirements, technology risks and ecosystem spillovers. The higher support for advanced packaging relative to legacy packaging recognizes the increasing technological value of heterogeneous integration and chiplet-based systems. Similarly, the inclusion of operating expenditure within eligible R&D and talent project costs recognizes that technology and workforce capability cannot be created exclusively through investment in physical assets.

However, incentive differentiation also creates a need for precise technical definitions. Detailed guidelines should clearly distinguish advanced from conventional activity, identify eligible expenditure, prevent artificial restructuring of projects and ensure that support is linked to genuine technology capability rather than equipment acquisition alone.

Design policy moves closer to the commercialization cycle

The combination of design infrastructure access, seed funding, equity co-investment, royalty financing and deployment-linked incentives is one of the most distinctive features of Semicon 2.0. It recognizes that semiconductor design companies face different financing requirements at the design, tape-out, validation and commercial deployment stages.

The framework also goes beyond conventional expenditure reimbursement by permitting the government to share early-stage risk through equity and royalty-linked structures. This could help address the financing gap faced by semiconductor startups, particularly where product-development cycles are longer than those generally supported by conventional venture funding. India's startup ecosystem nevertheless remains weighted towards semiconductor services, while a smaller share of companies develops proprietary semiconductor IP.[219]

The principal challenge after tape-out is market adoption. A technically functional design needs to complete post-silicon validation, meet reliability and industry standards, obtain customer qualification, secure manufacturing capacity and demonstrate long-term product support. Consequently, design-policy outcomes may be evaluated through qualified products, repeat orders, recurring product revenue, domestic IP ownership and incorporation into finished electronic systems, rather than through the number of supported entities or tape-outs alone.

The minister's comments on customer qualification reinforce this commercial interpretation of the scheme.[220]

Advanced packaging can become a bridge to higher value addition

Advanced packaging increasingly performs functions that were previously achieved primarily through transistor scaling. Chiplets, heterogeneous integration, advanced substrates and 2.5D/3D architectures allow different dies to be integrated into a high-performance system.[221] Semicon 2.0's separate recognition of advanced packaging is therefore more than an extension of conventional ATMP support.

India's emerging packaging capacity, existing chip-design talent and growing electronics base could provide a foundation for closer integration between chip architecture, package design, testing and final system development. This may offer a relatively near-term route to higher semiconductor value addition while domestic wafer-fabrication capabilities mature.

The opportunity is nevertheless conditional. Advanced packaging requires specialized package design and integration capabilities, advanced package substrates and interconnect materials, thermal-management solutions, precision assembly processes and package-level testing, inspection and reliability capabilities. Approving advanced packaging capacity without developing these adjacent capabilities could result in continued dependence on imported technology and materials.

Greater emphasis on emerging technologies under Semicon 2.0

Technology	Relevant Semicon 2.0 categories	Primary India opportunity
Chiplets and advanced packaging	Categories 8 and 9	Design-package integration, substrates, testing
AI accelerators	Categories 1-3 and 9	IP, SoCs, deployment and system development
Silicon photonics	Categories 6 and 9	Photonic design, fabrication, packaging and R&D
GaN and SiC	Categories 4, 6 and 9	Power, RF, materials, fabrication and packaging
Advanced displays	Categories 4, 7 and 9	MicroLED, display materials and process R&D
EDA, firmware and systems	Categories 1-3 and 10	Design infrastructure and chip-to-system capability
Sovereign AI and IP	Categories 1-3 and 9	Strategic IP, compute building blocks and deployment

219 The Rise Of India's Semiconductor Startups Report 2024 - Inc42 Media
220 Press Release: Press Information Bureau
221 EDMS-TC-Chiplet-Technology-and-Heterogenous-Integration.pdf

Emphasis on R&D and talent

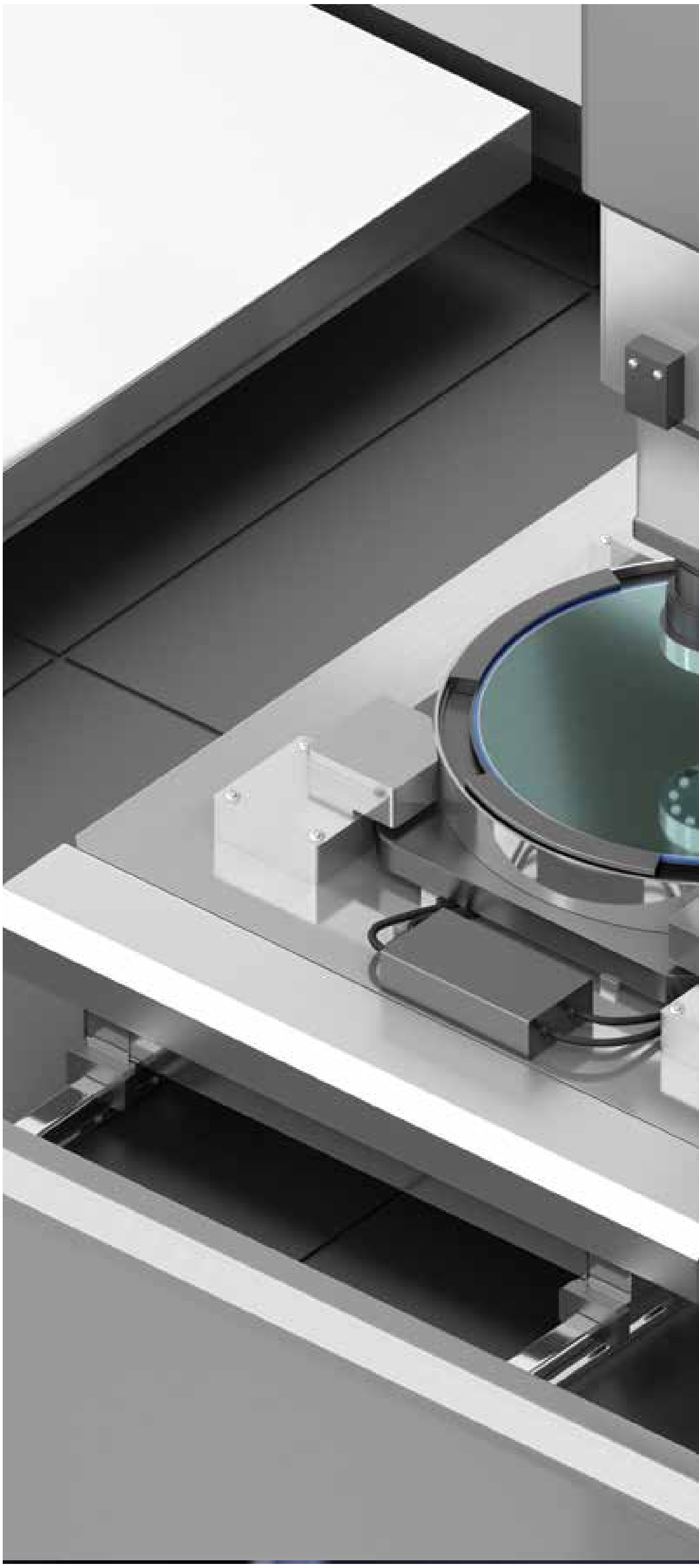
The inclusion of research and talent as separate pillars represents an important broadening of India's semiconductor policy architecture. The official Semicon 2.0 announcement identifies advanced semiconductor technologies and collaboration with research centers in India and abroad as priorities under the R&D pillar. The talent pillar seeks to deepen college-level design education and expand industry involvement in cleanroom, fab-construction and related ecosystem training. Eligible R&D and talent-development initiatives may receive support of up to 75% of project costs, including state incentives.

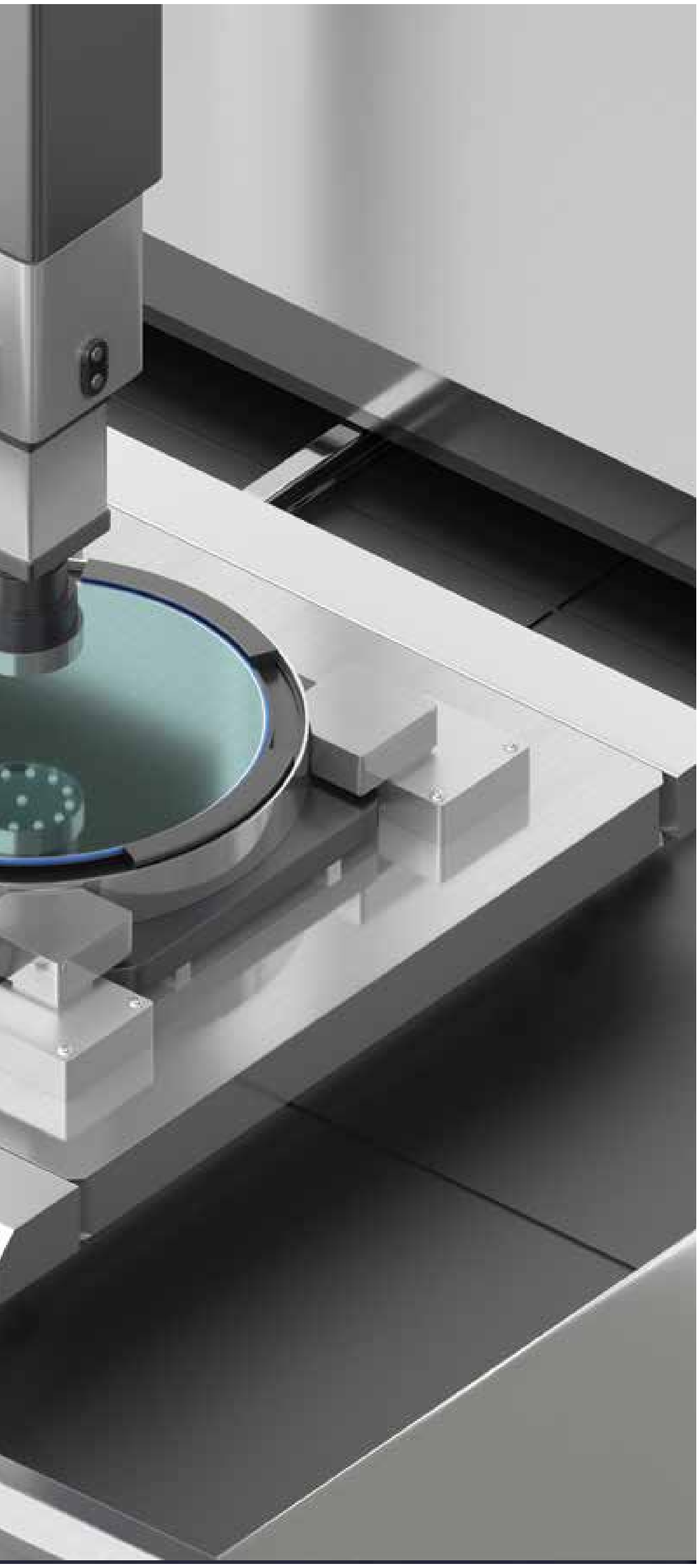
Talent support extends beyond chip-design education. The reference to manufacturing, cleanrooms, fab construction and ecosystem training reflects the wider workforce required for semiconductor facilities. This workforce includes process, equipment, packaging, test and facilities engineers; technicians; cleanroom and utility personnel; and instructors capable of delivering practical semiconductor training. Implementation guidelines should therefore distinguish among the requirements of design, fabrication, ATMP/ OSAT, equipment, materials and infrastructure-related occupations.

