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Franchise Report

India | Equity Strategy

Equity Research
March 3, 2025

STRATEGY NOTE

Semiconductors: India's Next Big Leap

India's big push for semiconductors is bearing fruit with $18bn of investments underway in a chip fab and four ATMP/OSAT projects. Our interactions with government suggest high focus on ecosystem expansion across the supply chain to quadruple electronics production to $500bn by 2030. We believe India has strong potential to replicate its manufacturing success in autos to semis, led by policy support, rising demand, low cost and strategic goodwill with the West.

Chip is the new oil: Electronics and semiconductors have become critical not only for the economic progress of a nation but also for national security. India's electronics demand is accelerating, led by rising incomes and digital adoption. Net electronic imports rose to $60bn in FY24, forming 25% of country's trade deficit, next only to oil (39%).

Big policy push: The Indian govt embarked on a path to promote domestic electronics manufacturing, and aims to quadruple production over FY24-31 to $500bn. While India has extensive design talent and assembly has picked up, value addition is low at 18-20%, which govt intends to raise to ~35% by 2030. The govt hence launched an additional $10bn program in 2021, providing incentives for ~50% of the project cost for chip and display fabs, and testing facilities. Certain states offer further ~20% incentive, taking total benefit to ~70%.

$18bn investments underway: The policy push is bearing fruit as five projects with $18bn of investments, including ~70% fiscal support, are under construction. Tata Electronics' $11bn fab for 28-110nm chips with PSMC of Taiwan is expected to start in 2026. The four ATMP/OSAT projects, expected to start over 2025-27, include: Tata's $3.3bn facility, Micron's $2.8bn DRAM/NAND plant, CG Power's $0.9bn project with Renesas, and Kaynes' $0.4bn facility. These projects are expected to create ~80K direct and indirect jobs. The state of Gujarat has taken a lead, attracting four projects, forming ~80% of total investments.

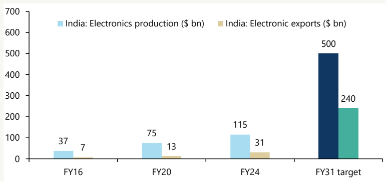
Focus on ecosystem expansion: In our meeting, Mr. Ashwini Vaishnaw, the Minister of Railways, Information and Broadcasting, and Electronics and IT, highlighted govt's strong focus on building the full semis ecosystem in India, with emphasis on establishing the entire supply chain, including chemicals, gases, equipment and components, along with leveraging India's strong design capabilities.

A practical approach to technology: While a 28nm fab with $11bn spend is modest vs TSMC's 2-5nm nodes and $235bn tangible gross block, ~56% of global installed wafer capacity is still 34nm-or-higher and players like GlobalFoundries and Infineon have comparable $20-35bn gross block. More importantly, India's manufacturing success, at least for now, may not lie in competing at the technology frontier, but in leveraging proven technologies and creating effective solutions, aligned with nation's rising demand and economic priorities. We see a strong parallel to India's success in autos. India, in early 1980s, struggled to kickstart auto manufacturing, but, with prudent policies and rising demand, is now #4 in production volumes and is exporting vehicles, while not at the forefront of technology.

A promising path: We believe India possesses several key ingredients for success in semis such as large fiscal incentives, policy support, rising demand, participation of large corporates, low manufacturing cost, strong design talent, and strategic goodwill with the West. On the flip side, industry faces hurdles of undeveloped supply chain, limited chip manufacturing talent, global competition and rapidly evolving technology. With a strong policy foundation and momentum accelerating, we believe India has potential to thrive in semiconductor manufacturing.

What's inside:
Interview with Mr. Ashwini Vaishnaw
Semiconductor projects underway
Apple's India journey
Chip evolution in Asia
India's big leap in autos
What is a chip?

Exhibit 1 - Big targets



Source: Government of India, Avalon, Jefferies

Exhibit 2 - $18bn investments underway

Company	Type	Investment ($bn)
Tata Electronics	Foundry	11.0
Tata Electronics	OSAT	3.3
Micron Technology	ATMP	2.8
CG Power	OSAT	0.9
Kaynes	OSAT	0.4
Total		**18.4**

Source: PIB, Company, Jefferies

Global electronics companies already manufacturing in India: Apple, Foxconn, Pegatron, Jabil, Samsung, LG, Philips

Companies evaluating supply chain opportunities in semis: Pidilite, Linde, Thermax, Gujarat Fluorochemicals, Jyoti CNC, Carborundum Universal, Schneider Electric Infra, Deepak Fertilisers, Jubilant Ingrevia, Praj Industries

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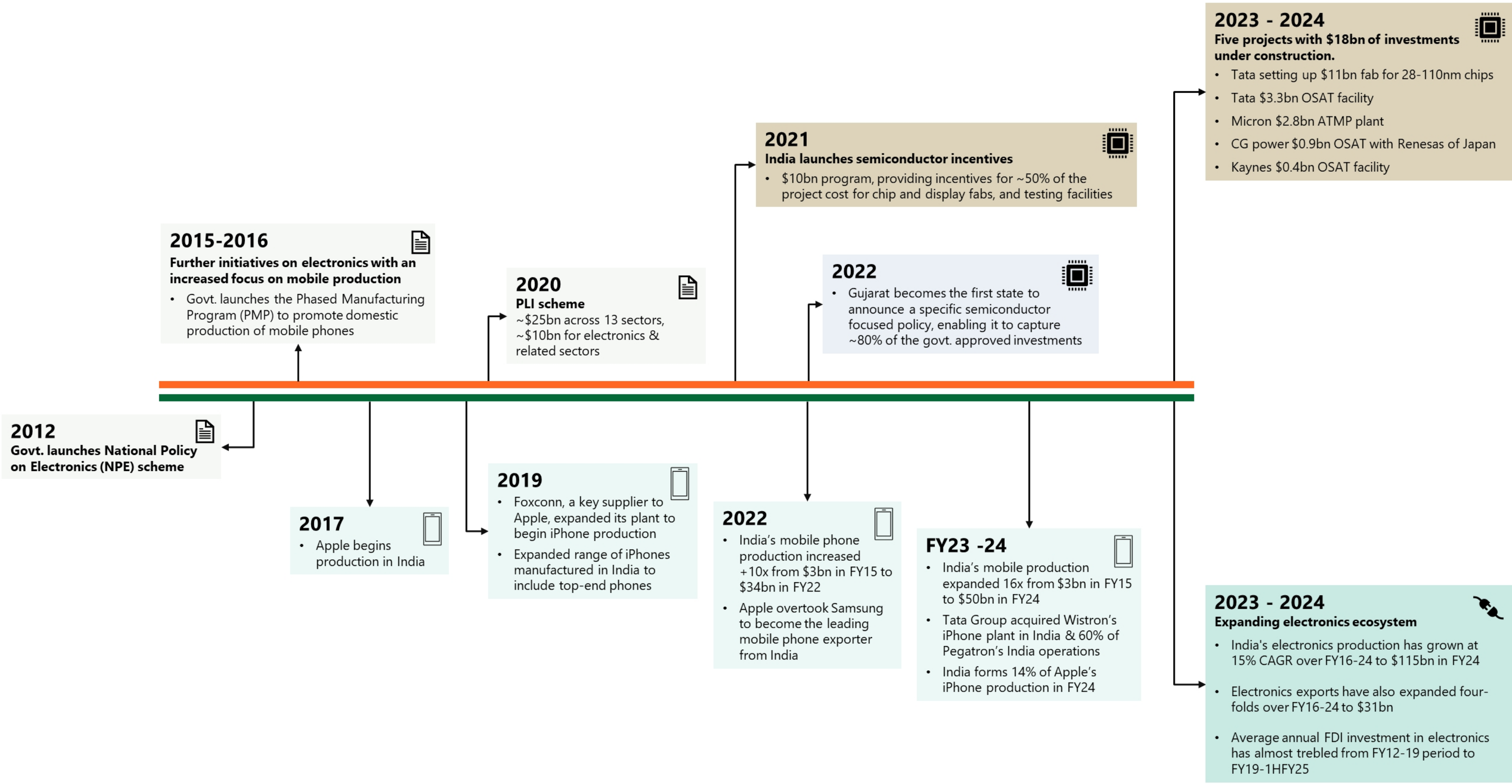
Exhibit 3 - India making consistent progress on path to creating a big semiconductor and electronics manufacturing ecosystem



Source: Government of India, Media articles (Economic Times, Times of India), Jefferies

Interview with Mr. Ashwini Vaishnaw, Hon'ble Minister for Railways; Information & Broadcasting; Electronics & Information Technology

Jefferies: What is the government's medium-to-long-term vision for the electronics and semiconductor industry in the country?

Mr. Vaishnaw: The Government of India aims to make India a global hub for electronics and semiconductors. In line with the vision of our Prime Minister, we plan to increase electronics manufacturing to $500 billion by FY 2030-31, creating 5.5–6 million jobs and reducing import dependence.

We aim to increase domestic value addition from 18-20% to over 35% by the end of the decade. With India's focus on AI, 5G/6G, IoT, and Electric Vehicles, the potential for growth in the semiconductor industry expands manifold. To capitalise on this opportunity, we are building a strong semiconductor ecosystem with a focus on chip design, fabrication, and packaging. The government is also developing a skilled workforce, strengthening R&D, and ensuring resilient supply chains.

The government aims to achieve this by fostering a conducive business environment and robust policy support. So it is the clarity of thought of our leadership coupled with the growing trust of global investors in India, which is driving our efforts towards becoming a global leader in this space.

Jefferies: How do you see the progression of India's semiconductor program?

Mr. Vaishnaw: The three years of the India Semiconductor Mission have been very satisfying. We are building the entire semiconductor ecosystem in our country, starting from a nascent phase despite the high complexity involved. When India announced its semiconductor program three years ago, it was received with a lot of scepticism. This initial scepticism has eventually faded as government efforts have strengthened the ecosystem, assuring that India is the next big semiconductor destination.

Today, the country has five units in the advanced stages of construction, and the first make-in-India chip will roll out this year. In 2026, we will see two more projects commissioned, and by 2027, we will see all the five projects producing chips. Other important industries needed to support semiconductor manufacturing like chemicals, gases, etc, are also setting up their facilities in India.

This underlines the consistency of government policies and the oppportunity available for industry to invest in India.

Jefferies: What, in your opinion, has enabled India to achieve this early success?

Mr. Vaishnaw: India's success in the India Semiconductor Mission (ISM) is driven by strong leadership, stable policies, focused execution, global trust and the presence of skilled talent pool in the country.

With over lakhs of STEM students graduating annually, we have a huge potential workforce base in chip design, embedded systems, and chip engineering. Talent is abundant in India where almost 2,000 GCCs (global capability centres) are working on advanced chip design for many global companies. We have more than 3 lakh designers working in India.

The world trusts India. We respect Intellectual Property Rights and the knowledge created by other countries. The way our PM has conducted our economic and foreign policy over the last 10 years, has gone a long way in developing this trust. We believe in long-term relationships and have a very robust & innovation-friendly policy framework along with political stability. This has helped us become a trusted partner for those who want to set up manufacturing in India.

Jefferies: What are the next focus areas for the government in semiconductor policy?

Mr. Vaishnaw: The Prime Minister has a clear vision of getting the entire semiconductor ecosystem in place, rather than focusing only on the fab or one part of the value chain.

There is a big focus on establishing the entire supply chain of gases, chemicals, special materials and equipment in the country. While India has a strong manufacturing base for gases and chemicals producing at parts-per-million purity, companies are now investing in R&D and enhancing capabilities to achieve the parts-per-billion purity that is required for semiconductors.

The government is already working on all these aspects comprehensively and industry partners are supportive. One of the largest equipment manufacturers has set up its first plant and looking at a much larger manufacturing facility for the equipment. One of the major chemical companies has also decided to set up the entire spectrum of speciality chemicals, gases, and the complete supply chain in India. This initiative will not only cater to domestic needs but also serve global markets

Jefferies: What steps is the government taking to develop the engineering talent required for the semiconductor industry?

Mr. Vaishnaw: India's talent pipeline is robust and the government is actively working to improve the quality of talent to lay a strong foundation for the electronics and semiconductor industry. India Semiconductor Mission (ISM) offers financial incentives and infrastructure support to nurture domestic semiconductor capabilities. Chips to Startup (C2S) Program is training engineers in VLSI and embedded system design, collaborating with over 400 academic institutions.

To establish a strong talent pipeline, the course curriculum is getting fully aligned with the requirements of the industry. Our idea of integrating industry and the university system has also been very well received. Higher Educational Institutes are now offering specialised, B.Tech, M.Tech course in semiconductor manufacturing.

The government is working with the three leading EDA design tool companies, Cadence, Synopsys and Siemens, to procure their entire software suite, and provide licenses across 104 universities in India. We have students in many universities who are designing chips using the latest tools while they are in their third year and final year of the projects.

With government support, incentives, and skilled talent, now is the right time to expand and invest in India.

Jefferies: How does the government see India's role in chip design?

Mr. Vaishnaw: India has a large engineering talent pool and houses ~20% of the world's semiconductor design workforce. The design prowess of India provides a solid foundation for expanding into fabrication, packaging, and electronic product development. The government intends to have more support for chip design.

In the semiconductor mission, we have approved about 25 applications for the design of chips, and 13 out of those have done very well. Three of them have started attracting venture capital and some of the chipsets being designed are at the advanced stage. The government is also planning to develop 25 chipsets critical for Indian industry and strategic needs.

Design Linked Incentive (DLI) Scheme supports startups and companies in chip design and IP creation through financial incentives. Semiconductor Research Centers and Centers of Excellence are being set up in collaboration with IITs, NITs, and research institutes to drive advanced chip design research.

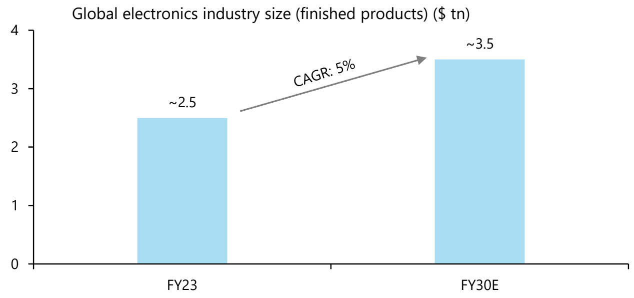
With a vast talent pool, government incentives, and a growing market, global companies can leverage India's existing design ecosystem to establish end-to-end semiconductor operations.

Chip is the new oil

Electronics, with semiconductors as its building blocks, have become critical not only for the economic progress of a country but also for its national security. The global electronics industry stood at c.$2.5 trillion in FY23, according to the government. Global semiconductor sales have almost doubled over the last 10 years to c.$0.6 trillion in 2024. Global chip production has crossed 1.1 trillion units, i.e. ~140 chips per person on Earth.

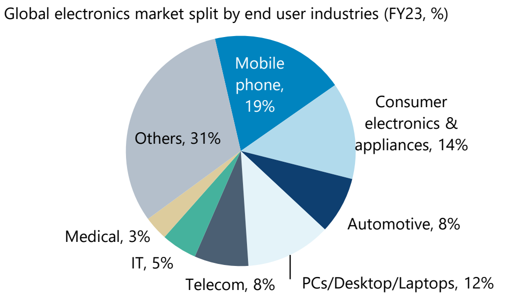
Electronics, and semiconductors as its building blocks, have become critical not only for economic progress but also for national security.

Exhibit 4 - Electronics is ~$2.5tn globally, expected to grow at 5% CAGR



Source: Government of India, Jefferies

Exhibit 5 - ...with a wide set of applications

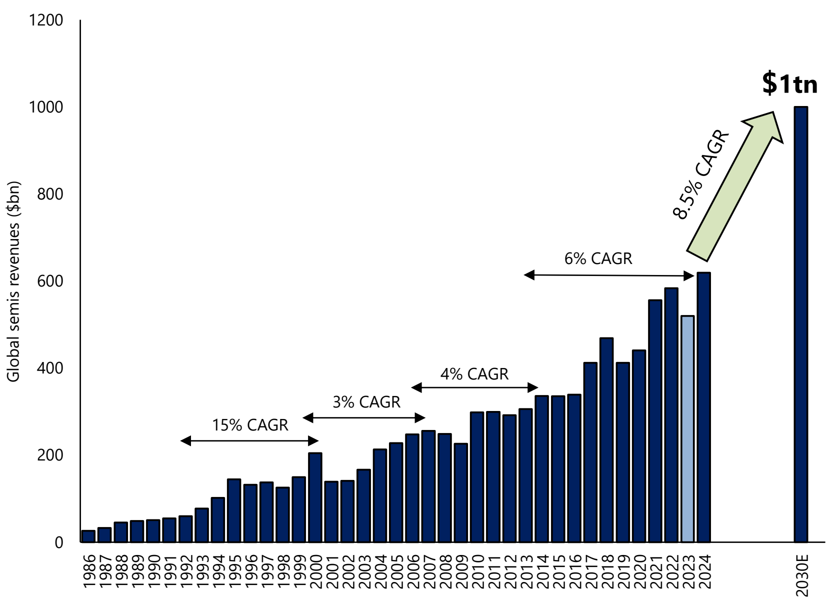


Source: Government of India, Jefferies

The rise of AI in the last two years has further increased the importance of semiconductors, with Nvidia last year showing a meteoric rise to become the world's most valuable company with a market cap of over $3 trillion. AI is increasing demand for chips in cloud AI deployments mainly for training models, as well as in the proliferation of edge AI for inferencing models. AI-related demand is, therefore, expected to further accelerate global semiconductor growth rates over the next six years, and JEF expects the industry to reach revenues of $1 trillion by 2030.

The rise of AI in the last two years has further increased the importance of semiconductors.

Exhibit 6 - Industry growth rates are steadily accelerating; we model $1tn by 2030 at 8% CAGR



Source: WSTS, Jefferies estimates

AI-related demand is expected to further accelerate global semiconductor growth rates.

The economic and security implications of AI also make it more imperative for countries around the world to have their own AI program, both in terms of chips as well as AI models. This need was highlighted by recent US regulations which separated countries based on the ease with which they can access AI-based semiconductors from US companies like Nvidia that dominate the industry at present. Only 18 countries have unrestricted access to these chips which include Australia, Canada, UK, Japan, Netherlands and Taiwan, while 120 countries including India, Saudi Arabia, Israel, UAE, Singapore and others face country caps. A third group which includes Russia, Iran and China are banned from getting these chips altogether.

Economic and security implications of AI also make it more imperative for countries around the world to have their own AI program, both in terms of chips as well as AI models.

Concentrated and vulnerable supply chain

The semiconductor industry is concentrated with US, a handful of European nations, Japan, South Korea, Taiwan and China together having a dominant position in almost every part of the supply chain. US-headquartered firms lead in chip design and manufacturing equipment with ~40-50% share of global industry revenues, and in design software/licensing with ~70% share. Dutch company, ASML, has almost a 100% share in advanced lithography equipment which is critical to the manufacture of any high performance chip.

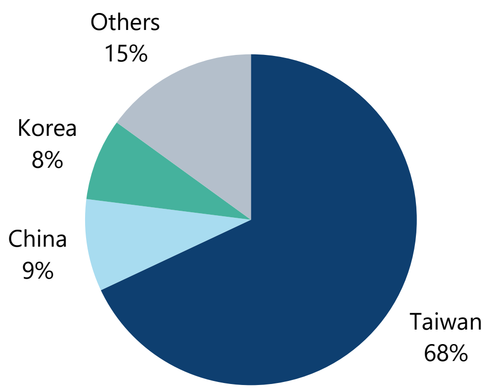
Industry is concentrated with US, a handful of European nations, Japan, South Korea, Taiwan and China together having a dominant position in almost every part of the supply chain.

Semiconductor contract manufacturing (foundry) is especially concentrated in Asia with Taiwan, Korea and China forming 85% of the segment. In leading edge logic (16nm and above), TSMC alone has estimated market share of over 80%, as per Trendforce, being the manufacturer of almost 100% of logic chips for AI servers and smartphones. East Asia is also a major hub for raw material as well as chip packaging and testing, which are crucial in the manufacturing process.

Foundry industry is especially concentrated in Asia with Taiwan, Korea and China accounting for 85% of this segment.

TSMC has an estimated market share of over 80%, being the manufacturer of almost 100% of logic chips for AI servers and smartphones.

Exhibit 7 - Share of semiconductor foundry revenues by country of origin



Source: Gartner, Jefferies estimates

A variety of factors have led to the concentration of semiconductor supply chain in East Asia. Countries such Japan, Taiwan and South Korea recognized the economic potential of the semiconductor sector early on and made strategic efforts to develop the industry, including providing subsidies for setting up fabrication facilities. Lower operating costs, availability of skilled workforce, outsourcing of manufacturing by fabless chip design companies, and resulting economies of scale of a dense ecosystem have also been important drivers.

Japan, Taiwan and South Korea recognized the economic potential of the semis early on and made strategic efforts to develop the industry.

Supply chain concentration is amplified by presence of a small set of companies having significant control over various stages of manufacturing. Some of these dominant companies include: 1) TSMC and Samsung Foundry in foundry, 2) Samsung Electronics, SK Hynix and Micron in memory, and 3) ASML in advanced photolithography systems.

A few companies have significant influence and control over various stages of manufacturing.

While the dominance of a few key countries and firms brings economies of scale, it also creates vulnerabilities. Any disruptions in operations of the dominant companies can have ripple effects through the industry, causing shortages, price volatility, and production delays. Such issues were particularly evident in the last few years across sectors like autos, consumer electronics and telecom. Policymakers across the world are become increasingly concerned with semiconductor supply chain concentration in East Asia for both economic and national security reasons.

While the dominance of a few key countries and firms in the supply chain brings benefits of economies of scale, it also creates excessive dependencies and vulnerabilities.

Exhibit 8 - Key raw material suppliers for TSMC

Major materials	Remarks	Major suppliers
Raw wafers	6 suppliers form 90%+ of the world's raw wafer supply	FST, GlobalWafers, SEH, Siltronic, SK siltron, SUMCO
Chemicals	12 companies are the major worldwide chemical suppliers	Air Liquide, BASF, DuPont, Entegris, Fujifilm Electronic Materials, Kanto PPC, Kuang Ming, Merck, RASA, Shiny, Tokuyama, Wah Lee
Lithographic materials	7 companies are the major worldwide suppliers of lithographic materials	DuPont, Fujifilm Electronic Materials, JSR, Nissan, Shin-Etsu Chemical, Sumitomo Chemical, T.O.K.
Gases	9 companies are the major worldwide suppliers of specialty gases	Air Liquide, Air Products, Central Glass, Entegris, Linde LienHwa, Merck, SK Speciality, Taiwan Material Technology, Nippon Sanso Taiwan

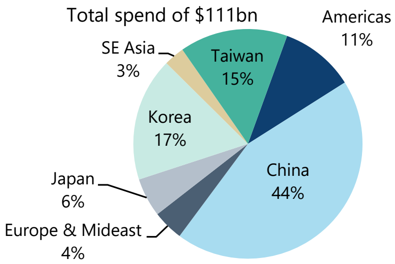
Source: Company, Jefferies

In recent years there has been a major increase in the efforts of countries/regions like the US, Europe, Japan and China to achieve greater self-sufficiency in semiconductors. Two factors have specifically played key role in spurring this effort on the part of governments outside of China.

- The severe shortage of semiconductors in 2021-22 materially restricted the production of a variety of products including cars, PCs, smartphones and industrial machinery due to a shortage of semiconductors. Governments in many of these countries were keen to ensure that this situation does not repeat itself again.
- The dominance of TSMC in manufacturing advanced logic chips for all applications including smartphones, AI servers and general servers, has made the vulnerability of the global semiconductor supply chain even more apparent, given China's claims to Taiwan and the possibility of military action. This has led to the US, European and Japanese governments providing significant funding support to companies like TSMC, Intel and Samsung Foundry to set up advanced logic manufacturing fabs in their countries/regions.

In recent years there has been a major increase in the efforts of US, Europe, Japan and China to achieve greater self-sufficiency in semiconductors.

Exhibit 9 - Semiconductor equipment spend by region (2024)



Source: SEMI

The severe chip shortages of 2021 and excessive dependence on Taiwan for advanced logic chips have led to the US, European and Japanese governments providing significant funding support to companies like TSMC, Intel and Samsung Foundry to set up advanced logic manufacturing fabs in their countries/ regions.

Trump's Tariff Threat: Trump has recently stated that the US government will impose a 25% tariff on all semiconductors coming into the US. He has also talked about tariffs as high at 100% on semiconductors from Taiwan. He has consistently made clear his preference for using tariffs to push semiconductor companies to set up fabrication facilities in the US, rather than incentivize them through subsidies as the Biden administration, as well as other governments around the world have been doing. Whether these tariffs will actually be implemented and if so, what the impact on the production plans of companies remains to be seen. However, we believe this action will have only a limited impact because of the following factors

- There is only a small amount of semiconductors that are directly imported to the US, which we estimate at a low to mid-single digit amount by value. This is because almost all electronics product assembly is done in Asia, Mexico, Eastern Europe etc, with manufactured goods being shipped to the US.
- While some US companies like Intel, Micron and Texas Instruments have wafer fabs in the US, none of them have Assembly and Test facilities in the US. Almost all Assembly and Test is done in Asian countries like Malaysia, China and Philippines. Therefore, even the chips of all US semiconductor companies will have tariffs imposed if this rule comes into effect.
- Imposing tariff on chips produced by TSMC would have greater negative impact on US customers of TSMC like Apple, Nvidia, Broadcom and Marvell, and their final customers like Amazon, Microsoft, Google etc, rather than on TSMC itself. These US companies have no alternative to TSMC, and therefore, the tariff primarily becomes a tax on them.

Trump has recently stated that the US government will impose tariffs on semiconductors coming into the US. Whether these tariffs will actually be implemented and if so, what the impact on the production plans of companies remains to be seen. However, we believe this action will have only a limited impact.

We, therefore, are not sure if the tariffs will have the desired effect of bringing a significant amount of semiconductor production to the US. However, from India's point of view, semiconductor companies clearly see the need to put manufacturing facilities in large end-markets like India, to avoid the potential tariffs in the future.

Semiconductor companies see the need to manufacture in large end-markets like India, to avoid the potential tariffs in the future.

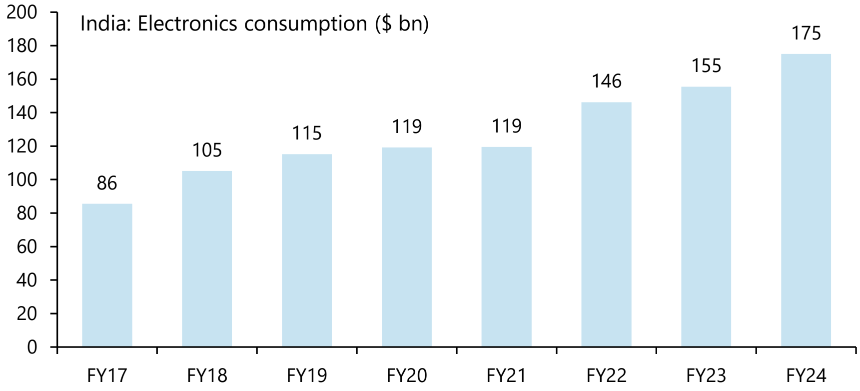
Electronics: A key focus for India

India's electronics consumption has doubled over the last seven years to about $175bn in FY24 led by rising disposable incomes, accelerating digital adoption and government's digitization push. India's net electronic imports rose to $60bn in FY24, forming 25% of the country's total trade deficit, next only to oil at $95bn (39%). The per-capita electronics consumption in the country is still less than half of global average, providing huge headroom for growth.