Training outcomes should be linked to industry demand. The value of a talent-development project will depend on whether the program is aligned with identifiable job roles, includes practical and industry-supervised learning and produces personnel capable of entering semiconductor operations with limited additional training. Project assessment should therefore consider employer participation, curriculum relevance, laboratory or simulation access, apprenticeship or internship arrangements, certification, placement and retention outcomes.

R&D support should create reusable technology capability. Semiconductor research requires continued access to design tools, process equipment, materials laboratories, cleanrooms, packaging and test facilities, metrology, reliability assessment and prototype-development infrastructure. In addition to individual research projects, support may therefore be directed toward shared platforms that can be used by multiple academic institutions, startups, companies and research organizations.

Commercialization should form part of the research pathway. Research outcomes should be assessed not only through publications and patents, but also through validated processes, prototype devices, licensed intellectual property, technology transfer, industry-led research programs, qualified products and private R&D leveraged. This would help connect academic research and institutional infrastructure with the product-development and manufacturing requirements of the semiconductor industry.



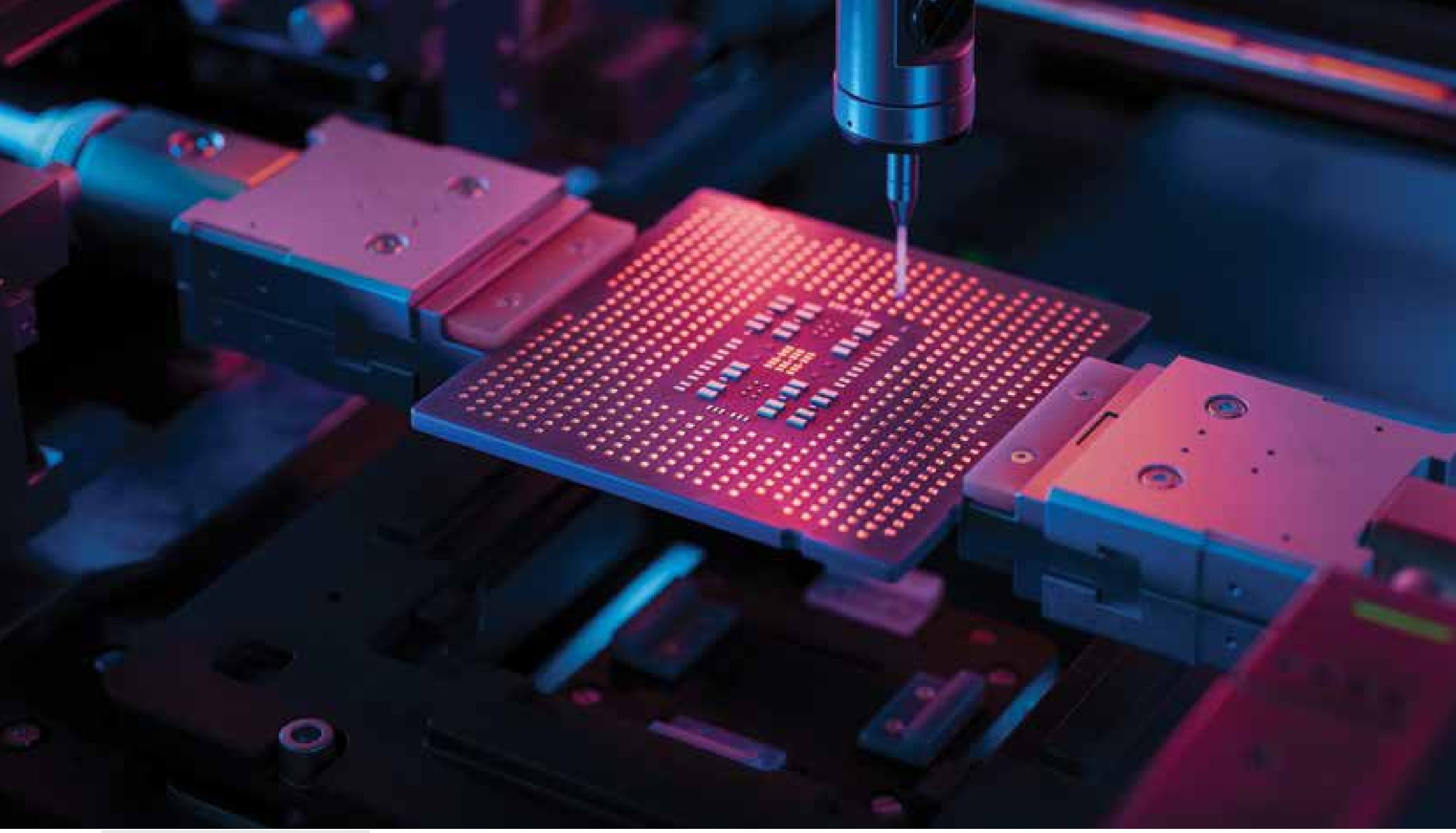


Global perspective: A broad policy framework, with evolving institutional depth

Semicon 2.0 brings India closer to the broad structure of semiconductor policies adopted by leading economies. The US combines manufacturing support with investment tax credits, R&D and workforce programs. South Korea combines tax incentives, R&D support, infrastructure and cluster development. Taiwan's ecosystem benefits from close integration among foundries, packaging companies,[222] universities, research organizations and industry-led training. Other jurisdictions also use combinations of grants, tax support, financing and research infrastructure.

India is at a timely inflection point in building a globally competitive semiconductor ecosystem. While leading semiconductor economies have developed institutional and cluster capabilities over several decades, the ongoing evolution of India's policy landscape and the reconfiguration of global supply chains present a critical window to accelerate this capability-building. The policy priority, therefore, is to move beyond individual scheme-led investments toward building connected clusters, commercializing technologies, developing a skilled workforce and creating qualified domestic suppliers — capabilities that will determine India's ability to capture value across the semiconductor value chain. Its opportunity lies in building depth in segments where existing strengths and emerging investments can reinforce one another, including design and intellectual property, specialized fabrication, compound semiconductors, advanced packaging, materials and talent. By developing competitive capabilities across these segments, India can evolve from a participant in the semiconductor value chain to an indispensable node in global semiconductor supply chains.

222 semiconductor-strategy-report-2025.pdf



Chapter 5

India's innovation story: A convergence of design, demand, manufacturing and policy

Previously, we examined the global semiconductor policy landscape, highlighting the range of fiscal and non-fiscal interventions adopted by leading semiconductor jurisdictions alongside India's incentive framework. The analysis demonstrated that India has established a competitive support ecosystem through targeted incentives and interventions.

However, while incentives are often effective in attracting initial investments, sustained leadership in the semiconductor industry is ultimately driven by a country's underlying competitive advantages. India combines an established chip design and engineering base, a large and growing domestic electronics market, emerging fabrication and packaging capacity, and a policy framework that increasingly supports the wider semiconductor ecosystem. Together, these strengths position India as both a competitive investment destination and a significant long-term semiconductor market.

The timing is equally compelling. As approved semiconductor projects move towards implementation and global companies seek more diversified supply chains, India has an opportunity to build on its existing strengths and deepen capabilities across manufacturing, research, supplier networks and talent. The key value propositions underpinning India's semiconductor ambitions are discussed below.

India's innovation story: A convergence of design, demand, manufacturing and policy

India's emerging-technology opportunity arises from the convergence of four capabilities: an established semiconductor design and software base, a growing electronics and digital market, expanding manufacturing and packaging capacity, and a policy framework that now supports a wider range of semiconductor technologies.

Its most developed semiconductor capability remains design and engineering. The workforce strategy identifies substantial domestic strengths in chip design and software, while also recognizing gaps in fabrication and packaging infrastructure. This talent base is relevant not only to conventional integrated circuit design but also to AI accelerators, embedded systems, verification, firmware, package design and system integration.

The country also has demand across applications relevant to emerging semiconductor technologies. AI infrastructure, telecommunications, automotive and electric mobility, industrial electronics, smart meters, consumer devices, defense and connected systems require combinations of compute, connectivity, sensing and power-management semiconductors. India's expanding electronics base can provide a downstream environment in which locally developed semiconductor products, reference platforms and system solutions may be evaluated and deployed. However, converting demand into domestic semiconductor value addition will require customer qualification, competitive products and stronger linkages among chip companies, OEMs, electronics manufacturers and system integrators.

Another critical factor is the emergence of domestic semiconductor manufacturing capability, with the approved project portfolio spanning silicon fabrication, silicon carbide, integrated gallium nitride and MicroLED activities as well as packaging facilities. This provides an initial base upon which more specialized capabilities in compound semiconductors, advanced packaging, substrates, testing and system integration could be developed.

Finally, the timing of Semicon 2.0 is relevant because its scope broadly corresponds with the technologies reshaping the global industry. The program covers semiconductor IP and product design, compound semiconductors, photonics, advanced displays, advanced packaging, R&D and specialized talent. The inclusion of equipment, materials, chemicals and gases also recognizes that technology leadership requires supporting supplier networks and process capability, not merely an individual fab or design project.

In terms of semiconductor manufacturing, India's strength lies in its large pool of engineers and technology professionals. It is estimated that India is home to nearly 20% of the world's chip design engineers[223]. Through government support, leading semiconductor companies have established chip design and research centers in India, as evidenced by the recent milestones achieved in technology and manufacturing:

- Unveiling of 3 nm chip design centers showcasing advancement to manage sophisticated designs in chip manufacturing.[224]
- Development of indigenous 32-bit microprocessor for space applications.[225]
- Manufacturing of the first homegrown Dhruv64: India's first 64-bit dual core microprocessor.[226]

Furthermore, the government has also launched several initiatives to boost the depth and quality of the talent pool in India[227]:

- New curriculum for integrated circuit manufacturing and VLSI design and technology
- Collaboration with industries and universities to boost research
- Skilled Manpower Advanced Research and Training (SMART) lab at NIELIT Calicut to train 1 lakh engineers nation-wide with 44,000+ already trained
- Widespread penetration of technical education anchored by Indian Institutes of Technology, Indian Institute of Information Technology, State engineering universities, among others.

The Government of India's C2S Programme is also playing a key role in enhancing the depth and quality of the country's talent pool for semiconductor design and manufacturing.

223 Press Release Page | Press Information Bureau
224 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2148393&reg=48&lang=2
225 https://www.isro.gov.in/vikram3201.html
226 https://www.pib.gov.in/PressNoteDetails.aspx?ModuleId=3&NoteId=156505&id=156505&reg=3&lang=2
227 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2148393&reg=48&lang=2

Chips to system innovation opportunities[228]

The C2S program strengthens India's competitiveness in semiconductors by addressing one of its biggest advantages and constraints simultaneously: a large engineering talent base but limited semiconductor design infrastructure. By providing access to advanced EDA tools, fabrication support, prototyping facilities and industry-led training, C2S lowers entry barriers for startups, MSMEs and academic institutions, enabling innovation without requiring massive upfront investment.

India's value proposition under C2S lies in its focus on **design-led capability building**. The program aims to train **85,000 industry-ready semiconductor professionals**, support creation of indigenous chip IP, ASICs, SoCs and FPGA designs and foster a robust fabless startup ecosystem. Through initiatives such as the **ChipIN Centre** and access to leading global EDA tools, India is building the foundation for a scalable semiconductor design ecosystem capable of supporting future manufacturing ambitions.

By combining talent development, design infrastructure, startup support and academia-industry collaboration, **C2S positions India as a global semiconductor design and innovation hub**. The program strengthens domestic intellectual property creation, reduces dependence on imported chip designs and creates a pipeline of skilled engineers and startups that can support India's long-term goal of becoming a significant player in the global semiconductor value chain.

India's contribution to the global design footprint[229]

India hosts about 20% of the global semiconductor design workforce, providing it a strong base in chip architecture, verification and intellectual property development. This advantage has been reinforced through the Design Linked Incentive Scheme launched in 2021, which recognized that semiconductor design forms a major part of the bill of materials (~50%) and provided proportionate fiscal incentives while making fabless design a strategic priority for long-term growth of the industry. As of January 2026, 24 chip design projects have been supported under the scheme, ranging from microprocessors and satellite communication to energy metering, surveillance and Internet of Things.

The impact of these initiatives is already visible. DLI-supported companies have successfully developed and fabricated indigenous chips, filed patents, attracted private investment and built specialized engineering teams along with specialized products such as the **recent unveiling of 3 nm chip designed in India – a milestone in global design capabilitie**s[230].

Policy support is strengthening the role of GCCs in India's semiconductor industry[231]

India's semiconductor GCC ecosystem has become a key pillar of the country's semiconductor value proposition, providing global firms with access to a large pool of specialized engineering talent and advanced design capabilities. As of FY2023, India hosted **55+ semiconductor GCCs across more than 95 centers**, employing over **50,000 semiconductor professionals**, with Bengaluru and Hyderabad accounting for over two-thirds of GCCs and more than 80% of the talent base. These centers work across **ASIC and RTL design, verification, DFT, physical design, system software, firmware, product engineering, pre-silicon verification and post-silicon validation**, enabling end-to-end product development capabilities within a single location.

The ecosystem is also expanding rapidly. In **Q4 CY2023, semiconductor companies accounted for 30% of all new GCCs established in India**, reflecting growing global confidence in India's semiconductor talent and innovation capabilities. By serving as centers for advanced design, engineering and talent development, GCCs are helping India strengthen its position as a global semiconductor design hub while creating the skilled workforce required to support the country's broader semiconductor manufacturing ambitions.

Recognizing the strategic role of GCCs, Indian states have introduced dedicated GCC-focused policies and incentive frameworks to attract global capability centers. This momentum aligns with the Government of India's efforts to formulate a **national GCC policy** aimed at further strengthening India's position as a global hub for high-value engineering, R&D and semiconductor design activities. Together, semiconductor GCCs are emerging as a critical bridge between India's strong design capabilities and its ambitions to build a globally competitive semiconductor manufacturing ecosystem.

228 https://www.impriindia.com/insights/chips-to-startup-programme/
229 https://www.investindia.gov.in/team-india-blogs/semiconductor-opportunity-india-semicon-india-mission-new-fabs-global-partnerships
230 https://worldtradescanner.com/India%20Semiconductor%20Vision%20Gathers%20Momentum%20with%203nm%20Chip%20Design%20and%20Large.htm
231 https://community.nasscom.in/communities/global-capability-centers/deep-dive-semiconductor-gccs-india

Software-hardware convergence[232]

India's semiconductor GCC ecosystem offers a unique value proposition by combining strong semiconductor engineering capabilities with a mature digital and software ecosystem. According to one industry assessment, India's advantage extends beyond manufacturing and is rooted in its established high-tech capabilities, including a large engineering base, AI maturity and expertise across semiconductor design and product development.[233]

This capability is being further strengthened through **ISM 2.0**, which expands the focus beyond fabrication to include **equipment, materials, design IP, supply-chain resilience and industry-led R&D and training centers**. By complementing India's software and design strengths with capabilities in semiconductor equipment and hardware development, ISM 2.0 seeks to create a more comprehensive semiconductor ecosystem that spans both the hardware and software layers of the value chain.

India's proposition should therefore not be framed as an attempt to replicate every established semiconductor capability. A more credible objective is to combine existing design and software strengths with selected positions in advanced packaging, compound semiconductors, power electronics, photonics, AI and edge systems and India-owned semiconductor products. The opportunity lies in developing areas where talent, application demand, policy support and emerging physical infrastructure reinforce one another.

Policy architecture for a competitive semiconductor ecosystem in India

End-to-end policy support

India's semiconductor strategy adopts an end-to-end ecosystem approach, spanning critical minerals, semiconductor manufacturing, electronic components and end-use industries. Through complementary policy interventions across both upstream and downstream segments, the government aims to strengthen domestic value addition and build a globally competitive semiconductor ecosystem, as shown below.

Upstream foundation	Core semiconductor ecosystem	Downstream demand creation
National Critical Mineral Mission - bolster supply of critical minerals	**Semiconductor manufacturing** – wafer fabs and compound semiconductors	**PLI IT Hardware**- Laptop, servers, etc.
		PLI Telecom - telecom equipment
Equipment Ecosystem - Semicon 2.0 for equipment and design	**ATMP-** Advance packaging and testing	**PLI automobile** - automotives
		PLI White goods - AC / LED
Talent and R&D - DLI under Semicon 1.0 / Initiatives for manpower upskilling	**Electronic Component Manufacturing Scheme -** boosting component ecosystem	**PLI Medical Device**; **PLI LSEM -** Mobile phone, etc.

232 https://www.capgemini.com/in-en/insights/research-library/india-as-the-emerging-global-semiconductor-gcc-hub/
233 Press Release Page | Press Information Bureau

While the **Critical Mineral Mission and the India Semiconductor Mission** support upstream semiconductor fabrication, assembly, testing and packaging capabilities, complementary schemes for electronic components, IT hardware, telecom, automobiles, medical devices, drones and large-scale electronics manufacturing stimulate downstream demand and ecosystem development. India's state governments also play an important role in strengthening semiconductor manufacturing through dedicated policies. These policies support the value chain through capital expenditure incentives, upskilling, R&D support, land and utilities, among other measures.

Transparency in benefits

Having established policy support across the semiconductor value chain from upstream inputs to downstream demand sectors, India has also adopted a transparent and outcome-based incentive framework to drive ecosystem development. By linking incentives to clearly defined targets and regularly monitoring progress, the government has created greater visibility and accountability in scheme implementation.

Semiconductor incentive design – pari passu mechanism

The preceding discussion highlighted India's overall policy support for semiconductor ecosystem development and the positive outcomes achieved under various incentive schemes. However, for semiconductor projects, which are highly capital-intensive, technology-intensive and characterized by long gestation periods, the timing and structure of incentive disbursement can be as important as the quantum of support itself. In this context, the India Semiconductor Mission's pari passu disbursement mechanism assumes particular significance, as it provides funding in line with project implementation milestones and investment commitments. Unlike many global semiconductor support programs that rely primarily on tax credits or grants, India's incentive framework provides milestone linked pari passu support, enabling continuous risk sharing between the government and investors.