India's electronics demand is growing fast led by rising disposable incomes, accelerating digital adoption and government's digitization push.

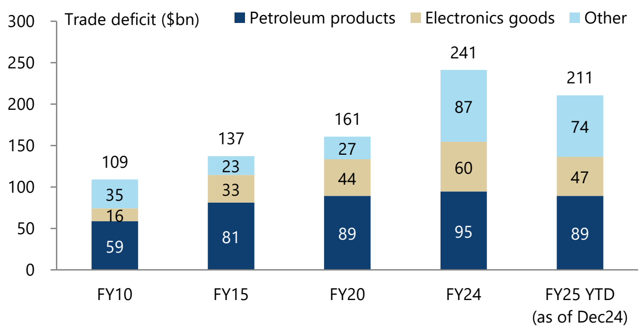
The per-capita electronics consumption in the country is still less than half of global average, providing huge headroom for growth.

Exhibit 10 - India's electronics consumption has grown at 11% CAGR since FY17



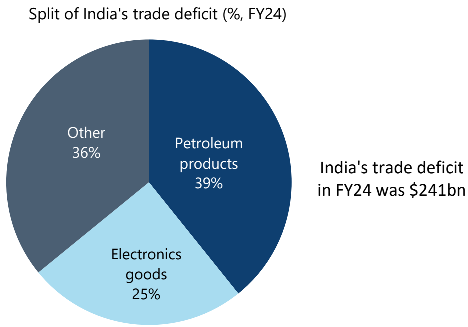
Source: Government of India, CMIE, Jefferies

Exhibit 11 - Electronic goods are India's second largest imports



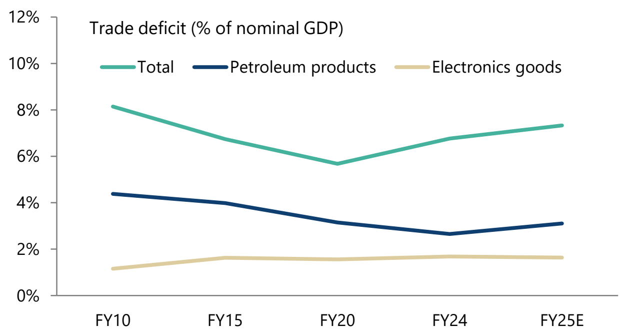
Source: CMIE, Jefferies

Exhibit 12 - ... and form ~25% of country's total trade deficit



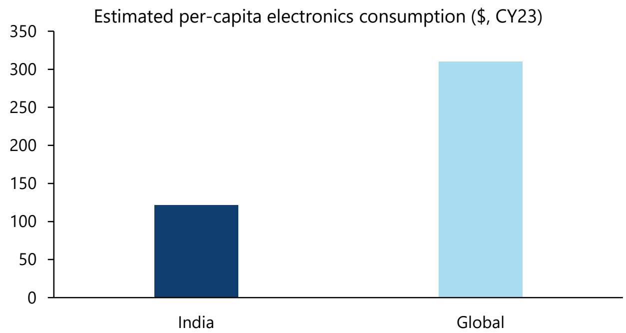
Source: CMIE, Jefferies

Exhibit 13 - Electronics trade deficit as a % of GDP has risen



Source: CMIE, Jefferies. FY25E based on annualized 9MFY25 data

Exhibit 14 - India's per-capita electronics consumption still low



Source: Government of India, World Bank, Jefferies

Recognizing the rising economic and strategic importance of the electronics sector, the Indian government has embarked on a path to promote electronics manufacturing in the country, both for domestic consumption and exports. Electronics manufacturing is also considered a key pillar for both the Make in India and Digital India programs.

Indian government has embarked on a path to promote electronics manufacturing in the country, both for domestic consumption and exports.

India's electronics production has grown at 15% CAGR over FY16-24 to $115bn in FY24, and the government has set a target of raising this to $500bn by FY31 (23% CAGR) by providing policy support and fiscal incentives to the sector. Electronics exports have also expanded four-folds over FY16-24 to $31bn, and the government is targeting $240bn by FY31, eight-folds over seven years. While the targets seem ambitious, the vision has propelled India on the path of developing an electronics ecosystem with strong growth in recent years.

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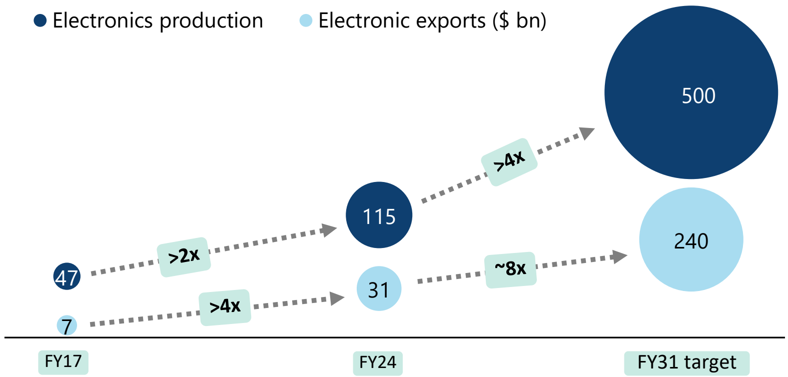
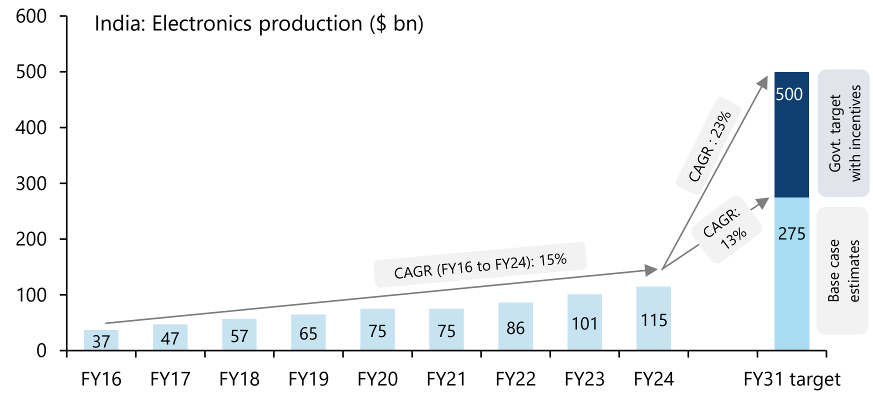
Exhibit 15 - India is targeting big expansion in electronics production and exports



Source: Government of India, CMIE, Jefferies

Exhibit 16 - Govt aim to more than quadruple electronics production to $500bn by FY31



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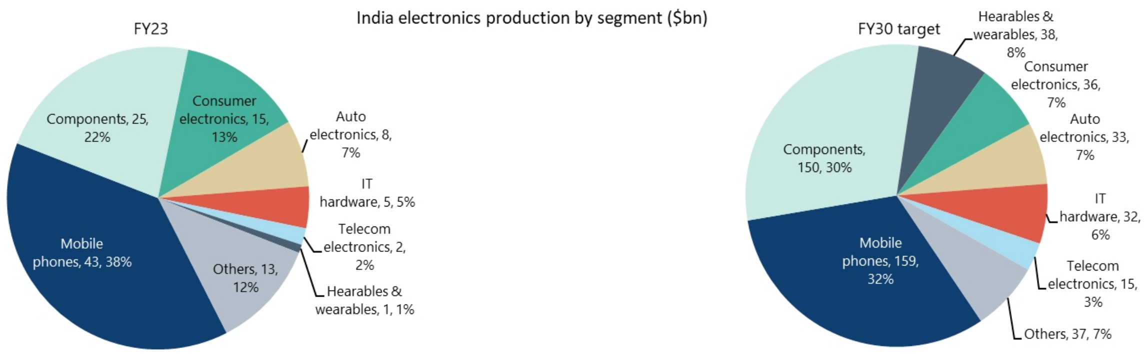
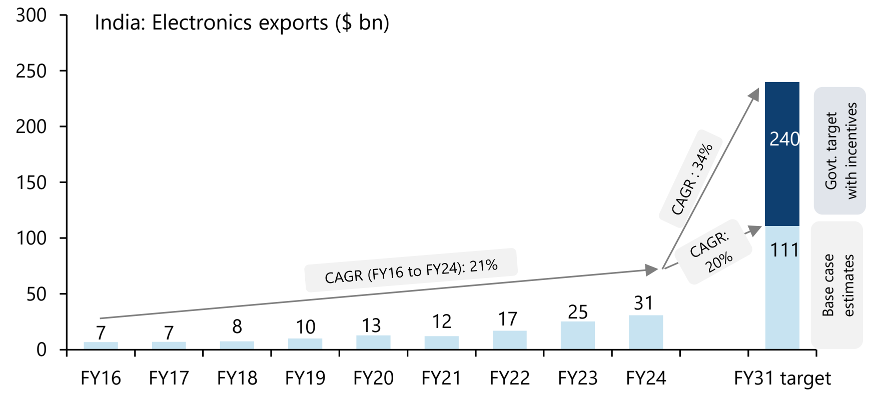
Source: Government of India, Avalon, Jefferies

Exhibit 17 - Electronic components are a key growth focus area for the government



Source: Government of India, Jefferies

Exhibit 18 - Raising exports is a key part of electronics policy



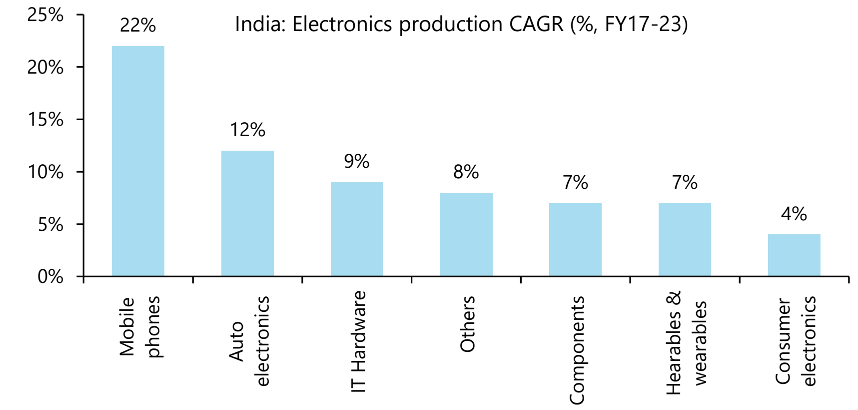
Source: Government of India, Jefferies

Electronics exports expanded four-folds over FY16-24 to $31bn, and the government is targeting $240bn by FY31, eight-folds over seven years.

India has made big strides in mobile assembly in recent years, and has become the second-largest manufacturer of mobile phones by volumes in the world. Production of mobile phones rose from about 58mn units in FY15 to about 330mn units in FY24. Export of mobile handsets has also increased from just ~$0.3bn in FY15 to $4.4bn in FY22 and further to ~$15bn in FY24. Multiple factors have contributed to this success: favorable government policies including incentive schemes such as PLI (production linked incentives), localization requirements, growing domestic demand, access to cheap skilled labor, infrastructure development and geopolitical tailwinds.

India has made big strides in mobile assembly in recent years.

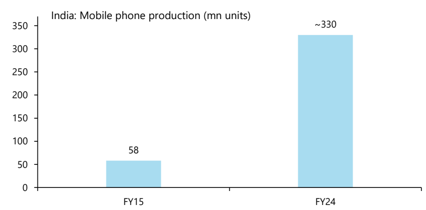
Exhibit 19 - Mobile was the fastest growing segment within electronics in recent years



Source: Government of India, Jefferies

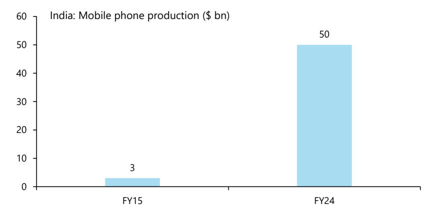
India has become the second-largest manufacturer of mobile phones by volumes in the world.