Timely disbursement of incentives

Entrepreneurs have recognized that the government's commitment to the timely disbursements of financial assistance for semiconductor projects.[234] Progress under Semicon 1.0 indicates timely facilitation of approved incentives and implementation support, with 12 manufacturing proposals approved, involving cumulative investments of over INR1.64 lakh crore. Of these, three units have already commenced commercial production, while another unit is expected to begin production in 2026. On the design side, 24 semiconductor design projects have been approved for financial support and 105 startups/MSMEs have been provided access to industry-standard EDA tools. This demonstrates the scheme's progression from approvals to on-ground execution across both manufacturing and design segments.

Favorable geo-location

India's critical geographical location and global logistics networks contribute to its attractiveness as a preferred destination for semiconductor business relocation. India's strategic location in the Indian Ocean serves as a global supply chain connectivity hub between the Middle East, Europe and West Africa from the western coast and Southeast and East Asia from the eastern shore. With this favorable location, India can serve as a global manufacturing hub and support efforts to diversify semiconductor supply chains, reducing dependence on China and other geopolitically sensitive locations in East Asia.[235]

Demographic advantage

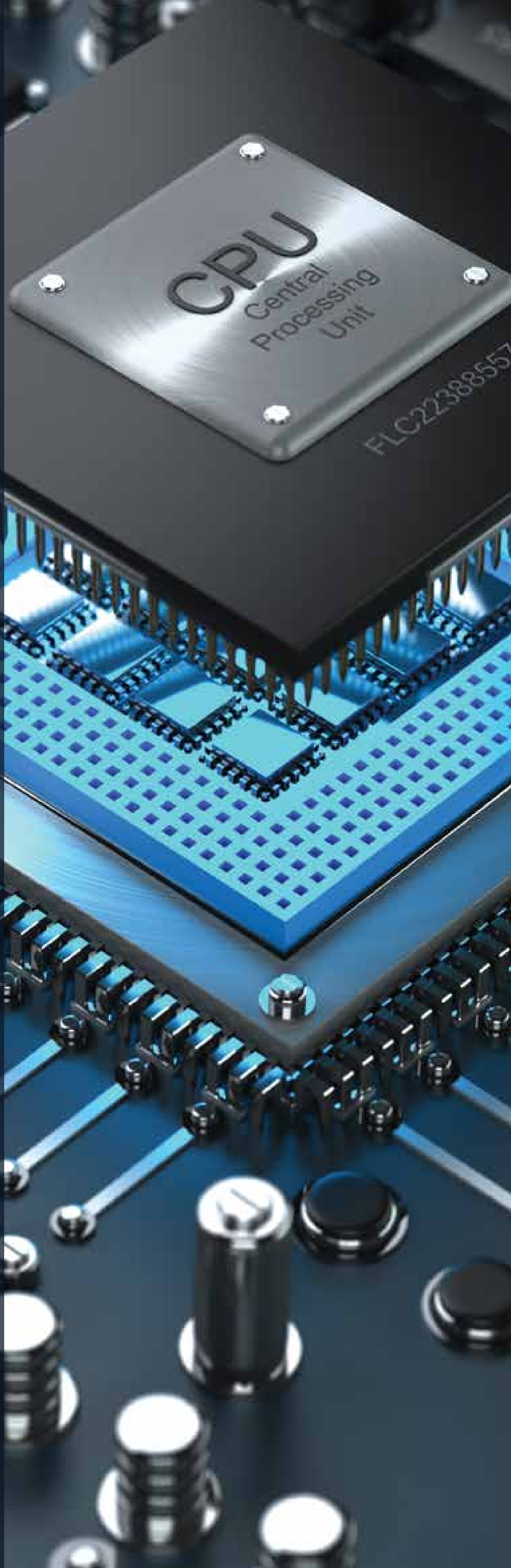
With a population estimated at 1.44 billion, in 2023 India became the world's most populous country. A key advantage is its young and expanding workforce, which could drive productivity improvements and growth in domestic consumption for many years.[236]

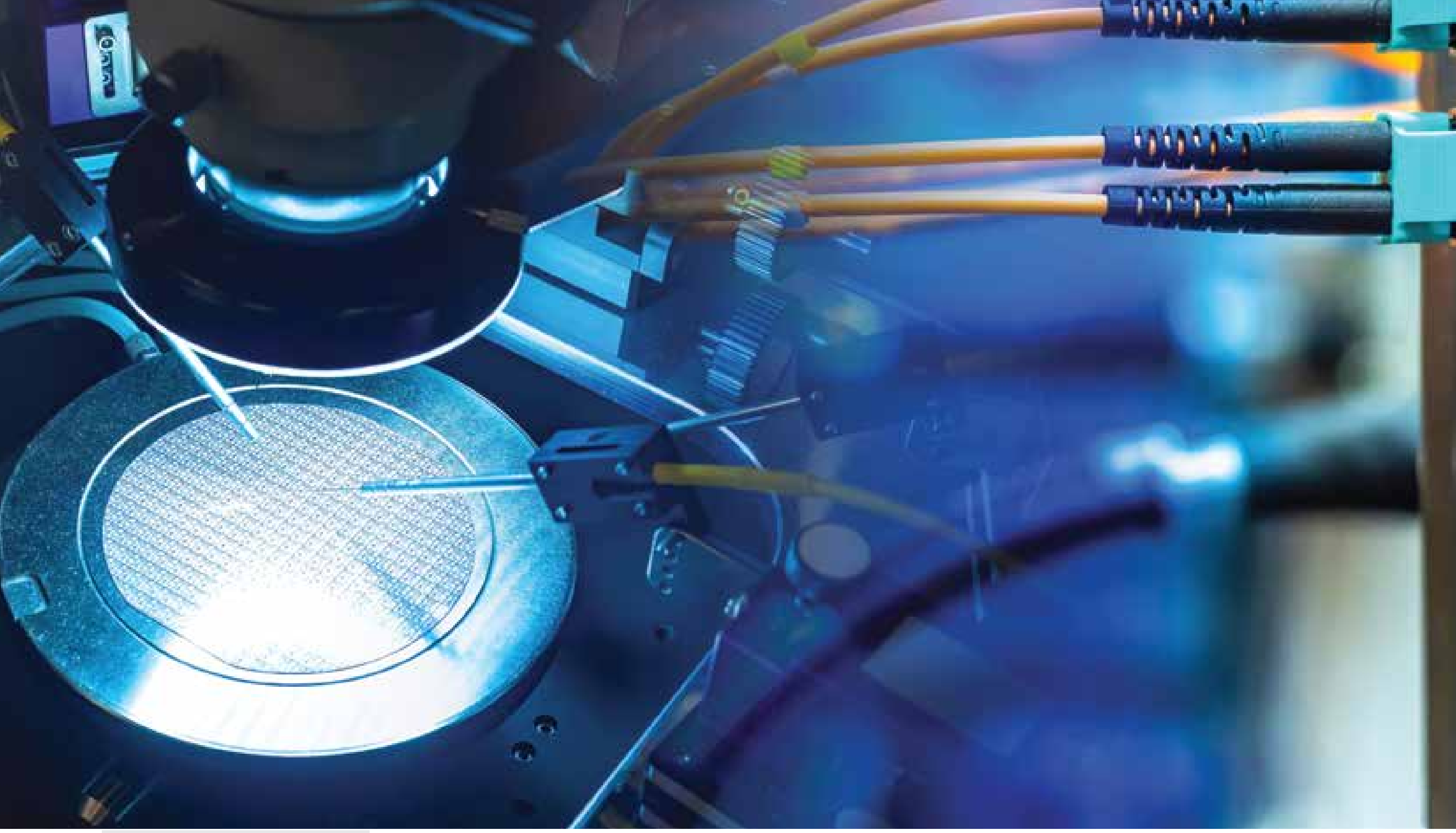
- India's demographic advantage, with **65% of its population below 35 years of age and a median age of 28 years**, is expected to remain a key growth driver.[237]
- India remains the largest contributor of human resources in the world, with 24.3% of incremental global workforce over the next decade expected to come from India.[238]
- As of 2025, India produces approximately 2.55 million STEM graduates per year, second only to China.[239]

234 Press Release Page | Press Information Bureau
235 https://www.icwa.in/show_content.php?lang=1&level=3&ls_id=12465&lid=7619
236 India's economic surge: from regional to global economic player - Economy and Finance
237 https://www.pib.gov.in/PressNoteDetails.aspx?ModuleId=3&NoteId=154867&reg=3&lang=2
238 https://www.ey.com/en_in/insights/india-at-100/reaping-the-demographic-dividend
239 https://educationforallinindia.com/wp-content/uploads/2026/03/The-STEM-Pipeline-in-India-From-Science-Classrooms-to-STEM-Degrees-UDISEPlus-2024-25-AISHE-2021-22.pdf

Overall, India's semiconductor value proposition extends beyond manufacturing incentives and domestic demand. The country combines a large and growing semiconductor market, deep design and engineering talent, a strong GCC ecosystem, and an increasing focus on semiconductor equipment, materials and design IP under ISM 2.0. With global semiconductor leaders already undertaking end-to-end activities in India, ranging from chip design and verification to firmware, product engineering and post-silicon validation, India is uniquely positioned as a hub for hardware-software convergence. This combination of market scale, talent, innovation and policy support strengthens India's position as a trusted semiconductor partner and enhances its strategic relevance in the evolving global semiconductor value chain.

Building on this progress, the next phase of growth may require moving beyond ecosystem creation towards ecosystem deepening. While India has made significant strides in attracting investments and building capabilities across the semiconductor value chain, sustained competitiveness will depend on strengthening technology access, talent development, infrastructure, supply-chain depth, innovation capacity and integration with global markets. The following chapter discusses key gaps in India's semiconductor growth story and outlines priorities for accelerating India's journey towards becoming a globally competitive semiconductor ecosystem.