Exhibit 20 - Rising mobile production



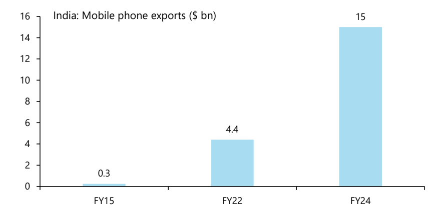
Source: Government of India, Jefferies

Exhibit 21 - ...up >15x in value in 9 years



Source: Government of India, Jefferies

Exhibit 22 - Mobile exports rising



Source: Government of India, Jefferies

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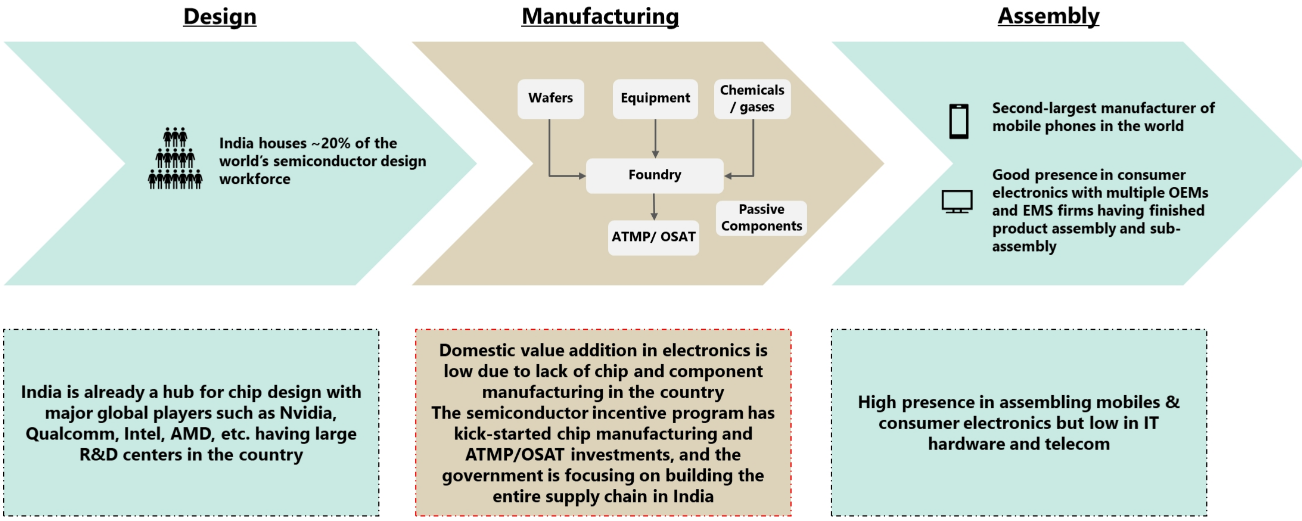
Big incentives for semiconductors manufacturing

The Indian electronics and semiconductor value chain is at an interesting crossroad with the country having strong chip design talent and a growing presence in assembly, but still low on value addition in manufacturing. On one end, India is already a hub for chip design with global companies such as Nvidia, Qualcomm, Intel, AMD, etc. having some of their largest R&D setups in India; the country houses ~20% of the world's semiconductor design workforce. On the other end, electronics assembly is picking up too, boosted by favorable government policies and geopolitical tailwind. However, domestic value addition has remained low at an estimated 18-20% as most components, including semiconductor chips, are still imported due to lack of local manufacturing. As per the government think tank, Niti Aayog, the electronics manufacturing sector faces cumulative cost disability of 10-14% for assembly and 14-18% for component manufacturing due to multiple reasons, including: 1) higher material, infrastructure and finance costs, 2) lower capex, R&D and tax incentives, and 3) adverse tariffs.

Indian electronics and semiconductor value chain is at an interesting crossroad with the country having strong chip design talent and a growing presence in assembly, but still low on value addition in manufacturing.

Exhibit 23 - India has strong presence in design and assembly but still low on domestic value addition and manufacturing



Source: Government of India, Jefferies

Exhibit 24 - India is already a hub for chip design and home to ~20% of the world's semiconductor design workforce

Company	Employees in India	Overview
AMD	6.5k+	Started in 2001 in India In 2023 announced plans to invest over $400m in India over 5 years
Applied Materials	~7.5k	Started in 2002 in India In 2023 announced plans to invest over $400m in India over 4 years
Infineon	~2k	R&D site and application center in Bengaluru
Intel	13k	Intel's largest design and engineering center outside the US Cumulative inv. in India:~$9bn over 25+ years
LAM Research	1k+	In 2025, signed MoU to invest over $1.2bn in India in 2024, announced decision to expand supply chain to India, and said that several custom and high-precision parts from Indian suppliers are already passing its qualification criteria
Nvidia	~4k	Engineering centers in Gurgaon, Hyderabad, Pune and Bangalore
Qualcomm	~16k	Engineering facilities in Bengaluru, Hyderabad, Noida, and Chennai

Source: Company, Media articles (Economic Times), Jefferies

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Exhibit 25 - While electronics assembly has picked up, domestic value addition remains low

Depth of India's Presence:		High	Medium	Low
Segment	**Products**	**Final Assembly / Sub-Assembly**	**Component Manufacturing**	**Design**
Mobile	Smartphones	- Assembly for mobiles has been localized; ~330mn units produced in FY24. - Sub-assemblies for battery pack, charger localised; - Camera module, display assembly ~25% localized	Production of mechanical and composites (casing, cable and box content, etc.) Eg. Tata Electronics for iPhone casing (10-15% BoM)	Minimal to no presence
Consumer Electronics	TV	- Multiple EMS firms and OEMs have finished product assembly and sub-assembly. - Display is the largest component sub-assembled in India	Open cells (~60% BoM) are imported	Limited design capabilities with local EMS companies
	Air Conditioner		Through-hole components, electro-mechanical components are manufactured	Domestic OEMs have established some design and engineering capabilities
	Refrigerator			
IT Hardware	Laptop	80%+ of laptops sold in the country are imported	Primarily import dependent	Minimal presence
	Server			
Telecom	4G / 5G RAN; Baseband unit (incl. CU, DU), Antenna / RRU, xPON, FTTH)	40%+ of total imports are from China	Primarily import dependent	Ongoing design efforts by a consortium led by TCS
Automotive	Powertrain, Body and Convenience, Connectivity	~65% import dependent (most OEMs import sub-assemblies)	Low tech components such as wire harness and connectors are manufactured (~10% BoM)	Leading domestic OEMs have established product design and engineering capabilities, but have limited capabilities in electronics
Hearables & Wearables	Smartwatch, headphone, wristband, glasses, ring, etc.	Largely box-assembly	Primarily import dependent	Minimal to no presence

Source: Government of India, Jefferies

Exhibit 26 - Cost disability in electronics value chain

	Assembly	Components
Tariffs & material	5%-6%	4%-5%
Logistics	2%-3%	2%-3%
Finance	1%-2.5%	4%
Capex subsidy	2%	3%-4%
Tax & R&D incentives	1%-2%	2%-3%
Total	**10%-14%**	**14%-18%**

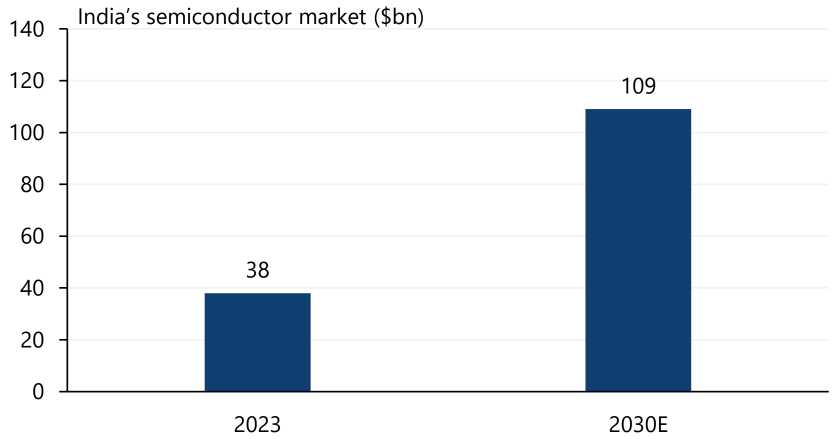
Source: Government of India, Jefferies

India's electronics manufacturing sector faces cumulative cost disability of 10-14% for assembly and 14-18% for component manufacturing.

After successfully advancing electronics assembly in the country, the government has shifted its attention to enhancing value addition from 18-20% currently to over 35% by the end of the decade, with a specific focus on semiconductor manufacturing. India's semiconductor market was ~ $38bn in 2023 and is expected to almost treble to $109bn by 2030, according to the government. In December 2021, the government introduced a new incentive scheme, with an initial outlay of ~$10bn over six years, for the development of semiconductor and display manufacturing ecosystem. The government recognized the large upfront investments and long lead times for such projects, and hence decided to provide fiscal support of 50% of the approved project cost on pari-passu basis, i.e. at the same rate as investments by a company; the structure of subsidy is thus better than the PLI schemes where incentives are linked to achieving production targets.

In December 2021, the government introduced a new incentive scheme, with an initial outlay of ~$10bn over six years, for the development of semiconductor and display manufacturing ecosystem.

Exhibit 27 - India semis market is expected to almost treble to ~$109bn by 2030



Source: Government of India, Jefferies

India's semiconductor market is estimated to surpass $100bn by 2030

The Indian government offered incentives for five categories of investments:

1. Semiconductor manufacturing: The scheme provides fiscal support for fabs with minimum 40K wafer capacity per month (12 inch wafers). While the initial policy supported 28nm and newer nodes, the revised scheme of October 2022 opened up incentives for all nodes. The applicant is required to own or possess production grade licensed technologies for proposed process and demonstrate the roadmap to advanced nodes through licensing or development. The scheme has a minimum capital investment threshold of Rs200bn (~$2.5bn).

While the initial policy supported 28nm and newer nodes, the revised scheme of October 2022 opened up incentives for all nodes.

2. Display: The government is providing fiscal support for display fabs with minimum monthly panel capacity of: 1) 60K for generation 8 or above TFT LCD, and 2) 30K for generation 6 or above AMOLED screens. The applicant is required to: 1) posses experience of owning and operating a commercial Gen6-or-higher TFT LCD fab, or 2) own or possess licensed technologies for Gen8 of TFT LCD or Gen6 of AMOLED technologies; and demonstrate the roadmap to advanced technologies through licensing or development. Minimum capital investment to avail incentives is Rs100bn (~$1.2bn).

Incentives for producing generation 8 or above TFT LCD and generation 6 or above AMOLED screens.

3. Compound Semiconductors, Silicon Photonics, Sensors and Discrete: The scheme has been extended for manufacturing compound semis, silicon photonics (SiPh), sensors (including MEMS) and discrete semis. Minimum capacity requirement is 500 wafers per month (in 100mm equivalent) with wafer size of 150 / 200mm or more.

The incentive scheme has been extended for manufacturing facilities for compound semis, silicon photonics (SiPh), sensors (including MEMS) and discrete semis.

- Compound semiconductors are made of two or more elements such as gallium nitride (Gam) and silicon carbide (SiC). These are used in optoelectronic (laser, LED), power electronics, microwave devices, solar cells etc.
- Silicon Photonics combines silicon chips with optical components to enable transmission and processing of light signals for communication and Lidar.

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- Sensors are used to detect physical, chemical or biological phenomenon such as temperature and motion. MEMS (Micro Electromechanical Systems) combine mechanical and electrical components on a single chip. MEMS are used in auto (airbags), consumer electronics (gyroscopes, microphones), healthcare (insulin pumps) etc.
- Discrete semis are standalone devices not integrated into a chip. These are used for power management, lighting, automotive and industrial applicants.

4. Assembly, Testing, Marking, and Packaging: The policy provides incentives for chip assembly, testing, marking, and packaging (ATMP), and outsourced assembly and test (OSAT) facilities with a minimum investment of Rs0.5bn ($6mn). An applicant must own and operate a commercial packaging unit or own or possess licensed technologies for the proposed unit with roadmap to advanced packaging.

Assembly, testing, marking, and packaging (ATMP), and outsourced assembly and test (OSAT) also covered under subsidies.

5. Design-Linked Incentives: The government has also offered incentives as well as infrastructure support to Indian companies across various stages of development and deployment of semiconductor design for ICs, chipsets, system on chips (SoCs), systems and IP Cores over a period of 5 years. The scheme provides reimbursement of up to 50% of eligible expenditure up to Rs150mn (~$2mn) per application for design, and 4-6% of sales over 5 years up to Rs300mn (~$4mn) per application for deployment.

Exhibit 28 - India is offering broad based incentives across semi nodes, display, and test & package facilities

Semiconductor fabs	Technology	All technology nodes including legacy
	Wafer size	300 mm (12 inches)
	Capacity	40K or more wafer starts per month (WSPM)
	Capital	Minimum investment of Rs200bn ($2.5bn)
	Incentive	50% of project cost to be borne by central government on a pari-passu basis
Display fabs	Technology	TFT LCD - Generation 8 and above; AMOLED - Generation 6 and above
	Capacity	TFT LCD - 60K panels/month or more; AMOLED - 30K panels/month or more
	Capital	Minimum investment of Rs100bn ($1.3bn)
	Incentive	50% of project cost to be borne by central government on a pari-passu basis
Compound semis, Silicon Photonics, Sensors & Discrete	Wafer size	150 / 200 mm or more
	Capacity	500 or more wafer starts per month (in 100 mm equivalent)
	Capital	Minimum investment of Rs1bn ($13mn)
	Incentive	50% of capex on a pari-passu basis
ATMP / OSAT	Capital	Minimum investment of Rs500mn ($7mn)
	Incentive	50% of capex on a pari-passu basis
Design Linked incentive	Scheme	Incentives and design infrastructure support to domestic companies for design of ICs, Chipsets, System on Chips (SoCs), Systems & IP cores
	Incentive	Reimbursement of 50% of eligible expenditure up to Rs150mn (~$2mn) per application for design
		Incentive of 4-6% of sales over 5 years up to Rs300mn (~$4mn) per application for deployment

Source: Government of India, Jefferies

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Our interactions with senior central government officials, leading the semiconductor and electronics initiatives, suggest a continued focus on expanding the ecosystem with emphasis on building capabilities across manufacturing, supply chain and design. The government, conscious of the large fiscal incentives in semiconductors, conducted detailed due diligence of companies on multiple parameters including technical abilities, financial strength, and domestic and global capabilities. The incentive scheme has been successful in kick-starting investments in foundry and testing facilities, although display fab projects are yet to start. The government also recognizes that the semiconductor ecosystem, especially in the initial years, would require support for infrastructure and supply chain. The government is emphasizing on expanding the component ecosystem to increase domestic value addition in electronics. It is also keen on: 1) more design initiatives especially with India possessing immense design talent with global majors such as Nvidia, Intel, Qualcomm and AMD having large R&D setups in the country, and 2) semiconductor equipment manufacturing starting in India.