Chapter 6

Segment-wise assessment of gaps

The semiconductor industry has emerged as a strategic pillar of economic growth, technological advancement and national security. While the Semicon India Programme 1.0 addressed several critical gaps by catalyzing investments in capital-intensive segments of the semiconductor value chain, Semicon India 2.0 has broadened the focus towards ecosystem development across design, manufacturing, materials, equipment, talent and innovation.

India's semiconductor ecosystem is also moving from policy formulation and project approval towards implementation. At this stage, gaps in infrastructure, suppliers, technology access, talent and commercialization could constrain the scale and competitiveness of emerging investments. It is therefore important to address these gaps now to ensure that current policy and investment momentum translates into sustainable domestic value addition. This chapter identifies the key gaps that currently exist across the semiconductor value chain, of which some may be addressed by Semicon 2.0 and examines the broader ecosystem challenges that may influence India's long-term competitiveness.

1.1 Infrastructure, technology and investments

Segment	Assessment	Gaps addressed by Semicon 2.0
Design	The emergence of large-scale indigenous fabless companies remains constrained by the substantial capital required to develop advanced SoCs, with investments in EDA tools, IP licensing, verification infrastructure and tape-outs often running into several hundred million dollars. Access to verified semiconductor IP libraries and regular Multi-Project Wafer (MPW) programs remains relatively limited, affecting the ability of startups and research institutions to rapidly prototype, validate and commercialize chip designs.	▪ To address persistent challenges relating to high design costs and limited access to critical design infrastructure, which remained even after ISM1.0, Semicon 2.0 introduced **Design Infrastructure Support (DIS)**, providing centralized access to EDA tools, semiconductor IP cores and MPW services, thereby enabling faster prototyping, validation and commercialization of chip designs. ▪ To broaden **participation of startups and MSMEs in the semiconductor ecosystem**, Semicon 2.0 enhances funding support through seed funding, equity co-investment and other innovative financing mechanisms for the design and development of semiconductor IPs, chips and system-on-chips (SoCs).
	Collaboration across chip design, packaging and system integration activities remains fragmented, creating challenges in translating design expertise into commercially deployable semiconductor products.	▪ Collaboration across systems remains a gap. ▪ To enable commercially deployable semiconductor products, Semicon 2.0 increased the incentive levels under Deployment linked incentive scheme from 4%-6% to 9%.
	There is a need for a public-private R&D institution, similar to Taiwan's ITRI, to bridge the distance between academia and industry which limits technology transfer, pilot-scale development and commercialization of emerging semiconductor technologies.	▪ Semicon 2.0 encourages consortium-led projects that involve semiconductor companies, academic institutions and R&D organizations, fostering stronger industry-academia collaboration and technology development. ▪ However, the government still needs to bring a public-private institution, as in the case of Taiwan.
Manufacturing fabs	Long gestation periods delay commercial viability, with semiconductor fabs typically requiring 4-5 years before production begins, followed by additional time for yield optimization, qualification and reliability testing before chips reach the market.	
	High capital intensity remains a major barrier, as modern semiconductor fabs require investments of over US$5 billion, while leading-edge facilities at advanced nodes can exceed US$15 billion	
	India has limited participation in leading-edge semiconductor manufacturing, with domestic manufacturing currently concentrated in mature nodes (28-110 nm), compared with ~44% of global wafer fabrication capacity at nodes below 33 nm and leading foundries deriving ~70% of revenue from 7 nm and more advanced technologies.	The government is advancing India's semiconductor capabilities beyond the initial 28 nm-110 nm node range by promoting R&D in advanced process nodes and next-generation semiconductor technologies through collaborations with leading domestic and global research institutions.

Segment	Assessment	Gaps addressed by Semicon 2.0
	Need for standardized Semiconductor Manufacturing Zones (SMZs) with reliable utility infrastructure, despite semiconductor manufacturing requiring uninterrupted access to high-quality power, ultra-pure water, industrial gases and other critical utilities.	
OSAT/ATMP	Advanced packaging and ATMP facilities require substantial capital investment, often running into hundreds of millions of dollars, even though they are less capital-intensive than semiconductor fabs.	Semicon 2.0 focuses on advanced packaging as a dedicated category, attracting fiscal support of up to 35% of capex, higher than the 25% support offered to legacy packaging facilities.
	Limited domestic capabilities in advanced packaging technologies, including CoWoS, HBM integration, FOWLP, PLP, SiP and 2.5D/3D packaging.	Pillar four of Semicon 2.0 aims to enhance capabilities in 2.5D/3D packaging, wafer-level chip scale packaging, heterogeneous integration and advanced substrate by providing financial support.
Equipment and raw materials	Limited domestic capabilities in semiconductor equipment manufacturing and hardware R&D, despite its strong design and software talent base.	▪ Semicon 2.0, Pillar 2 for machines and materials provides financial support for R&D facilities for semiconductor equipment of INR300 crore. ▪ In addition, it provides financial support of INR300 crore for manufacturing and assembly of equipment/refurbish equipment, sub-assemblies, components for use in all semiconductor fabrication and facilities. ▪ Pillar 5 emphasizes on hardware R&D in next-generation semiconductor technologies such as CMOS-based fabrication, silicon photonics, display technologies and chiplet-based architecture.
	Ecosystem for compound semiconductors and advanced materials, including silicon carbide (SiC) and gallium nitride (GaN), remains at an early stage of development.	▪ With the objective of integrating India in the global electronics value chain, Semicon 2.0 has introduced targeted interventions for the development of equipment and raw materials ecosystem in India. ▪ Pillar 3 of Semicon 2.0 provides financial support of INR50 crore for setting up manufacturing facilities for semiconductor grade raw materials, wafer, photo masks, photoresist and substrate.
	Imports continue to account for a significant share of critical semiconductor materials and substrates, including ABF substrates, glass and organic interposers, specialty gases and process chemicals.	
	Limited domestic production of semiconductor-grade materials, with most domestic chemicals and gases produced at parts-per-million purity levels, while semiconductor manufacturing requires parts-per-billion purity.	

Sources: Future of India's Semiconductor Industry I NITI Aayog; Assessing India's Readiness to Assume a Greater Role in Global Semiconductor Value Chains | ITIF; India's Semiconductor Manufacturing Strategy | Jefferies; The Rise Of India's Semiconductor Startups I Inc42

Thus, basis the above, while Semicon 2.0 has bridged the gaps across multiple segments (as highlighted in the previous chapter), there needs to be a continuous effort to streamlines other segments/ areas where support is required.

In addition to segment-specific challenges, several structural gaps exist across multiple segments of the semiconductor value chain and affect the overall competitiveness, scalability and resilience of the ecosystem. These challenges span policy support, financing and talent development and must be addressed holistically to enable sustainable growth of India's semiconductor industry. The key cross-cutting gaps include:

1.2 Policy-related challenges

While India has introduced significant policy measures to develop a domestic semiconductor ecosystem, several challenges continue to limit the sector's growth and competitiveness. These include gaps in state-level incentive frameworks, uneven policy support across semiconductor value-chain segments, and limited incentives for activities such as R&D, design, equipment manufacturing and cluster development. In addition, India's overall funding support remains modest compared to leading semiconductor economies. Addressing these gaps may be critical to strengthening India's semiconductor ecosystem and enhancing its attractiveness as a global investment destination.

Status of state-level incentive support

Absence of semiconductor state policies

- Several states, including **Karnataka, Telangana, Chhattisgarh** and **Uttarakhand**, currently do not have dedicated semiconductor incentive policies.
- States such as **West Bengal, Kerala, Himachal Pradesh** and **Delhi** have expressed intent to promote the semiconductor sector through draft policies, vision documents or roadmaps; however, no formal semiconductor policy has been notified as of **July 2026**.

Exclusion of semiconductor units from eligibility

- **Gujarat, Uttar Pradesh** and **Andhra Pradesh** explicitly exclude design units from availing incentives under their semiconductor policies. Additionally, **Rajasthan's policy does not explicitly clarify the eligibility of design units** for incentives.

Limited incentives

- While **Andhra Pradesh** has a semiconductor policy, it caters to only those projects that have been approved under ISM 1.0, with only limited fiscal incentives of capital and training subsidy.[240]
- Several states, including **Uttar Pradesh, Madhya Pradesh, Rajasthan, Tamil Nadu** and **Haryana**, do not provide direct fiscal incentives for water supply, despite the availability of uninterrupted, high-quality water being a critical requirement for semiconductor manufacturing.

Status of centre-level incentive support

- India's overall funding support remains relatively modest compared with major semiconductor-producing economies, across multiple segments of the semiconductor value chain. India has allocated a budget of INR76,000 crore (~US$7.9 billion) across all segments under Semicon 1.0 and INR1,27,500 crore (~US$13.3 billion) across all segments under Segment 2.0.

Segment	Global funding levels	India funding levels	
		Semicon 1.0	Semicon 2.0
Manufacturing fabs	US$30-39 billion	US$7.9 billion across design, manufacturing and OSAT/ ATMP	US$13.3 billion across all segments
ATMP/ OSAT	US$3 billion		
Equipment manufacturing	US$0.89-47.5 billion		
Design and R&D	US$0.3-12.87 billion		

240 Semiconductor and Display Fab Policy (4.0) 2024-29.PDF

India's total funding level across all segments is approximately US$21 billion, which is below global funding levels.

- Certain fiscal support mechanisms that are commonly available in leading semiconductor economies are currently not part of India's semiconductor incentive framework. These include:
  - Income tax incentives, such as production tax credits or enhanced deductions linked to capital expenditure and R&D expenditure, as provided in countries such as South Korea, Taiwan and China.
  - Interest subvention mechanisms for semiconductor companies to improve project viability and reduce financing costs.
  - Dedicated support for semiconductor cluster development to facilitate ecosystem-wide growth and economies of scale.