Our interactions with senior central government officials, leading the semiconductor and electronics initiatives, suggest a continued focus on expanding the ecosystem with emphasis on building capabilities across manufacturing, supply chain and design.

Gujarat emerging as India's semiconductor hub

State governments play a crucial role in establishing an industry ecosystem as infrastructure facilities and local business environment, besides financial incentives, can provide a significant impetus to the pace of project execution as well as raise the probability of its eventual success. The country has already witnessed emergence of several electronics manufacturing clusters, such as in the states of Tamil Nadu, Uttar Pradesh, Karnataka and Maharashtra. Several states are complementing the central incentives on semiconductor to attract investments too.

State governments can play a crucial role in project execution as well as its eventual success.

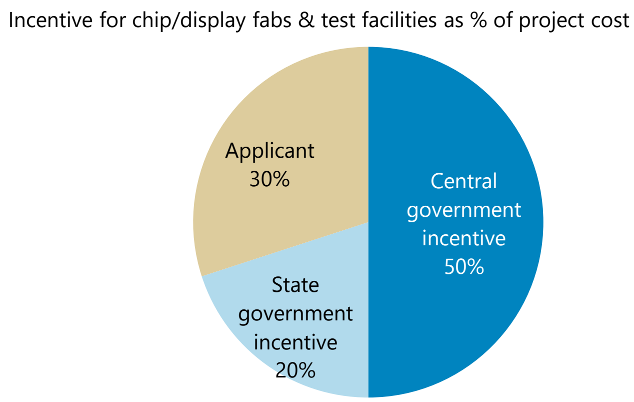
In 2022, Gujarat became the first state in the country to introduce a policy specifically catered to the semiconductor sector, enabling Gujarat to attract four of the five semiconductor projects that have been approved by the central government. These four projects account for ~80% (~$15bn) of the total $18bn investments in the ongoing semiconductor fab and OSAT/ATMP projects.

Gujarat has attracted four of the five semiconductor projects, accounting for ~80% of the total $18bn investments.

Gujarat's semiconductor policy aims to support the semiconductor sector via additional fiscal incentives, along with operational support including land allotment, expedited process approvals, and easy access to power, water, and gas utilities. The state is offering additional incentive of 40% of the capex assistance provided by the centre, which implies ~20% subsidy on the total project cost. In the Dholera Special Investment Region, eligible projects also benefit from 75% subsidy on first 200 acres of land, with a 50% subsidy on additional land for upstream or downstream projects. Other incentives include one-time 100% reimbursement of stamp duty and registration fees, Rs2/unit subsidy on electricity supply, exemption from electricity duty, a fixed water tariff of Rs12/cubic meter for five years, and a 50% capital subsidy for desalination plants.

Gujarat is offering additional incentive of ~20% of the project cost, along with subsidized power and water.

Exhibit 29 - Central and state incentives can together cover ~70% of semis project cost



Source: Government of India, Jefferies

Central and state schemes can cover ~70% of the project cost, providing a large incentive for companies to set up semiconductor and display fabs, and testing & packaging facilities.

The semiconductor industry requires uninterrupted power supply, large quantities of ultrapure water and access to specialty chemicals. Besides a broad policy support, Gujarat has a strong manufacturing ecosystem, supported by good infrastructure for power, water and logistics, along with a conducive business environment. The state has ~1,600km of coastline with 48 seaports handing 38% of India's total cargo in FY24, coupled with 5,300km of rail network and 19 airports along with a new airport planned in Dholera. Presence of bulk gas producing companies and a large chemical cluster in Dahej, located on the south-west coast of Gujarat, provides the state an additional advantage. Gujarat's strong manufacturing and logistics infrastructure, conducive business environment, and proactive policies have enabled the state to attract bulk of the investments in semiconductors.

Gujarat's strong manufacturing and logistics infrastructure, conducive business environment, and proactive policies have enabled the state to attract bulk of the investments in semiconductors.

Exhibit 30 - Gujarat semiconductor policy

Type of subsidy	Overview
Investment	40% of the capex assitance approved by the Central Government (implies 20% of the total cost of the project)
Power	Power tariff subsidy of Rs2/unit for a period of 10 years. Electricity duty exemption
Water	Rs12/cubic meter for a period of 5 years 50% capital subsidy for desalination plants
Fees	One-time reimbursement of 100% of stamp duty and registration fee
Other	Dholera Semicon City - 75% subsidy on the first 200 acres of land, with a 50% subsidy on additional land for upstream or downstream projects

Source: Government of Gujarat, Jefferies

Gujarat also unveiled its electronics policy in 2022 with the aim of establishing the state as a prominent hub for Electronics System Design & Manufacturing (ESDM), and generate around 1 million jobs in the sector by 2028. The state is providing assistance of 20% on projects requiring up to Rs10bn of capex and 15% incremental capex on projects requiring over Rs10bn. Capex assistance is payable in equal installments over a period of 5 years. Other incentives include a one-time reimbursement of 100% of stamp duty and registration fees, Rs1/unit subsidy on electricity supply, exemption from electricity duty, support of up to 25% of freight charges capped at Rs50mn p.a. for five years and reimbursement of 50% on import of manufacturing equipment, capped at Rs50mn.

Gujarat also outlined an electronics policy aimed at developing the Electronics System Design & Manufacturing (ESDM) ecosystem in the state.

Exhibit 31 - Gujarat electronics policy

Type of subsidy	Overview
Investment	20% capex assistance for capex incurred upto Rs10bn and 15% on incremental capex above Rs10bn. Capex assistance is payable in equal installments over 5 years
Power	Power tariff subsidy of Rs1/unit for a period of 5 years. Electricity duty exemption
Interest	Annual interest of 7% capped at Rs100mn p.a. on term loans
Fees	100% waiver on stamp duty and registration fees
Other	25% subsidy on freight charges capped at Rs50mn p.a. for 5 years Reimbursement of 50% on import of manufacturing equipment capped at Rs50mn

Source: Government of Gujarat, Jefferies

We met with senior officials in the Gujarat Government leading the electronics and semiconductor policy. The state took a very proactive approach and established a specific body GSEM to encourage the establishment of semiconductor industry in the state and to position Gujarat as a national hub for ESDM (Electronic System Design and Manufacturing). The state aligned its policy with the center such that any project approved by the central government under the semiconductor incentive scheme automatically became eligible for Gujarat's semiconductor policy benefits too. The state implemented a single-window clearance mechanism with GSEM also providing support for location assessment, along with facilitating trade and supply chain linkages. State officials are holding bi-weekly meetings with the companies undertaking semiconductor projects to expedite approvals and avoid execute bottlenecks.

We met with senior officials in the Gujarat Government leading the electronics and semiconductor policy.

An OSAT facility in Assam: The state of Assam announced its semiconductor policy in 2023, on similar contours as Gujarat. Assam is also providing additional incentive of 40% of the capex assistance by the central government, which implies ~20% subsidy on the total project cost; the capital subsidy is payable over five years. Assam is also offering land, water and power related incentives, along with payroll assistance of 20% of net wages for local employees to incentivize local employment. The state has been successful in attracting Tata Group's investment for the $3.3bn OSAT facility, making Assam the only state other than Gujarat to attract a large semiconductor project.

Assam is the only state other than Gujarat to attract a large semiconductor project.

Uttar Pradesh trying to attract semiconductor investments too: The state of Uttar Pradesh (UP) already has a strong electronics ecosystem, manufacturing ~40% of India's total mobile phones. The state released its semiconductor policy in 2024. It is offering additional incentive of 50% of the capex assistance provided by the central government, which implies ~25% subsidy on the total project cost. UP also offers: 1) 75% rebate on land costs for compound semis, sensors, ATMP, and OSAT, along with a 100% exemption on electricity duty for 10 years, 2) 50% exemption on inter-state power purchase and transmission costs for 25 years, 3) 100% waiver on stamp duty and registration fees, and 4) annual interest subsidy of 5%, capped at Rs70mn.

The state of UP released its semiconductor policy in 2024, which provides additional incentive of ~25% on the total project cost.

Exhibit 32 - Comparison of Assam vs UP semiconductor policies

Type of subsidy	Assam	UP
Investment	40% of the capex assistance approved by the Central Government (implies 20% of the total cost of the project)	50% of the capex assistance approved by the Central Government Government (implies 25% of the total cost of the project)
Power	Up to 50% exemption for 10 years from commercial operations date	100% exemption on electricity duty for 10 years 50% exemption on inter-state power purchase and transmission costs for 25 years
Land & water	Land at nominal prices and freehold transfer of land rights Water at Rs 5/cubic meter for the first 10 years of operation	75% rebate on land costs for investors in compound semiconductors, sensors, ATMP, and OSAT
Regulatory	100% waiver on stamp duty and registration fees	100% waiver on stamp duty and registration fees
Other	Assistance of 20% of net wages for local employees	Annual interest subsidy of 5% to units with investments up to Rs2bn, capped at Rs70mn (Rs10mn/p.a. per unit).

Source: State Government of UP, State Government of Assam, Jefferies

Chip incentives across countries

With the rising strategic importance of semiconductors and vulnerable supply chains, the world is witnessing a subsidy race to incentivize chip manufacturing. Some of the funding support that has been provided includes:

The US authorizes ~$39bn in subsidies for chip manufacturing and $13bn for semiconductor research and workforce training

US CHIPS Act: The US CHIPS and Science Act authorizes approximately $39 billion in subsidies for chip manufacturing and $13 billion for semiconductor research and workforce training. As part of this Intel has received $8.5 billion in grants, with an additional $11 billion in government loans. TSMC has been committed $6.6 billion to build fabs in Arizona, with three advanced logic fabs being planned in rapid succession. Micron has been provided $6.1 billion to enhance its semiconductor production capabilities in Boise Idaho and New York while GlobalFoundries has been allocated $1.5bn. Others like Samsung and SK Hynix are also in-line for funding. However, the Trump government is believed to be re-examining the commitments here and the extent to which this money will actually be disbursed is uncertain.

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European Chips Act: The European Chips Act will mobilize more than €43 billion in public and private investments to bolster Europe's semiconductor industry. This funding aims to enhance Europe's competitiveness and resilience in semiconductor technologies, supporting the digital and green transitions. TSMC, Intel, Infineon Technologies, STMicroelectronics and Global Foundries are some of the companies that have received funding under the European Chips Act.

Europe will mobilize more than €43bn in public and private investments to bolster the industry

Japanese Chip funding: Japan has pledged over $65 billion in support for its semiconductor and artificial intelligence sectors by 2030. Key projects that have received funding so far include TSMC's two mature logic fabs in Kumamoto. Rapidus, Japan's home grown advanced logic foundry startup, backed by funding from the government and various Japanese corporations, has also been the recipient of funding.

Japan has pledged over $65 billion in support for its semiconductor and artificial intelligence sectors by 2030

South Korea's semiconductor support plan: The South Korean government has unveiled an ambitious $250 billion funding plan to bolster its semiconductor industry. This includes investment in infrastructure, low interest loans, tax incentives and financial support programs. South Korean companies Samsung Electronics, SK Hynix, DB HiTek and Magnachip are the key recipients of this funding.

South Korea has unveiled an ambitious $250bn funding plan to bolster its semiconductor industry.

Apart from the above, Taiwan, Singapore and Malaysia have been supporting the semiconductor industry for many decades now through funding programs, tax incentives etc. These countries continue with these support programs, especially in the face of greater incentives provided by other countries in recent years as outlined above.

Exhibit 33 - With rising strategic importance of semiconductors, the world is witnessing a subsidy race to attract manufacturing

Region	Details of the policy
USA	- The US CHIPS and Science Act authorizes approximately $39 billion in subsidies for chip manufacturing and $13 billion for semiconductor research and workforce training.
	- Additional provision for investment tax credit for capital expenses for manufacturing of semiconductor and related equipment with total estimated benefit of $24bn.
EU	- European Chips Act aims to mobilize €43bn+ in public and private investments for semiconductors.
Japan	- Pledged over $65 billion in support for its semiconductor and artificial intelligence sectors by 2030.
Taiwan	- 25% tax credits (prior 15%) for expenditure in cutting-edge and innovative R&D for 7 years over 2023-29.
	- 5% tax credits for new machinery or equipment purchased for use in advanced manufacturing over 2023-29.
South Korea	- Unveiled an ambitious $250 billion funding plan to bolster its semiconductor industry.
China	- $143bn incentive policy including subsidies & tax credit to domestic semiconductor R&D and manufacturers.
India	- Incentive scheme with total initial outlay of ~$10bn, for semiconductor and display manufacturing.
	- Fiscal support of 50% of project cost on pari-passu basis for chip & display fab, and testing & packaging facilities.

Source: Government websites, Jefferies

While the total quantum of incentives in India appear lower that some other countries, the quantum of subsidy per project can be higher with central and state government willing to support up to 70% of project cost. Additionally, most other nations that are providing subsidies have a high focus on leading node chip facilities while India's incentive policy is agnostic to technology nodes as well as testing & packaging facilities.

Total incentives in India appear lower that other countries, but subsidy per project can be higher.

The financial subsidies alone may not be sufficient for the many global chipmakers to set up large manufacturing facilities in India. However, companies are likely to recognize the rising semiconductor demand potential of the country and consider local manufacturing, especially amid increasing global trends of trade protectionism and supply chain diversification.

Global companies are likely to recognize India's rising demand, amid increasing global trends of protectionism and supply chain diversification.

US$18bn investments underway in semiconductors

India's big push for semiconductors is bearing fruit as five projects with $18bn in cumulative investments are underway.

The big policy push for semis is bearing fruit as five projects with $18bn in investments, including ~70% fiscal support, are under construction. Tata Electronics is building a $11bn fab for 28-110nm chips in partnership with PSMC of Taiwan which is expected to start in 2026. The four OSAT/ATMP projects, expected to start over 2025-27, include: 1) Tata's $3.3bn facility for flip chip and ISIP (integrated system in packaging), 2) Micron's $2.8bn project for DRAM and NAND chips, (3) CG Power's $0.9bn plant in partnership with Renesas of Japan and Stars Microelectronics of Thailand, and (4) Kaynes' $0.4bn facility. These five projects are expected to create ~80K direct and indirect jobs

Exhibit 34 - Overview of Central Govt. approved projects

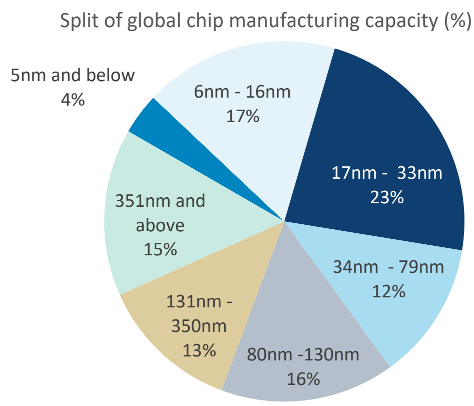
	Tata Electronics	Tata Electronics	Micron Technology	CG Power	Kaynes
Investment	Rs910bn / $11bn	Rs270bn / $3.3bn	Rs225bn / $2.8bn	Rs76bn / $0.9bn	Rs33bn / $0.4bn
Type	Foundry	OSAT	ATMP	OSAT	OSAT
Partnership	Powerchip Semiconductor Manufacturing Corp (PSMC), Taiwan	NA	NA	Renesas Electronics Corporation, Japan and Stars Microelectronics, Thailand	Globetronics, Malaysia, and Aptos Technologies, Taiwan
State	Dholera, Gujarat	Morigaon, Assam	Sanand, Gujarat	Sanand, Gujarat	Sanand, Gujarat
Technology / product	Analog and logic chips on 28-110nm technologies	Packaging technologies such as flip chip and ISIP (integrated system in packaging)	Assembly and testing for DRAM and NAND flash	Legacy packages such as QFN and QFP to advanced packages such as FC BGA, and FC CSP	Wire bond Interconnect, Substrate Based Packages
Segments	Computing, communications, automotive, IoT, and data storage markets	Automotive, electric vehicles, consumer electronics, telecom, mobile phones, etc.	Data centers, smartphones, notebooks, and IoT devices for both domestic and international markets	Consumer, industrial, automotive and power applications	Industrial, automotive, electric vehicles, consumer electronics, telecom, mobile phones, etc.
Capacity	50K 12-inch wafers/month	48mn chips/day	NA	15mn chips/day	6mn chips/day
Employment	20K+ direct and indirect skilled jobs	27k direct and indirect jobs	~5k direct and ~15k indirect jobs	Expected to employ ~5k people	NA
Expected completion	Construction underway; expected to be completed by 2026	Phase 1 expected to be operational in 2025	Phase 1 to be operational in 2025; second phase planned for latter half of this decade	Mini factory in FY26 and main facility by FY27	Expected to start operations by 4QFY26

Source: PIB, Company, Media articles (Economic Times, Business Standard), Jefferies

While a 28nm fab with $11bn spend appears modest when compared to TSMC's focus on 2-5nm nodes and $235bn tangible gross block, players like Global Foundries and Infineon have comparable $20-35bn tangible gross block.Also, about 56% of global installed wafer capacity is still 34nm-or-higher. More importantly, India's manufacturing success in semiconductors, for now, may not lie in competing at the tech frontier of innovation, but in leveraging proven technologies and creating cost-effective solutions, aligned with nation's rising demand and economic priorities.

India's manufacturing success, for now, may not lie in competing at the frontier of innovation, but in leveraging proven tech and creating cost-effective solutions, aligned with nation's economic priorities.

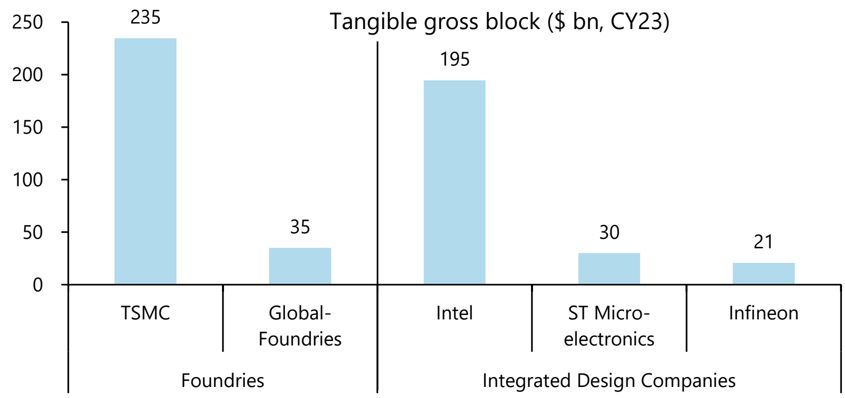
Exhibit 35 - About 56% of global wafer capacity is still 34nm and above



Source: SEMI

While a 28nm fab appears modest when compared to TSMC's focus on 2-5nm nodes, about 56% of global installed wafer capacity is still 34nm-or-higher.

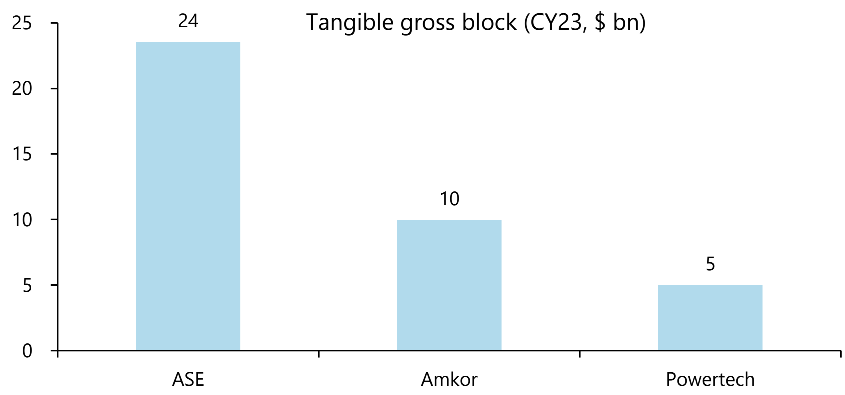
Exhibit 36 - A $11bn spend is modest vs TSMC, but not as small vs other global players



Source: Company, Jefferies

Tata's $11bn fab is tiny compared to TSMC's $235bn tangible gross block at end-FY23; however, players like Global Foundries and Infineon have comparable $20-35bn tangible gross block.

Exhibit 37 - Global frontline OSAT companies have $5-24bn gross block



Source: Company, Jefferies

The OSAT/ATMP facilities of Tata and Micron are coming at $2.8-3.3bn spend.

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Tata setting up India's first chip fab

Tata Electronics was established in 2020 as a greenfield venture of the Tata Group to focus on semiconductor and electronics businesses. The company is setting up a semiconductor foundry in Dholera in Gujarat in partnership with PSMC (Powerchip Semiconductor Manufacturing Corporation) of Taiwan. PSMC is the seventh largest professional foundry in the world; it has 6 semiconductor fabs in Taiwan with expertise in both logic and memory segments

Tata Electronics was established in 2020 as a greenfield venture of the Tata Group to focus on semiconductor and electronics businesses.

Tata's chip facility will have capacity of 50K 12-inch wafers/month for analog and logic chips on 28-110nm technologies. The fab will manufacture chips for applications such as power management IC, display drivers, micro-controllers (MCU) and high-performance computing logic, catering to global customer base across computing, communications, automotive, IoT, and data storage markets. The project will come at a total investment of $11bn (Rs910bn) with Tata bearing ~30% of the cost, and the Central and State Government together contributing ~70%.

The $11bn chip fab will have capacity of 50K 12-inch wafers/month for analog and logic chips on 28-110nm technologies.

Construction is underway and is expected to be completed in 2026. The project is expected to create 20K+ direct and indirect skilled jobs. Tata has partnered with Indian Institute of Science to train employees. Tata also intends to set up two additional semiconductor fabs in the next 5-7 years, as per media articles.

The project is expected to create 20K+ direct and indirect skilled jobs.

PSMC will provide design and construction support to build the greenfield fab, license a broad portfolio of technologies and provide engineering support to successfully transfer licensed technologies to the facility. Tata has also signed a MoU with Tokyo Electron Limited of Japan for training workforce on TEL's equipment and support ongoing improvement and R&D initiatives. TEL is a leading global manufacturer of equipment covering four key processes in chip production: deposition, coater/developer, etching and cleaning. TEL has a global installed base of 92K equipments and ships 4-6K new units very year to fabs.

PSMC of Taiwan will provide design and construction support, and license a broad portfolio of technologies.

Four OSAT/ATMP facilities under construction

Tata building an OSAT facility too

Tata Electronics is also setting up an OSAT facility in Morigaon in the state of Assam using indigenous packaging technologies for wire bond, flip chip and ISIP (integrated system in packaging), with plans of expanding the roadmap to advanced packaging technologies in the future. The facility will be built with an investment of $3.3bn (Rs270bn) and is expected to generate over 27,000 direct and indirect jobs in the region. The facility will have capacity of 48mn chips/day, catering to customers in industries such as automotive (especially electric vehicles), communications, network infrastructure etc. Construction is underway and the first phase of the facility is expected to be operational in 2025.

Tata is also setting up a $3.3bn OSAT plant in Assam with 48mn chips/day capacity.

Tata has also signed an MoU with ASMPT of Singapore to collaborate on establishing semiconductor assembly equipment infrastructure and solutions. ASMPT is a supplier of hardware and software solutions for semiconductor and electronics manufacturing industry. The collaboration will include workforce training, advancing service engineering infrastructure, automation, spare supports and boosting R&D initiatives in the area of wire bond, flip chip, advanced packaging and integrated system packaging.

Tata has also signed an MoU with ASMPT of Singapore to collaborate on establishing semiconductor assembly equipment infrastructure and solutions.

Micron's ATMP facility in Gujarat underway

Micron Technology is setting up an assembly and testing facility for DRAM and NAND chips in the state of Gujarat. Micron is a leading semiconductor player in memory and storage solutions, with 11 manufacturing sites globally, employing ~50K people.

Micron is setting up an assembly and testing facility for DRAM and NAND chips in the state of Gujarat.

Micron's India facility will procure wafers from company's global chip fabrication plants, and convert these wafers into ball grid array (BGA) integrated circuit packages, memory modules and solid-state drives for both domestic and international markets. The project will entail total investment of c.$2.8bn (Rs225bn) over two phases; Micron will invest c.30% of the project cost, and will receive fiscal support of 50% of the project cost from the Indian central government and another 20% from the Gujarat state government. Project construction started in 2023 and a pilot plant is already operational; the main plant of phase-1 is expected to be completed in 2025. The facility, spread over 93 acres in Sanand, is expected to employ ~5K people directly, and create ~20K total jobs including indirect employment. Phase-2 of the project is expected to be completed in the second half of the decade.

The $2.8bn project will procure wafers from Micron's global chip fabs, and convert these into BGA integrated circuit packages, memory modules and solid-state drives for both domestic and international markets.

Simmtech, a South Korea-based manufacturer of printed circuit boards and substrates, has also signed a memorandum of understanding (MoU) with Gujarat Government to invest about $150mn (Rs13b) in the state and set up a facility for supplies to Micron.

During our visit to the Micron facility, we observed a fast pace of construction activity and active government support. The company selected the state of Gujarat for its robust manufacturing infrastructure, conducive business environment and a good talent pipeline in the Sanand Industrial Park. The on-the-ground team highlighted that the state has a strong policy alignment with the center, which enables fast approvals. The state is also providing doorstep water and electricity supply, and also offering Rs1-2/kWh power subsidy for electronics and semiconductor projects. The team also cited various examples of extensive state assistance; for instance, amid an acute period of heavy rains and water logging the government provided swift pumping support to help restart activities. The state is also proactively working on enhancing the social infrastructure in the area, including residential colonies, schools and hotels.

During our visit to the Micron facility, we observed a fast pace of construction activity and active state government support.

Micron also entered into a MoU with the New Age Makers Institute of Technology (NAMTECH), an ArcelorMittal Nippon Steel India (AM/NS India) education initiative, to partner on advancing the development of a talent pipeline for semiconductor industry in India. The partnership will include experiential education and training programs focused on creating a proficient, competitive talent pool with diverse and sustainable engineering career paths.

Micron also entered into a MoU with NAMTECH, an ArcelorMittal Nippon Steel India education initiative, to create a talent pipeline for semis.

CG Power setting up OSAT plant with Renesas

CG Power is one of India's leading capital goods companies offering a diverse range of products such as motors for industrial systems, switchgears, and transformers for power systems, and rolling stock and signaling products for railways. Tube Investments, part of Murugappa Group, acquired a majority stake in CG Power in 2020, and currently owns 58% in the company.

CG Power (Murugappa Group) is setting up an OSAT facility in Sanand in Gujarat.