1.3 Regulatory related challenges

Certain semiconductor consignments, including wafers, bare dies, photomasks, engineering samples and cleanroom-sensitive equipment components, may be transported in sealed contamination-controlled, moisture-controlled or ESD-protective packaging. Industry stakeholders have indicated that physical Customs examination requiring such protected inner packaging to be opened at a conventional cargo-examination location may create product-integrity risks where suitable handling and resealing arrangements are unavailable.

The risk varies by product. Wafers, bare dies and photomasks may be vulnerable to particle contamination and handling damage, while moisture-sensitive packaged devices and ESD-sensitive components require packaging and handling controls appropriate to their classification. Semiconductor workforce guidance recognizes that minute contamination can affect device integrity, while established semiconductor handling standards prescribe controlled packing and shipping practices for moisture-sensitive devices.

The Customs (On-Arrival Movement for Storage and Clearance at Authorised Importer Premises) Regulations, 2025 provide a potential mechanism for eligible AEO Tier II and Tier III importers to move specified goods under bond to an authorized importer's premises, where the jurisdictional bond officer may examine the goods and submit the examination report electronically to the port. The facility is subject to prescribed warehouse, permission, product-classification and procedural conditions.

The existing eligibility conditions may nevertheless limit access for semiconductor design startups, research organizations and other companies, particularly where they do not hold AEO Tier II or Tier III status.

1.4 Talent related challenges

Semicon 1.0 played a key role in developing India's semiconductor design workforce through initiatives such as C2S and DLI. As a result, India now accounts for nearly 20% of the global semiconductor design talent pool. While India has built a strong semiconductor design talent base, significant workforce gaps remain across other segments of the semiconductor value chain, such as fabrication, packaging and advanced semiconductor technologies.

The following section identifies key talent gaps across the semiconductor value chain:

Segment	Key talent gap
Chip design	1. While the Chips to Startup (C2S) Programme[241] provides Multi-Project Wafer (MPW) fabrication support, it is delivered as project-based fabrication support rather than a standalone industry-recognized job-readiness certification program. 2. India currently lacks a dedicated, standardized curriculum for emerging areas such as AI chip and chiplet design, supported by hands-on training in industry-standard EDA tools, advanced packaging technologies and system-level integration workflows.
Fabrication	1. While India has introduced its first ITI-level UHP welding program at Dholera to train technicians for semiconductor cleanroom gas-delivery and piping systems, training programs for core fabrication processes such as deposition, etching and ion implantation remain limited[242]. 2. India lacks short-term, industry-recognized certification programs for diploma holders and mid-career professionals in areas such as cleanroom operations and contamination-control practices. 3. Foreign expertise is currently being transferred primarily through commercial partnerships; however, structured government-to-government training and workforce exchange programs are yet to be established.
OSAT/ ATMP	1. No dedicated ITI trade in wire bonding or die-attach operations exists yet 2. India's OSAT ecosystem is expanding into advanced packaging, driven by planned investments from several companies. However, India currently lacks a specialized certification pathway focused on 2.5D/3D IC packaging technologies 3. Absence of dedicated vocational and technician training programs for packaging operations such as wire bonding, die attach and related backend manufacturing processes.

How Semicon 2.0 addresses challenges related to talent and workforce

Under Semicon 2.0, the government has identified **talent development and capacity building** as a key focus area to support the growth of India's semiconductor ecosystem. Through Pillar 6, the program aims to build a robust, multi-tiered workforce across semiconductor design, fabrication, packaging, and allied domains, spanning undergraduate, postgraduate, doctoral and shop-floor levels.

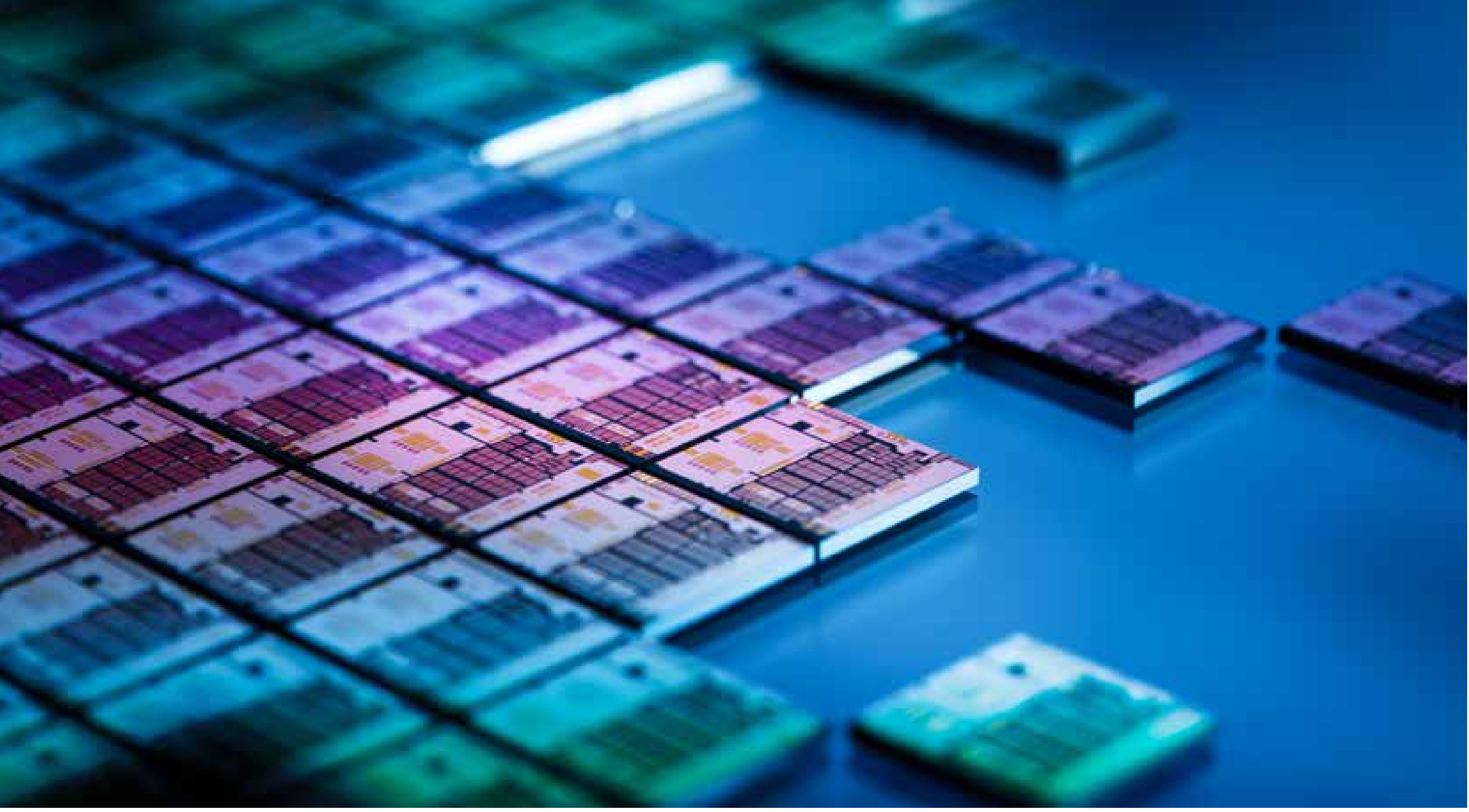
- To strengthen the **design talent pipeline**, the scheme supports access to advanced EDA tools, multi-project wafer fabrication services, post-silicon validation platforms and other capacity-building initiatives.
- To enhance **manufacturing capabilities**, the scheme promotes the establishment of dedicated training infrastructure, hands-on shop-floor training programs, and the strengthening of national nanofabrication and process laboratories to provide practical, industry-relevant training.
- The initiative also encourages participation from **academic institutions, R&D organizations, laboratories, scientific societies and training institutions**, fostering closer industry-academia collaboration to develop a future-ready semiconductor workforce.
- The government has also extended fiscal support of 75% for eligible projects towards capital and operational expenditure.

The Semicon India Programme, complemented by state semiconductor policies, has made significant progress in addressing many of the constraints mentioned above, by catalyzing investments, strengthening design capabilities, improving project viability through fiscal incentives and establishing the foundations of a domestic manufacturing ecosystem. While Semicon India 1.0 focused on targeted interventions to address critical manufacturing bottlenecks, Semicon India 2.0 envisions a broader approach aimed at closing ecosystem-wide gaps and developing an integrated semiconductor value chain.

Collectively, these interventions aim to strengthen India's semiconductor ecosystem across capital, technology, manufacturing, innovation, talent, supply chains and market adoption, laying the foundation for a globally competitive and self-reliant semiconductor industry.

Nevertheless, significant strategic opportunities remain across advanced technologies, semiconductor equipment and materials, R&D and technology commercialization and specialized talent development. Addressing these gaps in a timely manner, particularly through the next phase of semiconductor policy interventions, can help India deepen value chain participation, strengthen domestic capabilities across the ecosystem, and convert policy-led capacity creation into durable, globally competitive semiconductor capabilities.

241 Detailed Project Report on SMDP-S2S
242 Dholera Semiconductor Welding Training



Chapter 7

Roadmap for positioning India as a global semiconductor hub

Building on the analysis of segment-wise supply chain readiness, policy frameworks and India's investment proposition in the preceding chapters, this chapter presents industry expectations and recommended actions for the next phase of India's semiconductor ecosystem development. It identifies key gaps benchmarked against global leaders, investor priorities and policy interventions to enhance India's global competitiveness and investment attractiveness.

Augment fiscal measures to improve investment attractiveness

Additional fiscal measures are relevant at this stage because project-location and investment decisions can influence the next phase of semiconductor capacity creation. Based on the global benchmarking (mentioned in chapter 2) with the US, EU, Japan, Taiwan, China and South Korea and India's existing ISM and state incentives, the following additional fiscal measures could strengthen India's competitiveness:

Incentive type	Recommended fiscal measure	Global benchmark/rationale
Income tax incentives to encourage investment	Introduce a semiconductor-specific tax credit (20% to 30%) for fabs, ATMP, design, equipment and materials manufacturing.	Japan and South Korea offer semiconductor tax credits, while China provides corporate tax holidays for advanced nodes.
R&D tax deductions to encourage innovation	Provide enhanced R&D tax deductions/ credits for semiconductor design, process technologies, advanced packaging and equipment development.	Taiwan offers up to 25% R&D tax credit, while South Korea provides R&D tax credits of up to 50%.