CG Power is setting up an OSAT facility in Sanand in Gujarat in partnership with Renesas Electronics of Japan and Stars Microelectronics of Thailand. CG Power will own 92% stake in the entity, while Renesas and Stars Microelectronics will own 7% and 1% respectively. Renesas has 12 semiconductor plants globally, manufacturing microcontroller, analog, power, and System on Chip ('SoC)' products. Renesas will provide technology for select chip packages such as QFP (quad flat package), WB BGA (wired bond ball grid array), FC BGA (flip chip BAG), FC CSP (chip scale package). Renesas has also entered off-take commitments for the facility. Stars Microelectronics has 25-years of OSAT experience and will provide technology for legacy packages such as QFN and SOP/SOIC.

The facility will be in partnership with Renesas Electronics of Japan and Stars Microelectronics of Thailand.

The project will require total investment of $0.9bn (Rs76bn) over five years with the central and state governments providing ~70% capital subsidy. This will be the biggest greenfield project by any Murugappa Group company. The plant will have a capacity of 15mn chips/day for consumer, industrial, automotive and power applications. CG Power expects a mini factory to start operations in FY26 and the main facility to commence in FY27. The project is expected to employ ~5k people.

OSAT facility will require an investment of $0.9bn and will have a capacity of 15mn chips/day.

CG Power also intends to develop semiconductor product design capabilities. Its subsidiary Axiro has entered into an agreement with Renesas to acquire the latter's Radio Frequency (RF) components business, which had annual revenues of $56mn in CY23. CG Power will get access to equipment, IP, customers, select transferring employees, contracts and other licenses pertaining to the RF business in this transaction. Axiro intends to acquire more companies to further build is semiconductor product development capabilities.

CG Power, via its subsidiary Axiro, has entered into an agreement acquire Renesas's RF components business.

Kaynes entering OSAT space too

Kaynes Technologies is an Indian EMS (Electronics Manufacturing Services) player offering turnkey solutions, such as box build, PCBA (printed circuit board assembly), ODM (original design manufacturer) and product engineering, to diversified OEMs across autos, industrials, railways and other sectors. The company is foraying into OSAT and PCB manufacturing as it believes backward integration will enhance its ability to meet customer demand while yielding cost efficiencies and superior quality control.

Kaynes, an Indian EMS player, is backward integrating into OSAT and PCB manufacturing.

Kaynes Semicon, a subsidiary of Kaynes, received government approval for its OSAT project under the semiconductor incentive scheme in September 2024. The company is setting up a plant in Sanand in Gujarat at total investment of $0.4bn (Rs33bn), with Kaynes investing ~30% of and the central and state governments together funding ~70%. The OSAT plant will have capacity of 6mn chips/day. Kaynes had raised Rs14bn via QIP in Q3FY24 to strengthen its balance sheet to fund the project. The company mentioned in its 3QFY25 call that it has taken possession of land and started construction of the plant; operations are expected to commence in 4QFY26. Kaynes has already signed MOUs with three customers, and it is targeting ~Rs35bn sales from the OSAT business by FY30.

The company is setting up a plant in Sanand in Gujarat, with total investment of $0.4bn (Rs33bn).

Kaynes has technology partnerships with Globetronics of Malaysia and Aptos Technologies of Taiwan. Globetronics has entered into a technology provision agreement with Kaynes Semicon to provide OSAT technical services for $8mn; Globetronics will also re-invest $5mn in Kaynes Semicon in form of convertible non-cumulative preference shares (CCPS).

Kaynes has technology partnerships with Globetronics of Malaysia and Aptos Technologies of Taiwan.

Kaynes has also entered into a collaboration agreement with Aptos Technologies, a subsidiary of Taiwan Mask Corporation, to enhance its semiconductor packaging and testing capabilities. Kaynes will invest up to $5.5mn for technology transfer and training, with Aptos offering technical training and know-how licensing. Kaynes has also entered into a strategic partnership with ASMPT for providing best practices and advanced knowledge, enhancing local expertise, improving operational efficiency, and strengthening the semiconductor supply chain ecosystem in India.

Kaynes is also setting up a HDI (High Density Interconnect) PCB manufacturing plant in Oragadam in Tamil Nadu. The project will entail investments of ~$165mn (Rs14bn), of which Kaynes will contribute ~40-50% while the balance ~50-60% will come in form of government subsidies. Unlike the central government's chip fab and OSAT incentive program where the funding support is on pari-passu basis, the subsidies for the PCB project will come post the commencement of operations. The company has already procured land and expects to start operations in 4QFY26.

Kaynes is also setting up a HDI (High Density Interconnect) PCB plant in Tamil Nadu for ~$165mn (Rs14bn).

Potential supply chain opportunities

Semiconductor production is an intricate process requiring specialized chemicals and gases, supported by clean rooms, and uninterrupted power and water supply. A reliable supply chain of high quality raw material is crucial. The advent of chip manufacturing and OSAT should create an entire ecosystem of suppliers and service providers, benefiting multiple stakeholders.

The advent of chip manufacturing and OSAT facilities should create an entire ecosystem of raw material suppliers and service providers.

In our meeting, Mr. Ashwini Vaishnaw, the Minister of Railways, Information and Broadcasting, and Electronics and IT, highlighted govt's strong focus on building the full semis ecosystem in India, with emphasis on establishing the entire supply chain, including chemicals, gases, equipment and components, along with leveraging India's strong design capabilities.

Our interactions with the government suggest high focus on ecosystem expansion across the supply chain.

Several companies are making an attempt to participate in the supply chain and have discussed the opportunity in recent conference calls.

Exhibit 38 - Companies evaluating semiconductor supply chain opportunities

Company	Key stats ($Bn)	Sector	Overview / commentary
Pidilite Industries (PIDI IN)	**Mcap: 15.5 Revenue (FY24): 1.5**	**Specialty Chemicals**	Manufactures consumer and specialty chemicals. It has 500+ products encompassing 5,200+ SKUs range across adhesives & sealants, construction chemicals, art & craft products and polymer emulsions.
			3QFY25 call: And lastly, I think what we are doing in all of this is continue to look at opportunities, which may arise, particularly in the area of EV and semiconductors in the future, which we could be able to tap...
Linde (LIIL IN)	**Mcap: 6.0 Revenue (FY24): 0.3**	**Materials**	Manufactures and distributes oxygen, hydrogen, nitrogen, argon and specialty gas mixtures.
			Media article: planning to put up plants for high purity gasses...actively supports investments in this critical sector and is committed to supporting its growth in India.
Thermax (TMX IN)	**Mcap: 4.4 Revenue (FY24): 1.1**	**Electrical Power Equipment**	Provides engineering solutions to energy and environment sectors. The company has three manufacturing facilities in India and one in China.
			4QFY24 call: ...we finished the majority acquisition of TSA as well, which will give us entry into ultrapure water for pharma sector and also then for food and some of the semiconductor industries.
Gujarat Fluorochemicals (FLUOROCH IN)	**Mcap: 4.5 Revenue (FY24): 0.5**	**Basic & Diversified Chemicals**	Manufacturer of refrigerant gases, caustic soda, chloromethane, polytetrafluoroethylene (PTFE), fluoropolymers, fluoromonomers, specialty fluorointermediates, specialty chemicals, etc.
			3QFY25 call: ...industry dynamics in key sectors such as automotive, semiconductors and EVs present large scale opportunities for value-added fluoropolymers. These developments are anticipated to translate into significantly higher revenues and margins for GFL in next financial year" 4QFY24 call: ... And as far as PFA (Perfluoroalkoxy Alkanes) is concerned for semicon, I had indicated that earlier as well, that we are already supplying PFA to semiconductor applications...
Jyoti CNC Automation (JYOTICNC IN)	**Mcap: 2.1 Revenue (FY24): 0.2**	**Machinery & Equipment**	Manufactures industrial machinery, such as CNC turning, vertical, horizontal, and multi tasking machinery for agriculture, auto, general engineering, infrastructure, medical, oil and gas, power, pumps, railways, and telecommunication industries.
			1QFY25 call: ..In terms of a semiconductor, our design team is working out and we are working close to the two more semiconductor manufacturers over here and to be a global player over there.

Source: Company, Bloomberg, Jefferies

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Exhibit 39 - Companies evaluating semiconductor supply chain opportunities

Company	Key stats ($Bn)	Sector	Overview / commentary
Carborundum Universal (CU IN)	Mcap: 1.8 Revenue (FY24): 0.6	Building Materials	Part of the Chennai-based Murugappa group; engaged in manufacturing of abrasives, ceramics, refractories, and electro-minerals. 2QFY25 call: ...construction is on the full swing whether it is a ceramic for semiconductors...expansion is more on the engineered ceramic side which is one, for supplying to semiconductor fab equipments.
Elgi Equipments (ELEQ IN)	Mcap: 1.5 Revenue (FY24): 0.4	Flow Control Equipment	Manufacturer and supplier air compressors & automotive equipment. 2QFY25 call: As far as oil-free compressors is concerned, yes, we are playing in the semiconductor market -- opportunity, still early days but we are -- quotes are in, we are in touch with various customers. We already have good installations in the semiconductor industry in Malaysia...So we are using all those references to gain entry into the segment...
Schneider Electric Infrastructure (SCHN IN)	Mcap: 1.7 Revenue (FY24): 0.3	Electrical Power Equipment	Manufactures power distribution equipment, transformers, medium voltage switchgears, and substation automation equipment. 3QFY24 call: ... when someone is making a semicon plant, what we can do right from the time he receives raw material, various processes of making chips, fibers and consolidating it, what we can do in terms of giving equipment and also loaded with software, which can help him to drive his throughput with more efficiency and with more sustainability...
Deepak Fertilisers & Petrochem (DFPC IN)	Mcap: 1.4 Revenue (FY24): 1.0	Basic & Diversified Chemicals	Manufactures anhydrous liquid ammonia, heavy chemicals, fertilizers and synthetic resins and methanol. 3QFY25 call: Going forward, IPA (Isopropyl Alcohol) getting into electronic-grade semiconductor is the opportunity or what we call it high-purity chemical, is an opportunity for us in this space.
Jubilant Ingrevia (JUBLINGR IN)	Mcap: 1.1 Revenue (FY24): 0.5	Speciality Chemicals	Provides life science and chemicals products, including pyridine and picolines, CDMO, speciality ethanol, acetyls, and crop protection chemicals, etc. 3QFY25 call: ...semiconductor, as I mentioned, it's a journey we have taken only about 10 months back. We have gotten good traction. We have almost eight to 10 different products and RFPs which we have been discussing with customers. On a few of them, we have sent the samples. We are hoping to get our first commercial order in FY26...
Praj Industries (PRJ IN)	Mcap: 1.0 Revenue (FY24): 0.4	Building Construction	Engineering solutions for distillery and brewery wastewater treatment and utilization. 2QFY25 call: We are trying to have a dialogue with several customers who are -- who have announced the project for setting up semiconductor facilities.... 4QFY24 call: ...if the semiconductor chip manufacturing needs water which is of the same level of quality and purity that is required for pharma application, and so from that perspective -- from a capability perspective, we already have the capability.

Source: Company, Bloomberg, Jefferies

Expanding electronics ecosystem

To promote domestic electronic manufacturing and reduce import dependence, Indian government launched the first National Policy on Electronics (NPE) in 2012, which included multiple incentive schemes such as: 1) Modified Special Incentive Package Scheme (M-SIPS) to promote investments via subsidies and reimbursements, and 2) Electronics Manufacturing Clusters (EMC) scheme to develop industrial parks for electronics manufacturing. In 2016, the government launched a roadmap for Phased Manufacturing Programme (PMP), increasing custom duties on imported mobile phones to promote domestic manufacturing. An Electronics Development Fund, a fund of funds to provide financial support to the electronics sector, was also established.

Government launched the National Policy on Electronics (NPE) in 2012, to promote electronics manufacturing and reduce import dependence.

The initial NPE and related schemes achieved limited success as India's electronics exports remained in $7-10bn range over FY12-19, while electronics trade deficit as a percentage of country's GDP rose from 1.3% in FY12 to 1.9% in FY19.

The initial NPE 2012 and related schemes achieved limited success.

Exhibit 40 - Kickstarting the electronics ecosystem in India

	Scheme	Benefits
2012 - 2019	NPE	First comprehensive policy framework to promote domestic electronic manufacturing and reduce import dependence. Key initiatives included M-SIPS, Electronics Manufacturing Clusters (EMC), Phased Manufacturing Programme (PMP) and Electronics Development Fund (EDF).
	M-SIPS	To promote investments in electronics manufacturing sector, M-SIPS provided financial incentives such as capital subsidies (20% to 25%) and reiumbursements to offset investment costs.
	EMC	Provided financial support to develop industrial parks with facilities including testing labs, logistics and skill development centers. Led to the development of key hubs such as Tamil Nadu, Karnataka, Uttar Pradesh etc. 19 Greenfield EMCs and 3 Common Facility Centres (CFCs) have been approved.
	PMP	Increased customs duties on imported mobile phones to promote domestic manufacturing of cellular mobile handsets.
	EDF	Fund of funds to provide financial support to the electronics sector to promote innovation, R&D and product development in ESDM, nanoelectronics and IT. As of FY20, EDF had invested Rs1.4bn in seven funds.
2019 - present	NPE 2.0	Revised NPE policy introduced in 2019, including new initiatives such as SPECS and EMC 2.0.
	SPECS	Launched in 2020. Promote domestic production of electronic components and sub-assemblies via providing a financial incentive of 25% on capital expenditure
	EMC 2.0	To develop industrial clusters for electronics manufacturing by providing upto 50% support
	PLI	Government launched broad-based production linked incentive (PLI) program in 2020 allocating ~$25bn across 13 sectors, inc. ~$10bn to electronics.
	Semiconductor programme	Government launched a ~$10bn program in 2021, providing incentives for ~50% of the project cost for chip and display fabrication, and testing facilities

Source: Government of India, PWC, Jefferies

The government made a renewed effort in 2019 with NPE 2.0, introducing the Scheme for Promotion of Manufacturing and Electronics Components and Semiconductors (SPECS), providing a 25% capex subsidy to encourage domestic manufacturing of electronics components and semiconductor parts. A Modified Electronics Manufacturing Clusters (EMC 2.0) scheme to encourage development of electronics manufacturing clusters was also introduced. Semis received a big boost with launch of the specific ~$10bn scheme in 2021, providing fiscal support of ~50% of the project cost for chip and display fabs, and testing facilities.