The proposed fiscal measures would support the financial viability of semiconductor projects by reducing the cost of capital and improving project bankability. Faster financial closure and the availability of a sustained pipeline of investable projects would further strengthen India's competitiveness in attracting semiconductor investments across the value chain. Over time, this investment base can support India's broader ambition to build leadership in frontier chip design, advanced packaging and next-generation semiconductor material, while expanding domestic manufacturing capabilities across mature and compound semiconductor technologies.

Align state semiconductor policies with the expanded scope of Semicon 2.0

State policies need to evolve along with Semicon 2.0 for new investments to receive coordinated support across materials, equipment, R&D, talent and infrastructure.

- Most state semiconductor policies were designed around the objectives of Semicon 1.0 and therefore focus primarily on semiconductor fabs and ATMP/ OSAT facilities. With Semicon 2.0 expanding support to new segments such as semiconductor materials, specialty chemicals, gases, equipment manufacturing, R&D and talent development, states must consider updating their policies to cover these emerging segments.
- Policies in states that currently lack dedicated semiconductor policies can notify comprehensive frameworks, while existing policies can expand eligibility criteria, enhance incentive coverage and ensure alignment with national priorities.

The need for such alignment is already evident. Odisha has signalled this shift by proposing incentives for semiconductor equipment, specialty gases, chemicals, advanced materials, and other supply-chain segments. Such harmonization between central and state initiatives would improve investor confidence and strengthen ecosystem-wide development. Targeted state-level interventions would allow incentives and infrastructure support to be aligned with the capabilities and gaps of individual states. Aligning these interventions with central government incentives may also enable consistency with India's broader semiconductor agenda and support coordinated ecosystem development across the value chain. This would allow states to develop clearer investment propositions and specializations based on their respective strengths. Collectively, these state-level capabilities could support India's wider ambition to develop leadership across selected segments of the semiconductor value chain, particularly advanced packaging, wide-bandgap materials such as silicon carbide and gallium nitride and mature and compound semiconductor manufacturing.

Adopt targeted state-level policy measures

As states differ in their semiconductor ecosystem strengths and readiness, targeted policy interventions are required to address specific gaps and unlock growth opportunities. The table below outlines targeted policy interventions for individual states based on their existing capabilities, ecosystem strengths and identified gaps across the semiconductor value chain.

Policy recommendation	Target states
Notify dedicated semiconductor policies to provide clear strategic direction	Maharashtra, Karnataka, Kerala, West Bengal, Delhi, Telangana, Uttarakhand, Himachal Pradesh
Expand policy coverage across the semiconductor value chain to include design, equipment, materials, etc.	Gujarat, Andhra Pradesh, Assam, Punjab, Uttar Pradesh,
Link capital subsidies to investment levels through a graded structure to incentivize larger investments	All states
Strengthen design and innovation incentives to support fabless companies, IP creation, prototyping, etc.	Gujarat, Andhra Pradesh, Assam, Punjab
Introduce infrastructure-focused incentives	Andhra Pradesh, Haryana, Goa, Assam
Strengthen fiscal incentives to improve project viability	Interest subvention: Gujarat, Andhra Pradesh, Assam, Haryana, Goa, Punjab Land support: Andhra Pradesh, Assam, Punjab, Goa SGST reimbursement: Gujarat, Andhra Pradesh, Assam, Punjab, Goa
Develop dedicated semiconductor clusters to enable economies of scale	Haryana, Goa, Assam
Promote green semiconductor manufacturing	Gujarat, Andhra Pradesh, Assam, Goa, Haryana, Punjab

Create a comprehensive semiconductor talent development framework

While India has developed a semiconductor design talent pool, skill gaps remain across fabrication, advanced packaging, equipment maintenance, cleanroom operations and semiconductor manufacturing processes. As approved semiconductor projects progress towards commercialization, developing a specialized manufacturing workforce will be critical to support ecosystem scale-up and long-term competitiveness. Developing a future-ready semiconductor talent pipeline will require coordinated action across academia, industry and government, including the following measures:

- A dedicated semiconductor skilling framework should be established covering universities, polytechnics, ITIs and industry-led training programs.
- Dedicated certification courses in areas such as photolithography, process engineering, wire bonding, advanced packaging and equipment operations should be developed in collaboration with industry.
- International training partnerships with leading semiconductor economies such as Taiwan, South Korea and Japan can further accelerate workforce preparedness and support India's expanding manufacturing ecosystem.
- Development and periodic updating of curricula and certification programs by academic institutions and industry jointly across semiconductor design, manufacturing, materials and advanced packaging, aligned with evolving technology and workforce requirements
- Technical and engineering programs providing practical exposure to industry-standard Electronic Design Automation tools, multi-project wafer runs and advanced packaging technologies, supported by apprenticeships and on-site training at fabrication and Outsourced Semiconductor Assembly and Test facilities.
- Long-term partnerships with leading global universities and research institutions supporting curriculum co-development, faculty exchange and joint research, while global experts should be engaged across academic institutions, fabrication facilities, design hubs and training academies with explicit knowledge-transfer objectives.

Building on the talent gaps identified across the semiconductor value chain and drawing on global best practices adopted by leading semiconductor economies, the following table outlines segment-wise key recommendations to strengthen India's semiconductor talent ecosystem.

Segment	Key recommendations to fill the talent gap
Chip design	1. Institute a certification program in RTL-to-GDSII* design, covering RTL coding, logic synthesis, place-and-route and timing closure using industry-standard EDA tools. 2. Add AI-chip and chiplet design modules to B. Tech/ M. Tech VLSI curriculum. *RTL (Register Transfer Level): A hardware design description that defines how data moves through a chip and is processed by digital logic. GDSII (Graphic Data System II): The final chip layout file containing physical design information used by semiconductor fabs for manufacturing.
Fabrication	1. Develop an ITI* diploma in photolithography and thin-film process operations, focused specifically on fabrication unit processes such as deposition, etching and ion implantation, with cleanroom protocol certification built into the curriculum. 2. Establish mid-career short-term certification programs to rapidly train technicians in cleanroom operations, contamination control and equipment maintenance. 3. Launch a government-to-government semiconductor training exchange program with leading semiconductor hubs such as Taiwan and South Korea for on-site fab workforce training. *ITI (Industrial Training Institute): A vocational training institution that provides industry-oriented technical skills and hands-on training for technicians and trade workers.
OSAT/ ATMP	1. Develop an ITI trade certification in wire bonding, die-attach operations and other specialized OSAT operations. 2. Add a separate advanced-packaging (2.5D/3D IC) certification for experienced OSAT technicians.

These measures are expected to deepen specialized capabilities across semiconductor design, fabrication, advanced packaging, materials and equipment operations. Industry-aligned curricula, practical training and certification would strengthen the availability of fab-ready technicians and engineers, while international institutional partnerships and structured knowledge transfer would improve teaching quality, research depth and system-level expertise. By developing domestic specialization across the semiconductor value chain, these interventions can provide the workforce foundation required to support India's long-term pursuit of greater chip self-sufficiency and domestic value retention.

Develop cluster-based semiconductor manufacturing ecosystems

Common infrastructure and supplier networks may be developed in parallel with anchor projects to support efficient commissioning and operations. Global semiconductor leaders such as Taiwan and South Korea have demonstrated the importance of cluster-based development in improving competitiveness and reducing operational costs.

- India must consider promoting dedicated semiconductor clusters with common infrastructure including uninterrupted power supply, ultra-pure water systems, specialty gas networks, waste-treatment facilities, testing infrastructure and logistics support.
- Co-location of fabs, ATMP facilities, equipment manufacturers, material suppliers, research institutions and training centers would create economies of scale, shorten supply chains and improve project viability.
- Such integrated clusters can significantly strengthen India's value proposition for semiconductor investments.
- Semiconductor clusters must be assessed against defined standards for power quality, ultra-pure water, industrial gases, waste treatment, environmental approvals, emergency response, logistics, supplier access and workforce availability before approving large anchor projects.

The development of integrated semiconductor clusters can support faster ramp-up and higher utilization of manufacturing assets, while facilitating the integration of Indian facilities into global semiconductor supply chains. Co-location of fabrication and packaging facilities with materials, substrates and other upstream capabilities would further help reduce supply-chain risks, improve cost control and increase domestic value addition across the semiconductor production stack. The scale and coordination enabled by these clusters would strengthen India's position as a significant global semiconductor player and support the production of high-volume, cost-competitive chips for locally relevant applications, including affordable 5G and 6G devices, edge processors, microcontrollers, sensors and charger integrated circuits.

Building domestic market for Indian Semiconductors

Startups and MSMEs play a crucial role in India's semiconductor ecosystem. However, their competitiveness may be constrained by the economies of scale that mature semiconductor players have achieved, which enables them to supply chips to Indian end-use industries at more competitive prices. To create a level playing field and strengthen demand for domestic semiconductors, India could consider incentivizing the use of domestically manufactured chips through domestic value-addition or sourcing criteria in downstream industries.

A useful precedent is India's mobile manufacturing journey. The sector initially grew through assembly-led operations supported by targeted policy interventions and large-scale investments from global manufacturers. However, policy support gradually evolved beyond final assembly to promote localization of components, supplier development, domestic value addition and ecosystem creation. For instance, the recently launched Mobile Manufacturing Scheme provides an additional 1.5% incentive for domestic sourcing of key components such as display modules and batteries.[243] Over time, India expanded from being an importer of finished mobile phones to becoming a major manufacturing hub supported by a growing base of component suppliers, EMS players, tooling providers and domestic manufacturers. The success of this approach was driven not only by attracting anchor investments but also by creating sustained domestic demand, supporting local suppliers and gradually increasing domestic content across the value chain.

A similar evolution is required for the semiconductor sector with respect to linking domestic sourcing to enhanced incentives under the scheme. This can create assured domestic demand, improve scale for Indian semiconductor manufacturers and encourage new entrants into the sector.

Establish a national semiconductor research and commercialization platform

India currently lacks a dedicated institution that can bridge academic research, industry requirements and commercial deployment of semiconductor technologies. Establishing a national semiconductor research and commercialization platform, modeled on institutions such as Taiwan's ITRI or Belgium's IMEC, can support indigenous IP development, pilot-scale manufacturing, technology validation and industry-academia collaboration. Such a platform can provide common access to design infrastructure, prototyping facilities, advanced packaging capabilities and technology-transfer support, helping startups, MSMEs and research institutions convert innovation into commercially viable products.

The proposed platform would contribute to accelerating the progression of frontier semiconductor technologies through successive Technology Readiness Levels and developing a pipeline of reusable intellectual property, reference flows and contributions to international standards. This would support India's transition from a design-execution base towards ownership of advanced intellectual property and the development of next-generation semiconductor architectures. Over time, these capabilities could help reduce royalty outflows, strengthen freedom to operate and enhance India's visibility and influence in emerging semiconductor standards.

Implementation priorities

- Academic and research institutions to align pre-competitive research with India's fabrication, advanced packaging and materials roadmaps, with industry participation in identifying research priorities and supporting technology validation.
- Shared pilot lines, materials and integration testbeds to be made accessible to academic institutions, start-ups and semiconductor companies, supported by clear frameworks for intellectual property, data sharing and technology transfer.
- Joint research programs and laboratories with domestic and global industry partners to support technology absorption, indigenous intellectual property creation and the transfer of research outcomes to commercial entities.

243 https://www.pib.gov.in/PressReleasePage.aspx?PRID=2302098&reg=48&lang=1

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Operationalize and extend controlled examination for sensitive semiconductor imports

CBIC may consider operationalizing a semiconductor-specific facilitation protocol under the framework for on-arrival movement, storage and clearance at authorized importer premises. The protocol could identify eligible products such as semiconductor wafers, bare dies, photomasks, prototype or engineering samples, moisture-sensitive devices and cleanroom-ready equipment.

Where documentary verification, seal verification, outer-package examination, imaging or non-intrusive inspection is sufficient, the protected inner packaging should remain unopened. Where opening is necessary, examination should follow declared ESD, moisture and contamination-control requirements, with suitable arrangements for handling, recording and resealing.

CBIC may also evaluate a proportionate route for compliant semiconductor design companies, startups, research institutions and other companies which may not satisfy the existing AEO Tier II or Tier III requirements. Possible options for evaluation include examination at an approved common control facility, use of an authorized custodian, or a product-specific relaxation under the regulations. Any such route should retain risk-based selection and Customs supervision.

This recommendation is not for exemption from Customs examination. It seeks to adapt the location and manner of examination to the technical characteristics of sensitive semiconductor products.

Supplier qualification program

Establish programs through which equipment manufacturers, fabs and OSAT companies identify components capable of localization, mentor potential Indian suppliers and support testing and qualification. The objective should be entry into global approved-vendor networks, not merely domestic procurement.

India has made significant progress in building the foundations of a domestic semiconductor ecosystem through targeted policy support, growing private-sector investments, strategic international partnerships and a strong talent base. While Semicon India 1.0 focused on addressing critical investment-intensive gaps, Semicon India 2.0 marks a strategic shift towards developing capabilities across the broader semiconductor value chain, including design, manufacturing, materials, equipment, R&D and talent.

As India moves from capacity creation to ecosystem development, acting now may be critical to capture the emerging opportunity and translate current policy momentum into long-term gains. The focus must be on strengthening domestic value addition, fostering innovation, deepening supply-chain capabilities and addressing gaps in technology, talent, infrastructure and commercialization. With sustained policy support and coordinated action across government, industry, academia and states, India can leverage this window to emerge as a globally competitive, resilient and trusted semiconductor hub.

What next for India

India's semiconductor journey has entered a decisive phase. The foundations of a domestic ecosystem are now being established through significant public investments, anchor manufacturing projects, expanding design capabilities and a broader policy framework under Semicon India 2.0. The next stage of development, however, may require India to look beyond capacity creation and focus on building a self-sustaining semiconductor economy anchored in domestic demand, innovation and value addition across the electronics value chain. The objective may not merely be to manufacture chips in India, but to create an ecosystem where chips designed, produced and packaged in India are increasingly deployed in products designed and manufactured within the country itself.

India is projected to become a semiconductor consumption market of approximately US$200 billion by 2035.[244] Yet a significant share of this demand is presently embedded in imported electronic systems, modules, kits and assembled products, resulting in limited domestic value capture. This presents one of India's largest strategic opportunities. By strengthening domestic system design, electronics product development and advanced manufacturing across sectors such as consumer electronics, automotive, industrial automation, telecommunications, aerospace, defense, medical devices and artificial intelligence, India can transform semiconductor demand into a powerful driver of indigenous semiconductor production. Creating such downstream demand pull may be as important as supporting semiconductor supply-side investments.

India's distinctive advantage lies in the convergence of three strategic strengths that few countries possess simultaneously: a globally competitive semiconductor design ecosystem, one of the world's fastest-growing electronics markets and an increasingly attractive manufacturing base along with an extensive pool of talent. Leveraging these strengths to create globally competitive products and platforms can enable India to occupy a unique position within global semiconductor supply chains. Rather than replicating the trajectories of traditional semiconductor powers, India has the opportunity to chart a differentiated path centered on design-led manufacturing, advanced packaging, compound semiconductors, trusted supply chains and system-level innovation.

As global supply chains continue to diversify and nations seek resilient sources of semiconductor production, India is uniquely positioned to emerge as a trusted partner in the global semiconductor ecosystem. The coming decade therefore represents more than an opportunity to build semiconductor manufacturing capacity; it represents an opportunity to establish India as a globally significant center for semiconductor innovation, product development and electronics manufacturing. With continued policy commitment, coordinated execution and a sharp focus on domestic value creation, India can transform its projected semiconductor demand into a strategic engine for technological leadership, industrial competitiveness and long-term economic growth.

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Glossary

Acronyms	Full form
PLI	Production Linked Incentive
ISM	India Semiconductor Mission
INR	Indian National Rupee
IP	Intellectual Property
EDA	Electronic Design Automation
R&D	Research and Development
ITRI	Industrial Technology Research Institute
IMEC	Interuniversity Microelectronics Centre
AI	Artificial Intelligence
MEMS	Micro-Electromechanical Systems
EV	Electric Vehicles
ATMP	Assembly, Testing, Marking and Packing
OSAT	Outsourced Semiconductor Assembly Test
SoC	System-on-Chips
SiC	Silicon Carbide
GaN	Gallium Nitride
GaAs	Gallium Arsenide
InP	Indium Phosphide
Si	Silicon
2.5 D/3D packaging	Two and a half dimensional packaging and three-dimensional packaging
OLED	Organic Light-Emitting Diode
MicroLED	Micro Light-Emitting Diode
IC	Integrated Circuit
VCSELs	Vertical-cavity surface-emitting lasers
LiDAR	Light Detection and Ranging
NIST	National Institute of Standards and Technology
SiP	System In Package
TFT	Thin-film transistors
LCD	Liquid Crystal Display
InGaN	Indium Gallium Nitride
AlGaInP	Aluminum Gallium Indium Phosphide
CMOS	Complementary Metal Oxide Semiconductor
VLSI	Very large-scale integration
SAMARTH	Silicon and Advanced Semiconductor Manufacturing Research and Training Hub
PMFBY	Pradhan Mantri Fasal Bima Yojana
5G/6G	Fifth Generation and Sixth Generation
DLI	Design Linked Incentive Scheme
AMOLED	Active Matrix Organic Light Emitting Diode
WSPM	Wafer Starts Per Month
RISC-V	Reduced Instruction Set Computer – Five
DIR-V	Digital India RISC-V
C2S	Chips to Startup Programme

Acronyms	Full form
SGST	State Goods and Services Tax
CoE	Centre of Excellence
ZLD	Zero Liquid Discharge
DDIC	Display Driver IC
3DHI	3D Heterogeneous Integration
ROK	Republic of Korea
B2B	Business-to-business
AICTE	All India Council for Technical Education
GCC	Global Capability Centers
ITI	Industrial Training Institute
CAPEX	Capital Expenditure
DAO	Discrete, Analog and Others
IoT	Internet of Things
Nm	Nanometers
EUV	Extreme Ultraviolet
CoWoS	Chip-on-Wafer-on-Substrate
IRA	Inflation Reduction Act
CHIPS	Creating Helpful Incentives to Produce Semiconductors Act of 2022
DARPA	Defence Advanced Research Projects Agency
MOSIS	Metal Oxide Semiconductor Implementation Service
DRAM	Dynamic Random Access Memory
KRW	South Korean Won
CIT	Corporate Income Tax
RA	Reinvestment Allowance
CAGR	Compound Annual Growth Rate
OCI	Overseas Citizenship of India
MSME	Micro, Small and Medium Enterprises
BoM	Bills of Materials
OPEX	Operational expenditure
MPW	Multi-Project Wafer
LED	Light Emitting Diode
NIELIT	National Institute of Electronics and Information Technology
ASIC	Application Specific Integrated Circuit
FPGA	Field-Programmable Gate Array
RTL	Register Transfer Level
DFT	Design For Testability
STEM	Science, Technology, Engineering and Mathematics
HBM	High Bandwidth Memory
FOWLP	Fan-Out-Wafer-Level Packaging
PLP	Panel Level packaging
ESD	Electrostatic Discharge
AEO	Authorized Economic Operator
UHP	Ultra High Purity

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