The revised 2019 NPE scheme, along with additional PLI and semiconductor incentives, provided a fresh impetus to domestic manufacturing.

India also launched a broad-based production linked incentive (PLI) program in 2020 allocating ~ $25bn across 13 sectors to enhance India's manufacturing capabilities and exports. Electronics is a key focus of PLI with ~$10bn allocated in incentives across: 1) mobile phones and components, 2) IT hardware, laptop, tablet, PC and servers, 3) White goods such as air conditioners and LED lights, and 4) telecom hardware.

About 40% of PLI incentives are allocated to electronics and related sectors.

Exhibit 41 - The PLI scheme has ~$25bn in incentives, with ~$10bn allocated for electronics and related sectors

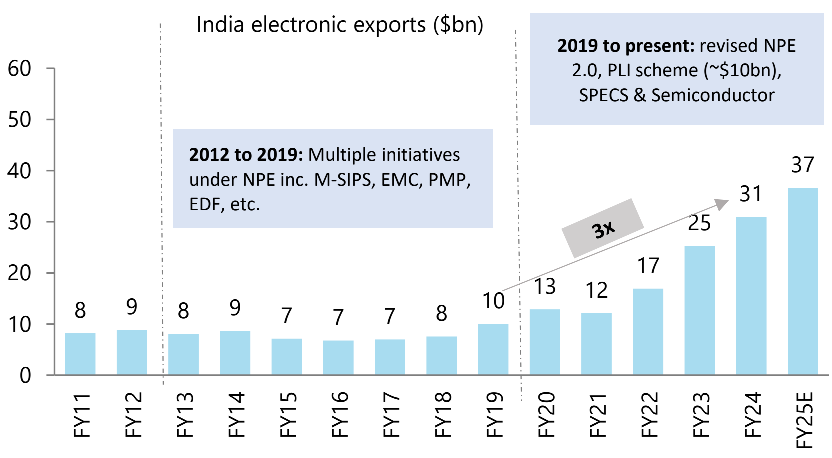
Sector	Scheme outlay ($ bn)	Remarks
Large scale electronics manufacturing	4.8	32 companies approved including Samsung, Foxconn, Wistron, Pegatron
Auto & auto comps	3.2	95 applicants have been approved including Maruti, Hyundai, M&M
Solar PV modules	3.0	14 companies approved including Reliance, Tata Power, JSW
Advanced chemistry cell	2.3	3 companies approved including Reliance, Ola and Rajesh Exports
IT Hardware	2.1	14 companies approved including Dell, Dixon, Lava
Pharmaceuticals	1.9	55 companies approved including Sun, Dr. Reddy, Lupin, Cipla
Telecom hardware	1.5	42 companies approved including Nokia, Samsung, Syrma, Tejas Networks
Food processing	1.4	182 applications approved including HUL, ITC, Nestle, Dabur
Textile products	1.3	64 applications approved including ABFRL, RWSM, Arvind
Drug intermediaries (DI) and APIs	0.9	35 companies approved including Macleods, Granules
Specialty Steel	0.8	27 companies approved including Tata Steel, JSW Steel, SAIL, AMNS
White goods	0.8	84 companies approved including Daikin, Blue Star, Havells, Voltas
Medical devices	0.4	23 companies approved including Philips, Panacea, BPL, Siemens

Source: Government of India, Jefferies

With a fresh policy impetus and increased incentives, the Indian government has been able to expand electronics manufacturing ecosystem in recent years. India's electronics exports trebled over FY19-24 to $31bn in FY24. While electronics imports have also risen during this period as most of the components are still imported, the electronics trade deficit as percentage of country's nominal GDP, after rising from 1.3% in FY12 to 1.9% in FY19, has been in 1.7%-1.9% range over FY19-24. Average annual FDI (foreign direct investment) in the electronics sector has almost trebled from FY19-1HFY25 compared to FY12-19 levels.

With a fresh policy impetus and increased incentives, the Indian government has been able to expand electronics manufacturing ecosystem in recent years.

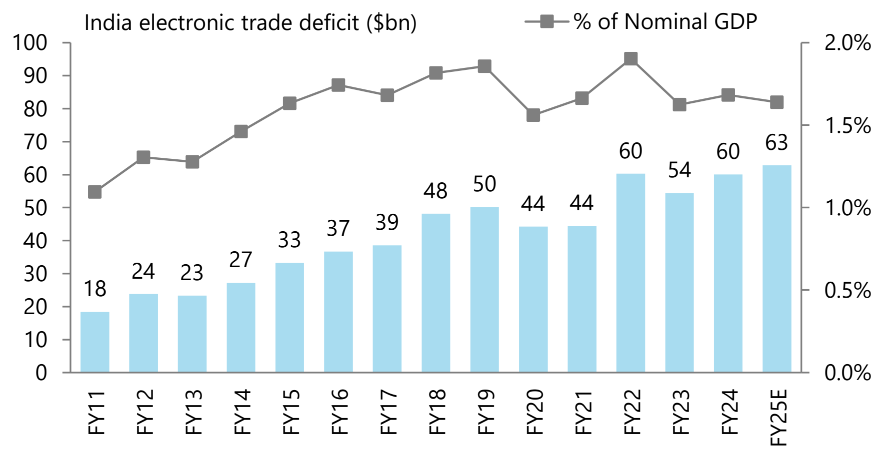
Exhibit 42 - Rising electronics exports



Source: CMIE, Jefferies. FY25E based on annualized 9MFY25 data.

India's electronics exports trebled over FY19-24 to $31bn in FY24.

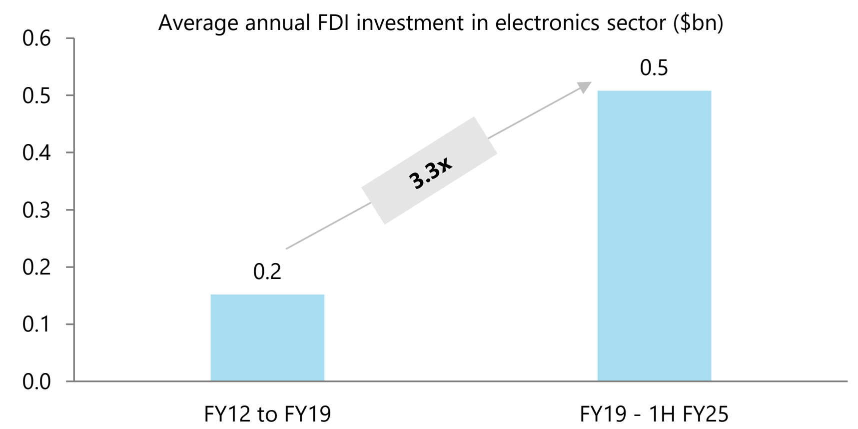
Exhibit 43 - Electronics trade deficit as % of GDP rose over FY11-19, but range-bound since



Source: CMIE, Jefferies. FY25E based on annualized 9MFY25 data.

Electronics trade deficit as percentage of country's nominal GDP, after rising from 1.3% in FY12 to 1.9% in FY19, has been in 1.7%-1.9% range over FY19-24.

Exhibit 44 - FDI investment in electronics sector



Source: Government of India, Jefferies

Average annual FDI investment has almost trebled.

Exhibit 45 - Select large global electronic manufacturing services (EMS) players in India

Company	HQ	Locations in India	Manufacturing presence in India
Foxconn	Taiwan	Tamil Nadu, Karnataka, Telangana	Mobile phones, consumer electronics, industrial, telecom & IT hardware
Flex	USA	Tamil Nadu, Karnataka	Consumer electronics, auto, industrial, Telecom, medical & IT hardware
Jabil	USA	Maharashtra, expansion plans in Tamil Nadu and Gujarat	Consumer electronics, automotive, telecom, medical, aerospace & IT hardware
Wistron Infocomm India; acquired by Tata Electronics	Taiwan	Karnataka	Wistron's iPhone assembly business in India was acquired by Tata Electronics
Pegatron Technology India; Tata acquired 60% stake	Taiwan	Tamil Nadu	iPhone manufacturing plant JV with Tata group; Tata owns 60% stake

Source: Company, Ace Equity, Media articles (Economic Times, Financial Express), Jefferies

Exhibit 46 - India presence of key global consumer electronics companies

	Apple India	Samsung India Electronics	LG Electronics India	Sony India	Philips India
Product portfolio	Smartphones, laptops, tablets, and wearables	Smartphones, wearables, tablets, laptops, and home appliances	Consumer electronics and home appliances	Consumer electronics and home appliances	Consumer electronics, personal care devices, automotive electronics and healthcare devices
Presence in India	Apple started selling iPhones in India in 2008 and started local assembly of iPhones in 2017. Share of India in iPhone production has risen from 1% in 2021 to ~14% in FY24.	Samsung entered India in 1995; it has two manufacturing facilities, one design center and multiple R&D centers. India R&D center is Samsung's largest R&D centre outside Korea.	LG has one of the largest in-house production capacity of consumer electronics (excluding smartphones) in India with installed capacity of ~14mn products. LG's India has also filled a DRHP for listing in India.	Sony entered India in 1994.	Philips entered India in 1930; it has a manufacturing plant in Maharashtra & a software development centre in Bangalore.
Key stats (FY24)					
India revenue ($ mn)	8.1	12.0	2.6	0.9	0.7
India revenue as a % of global	2%	6%	4%	1%	4%

Source: Company, LG DRHP, Jefferies

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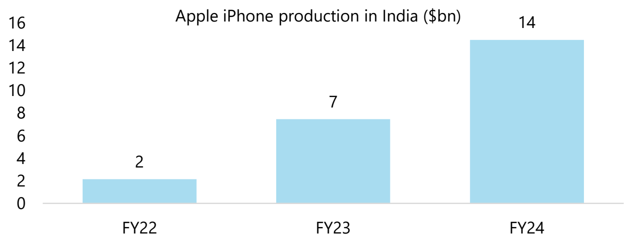
Case Study: Apple's journey in India

Apple began its journey in India in 2008, when it started selling iPhone 3G, and surpassed $1bn in sales in 2015. It began assembling iPhones in India in 2017 via its manufacturing partner Wistron. Subsequently, Apple's other suppliers, such as Pegatron and Foxconn, also established manufacturing facilities in India. The company started assembling older generation phones initially, but now produces new generation devices and is enhancing its supply chain. Share of India in iPhone production, as a result, has increased from just <1% in 2017 to ~14% in FY24. In FY24, Apple produced ~$14bn of iPhones in India, and exported ~$10bn of phones from the country. Apple continues to expand its manufacturing presence in India, and, as per media articles, is targeting to increase the share of India in its iPhone production from ~14% currently to ~25% in coming years.

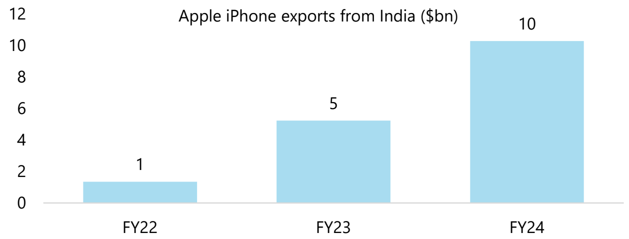
Share of India in iPhone production has increased from less than 1% in 2017 to ~14% in FY24.

Exhibit 47 - Apple has ramped up its iPhone production in India



Source: Media articles (Times of India), Jefferies

Exhibit 48 - iPhone exports have increased ~8x over FY22-24



Source: Media articles (Times of India), Jefferies

Exhibit 49 - Apple's rising presence in India

Year	Details
2008	- Apple started selling iPhones in India; iPhone 3G was introduced.
2016	- Apple files application to set up own stores in India.
2017	- Wistron, Apple's first major manufacturing partner in India, sets up a production facility in Karnataka.
	- Local assembly of iPhones (iPhone SE) started in Karnataka.
2019	- Foxconn, a key supplier to Apple, expanded its plant in Tamil Nadu to begin iPhone production.
	- Expanded the range of iPhones manufactured in India to include top-end phones.
2020	- Salcomp, one of the largest suppliers of chargers for Apple phones, started operations in Tamil Nadu.
	- Apple launched its first online store in India.
2022	- Pegatron started manufacturing iPhones in India starting with iPhone 12.
	- Foxconn started assembling iPhone 13 and the flagship iPhone 14 in India.
	- Apple overtook Samsung to become the leading mobile phone exporter from India in November.
2023	- Share of India in Apple's production rose from just 1% in 2021 to ~10%
	- Apple, through its suppliers Foxconn, Pegatron and Wistron, produced ~$7bn of iPhones in India in FY23.
	- Tata Group acquired Wistron's iPhone plant in India
	- Apple opened its first two retail stores in Mumbai and New Delhi in India.
2024-25	- Apple produced ~$14bn of iPhones in India in FY24; ~14% of global production.
	- iPhone exports from India nearly doubled from ~$5bn in FY23 to $10bn in FY24.
	- iPhone models manufactured in India include 12, 13, 14, 15, and the entire 16 lineup.
	- Tata Electronics acquired controlling stake of 60% in Pegatron's India operations.

Source: Company websites, Media articles (Reuters, Bloomberg, Economic Times), Jefferies

Apple produced ~$14bn of iPhones in India in FY24; ~14% of global production.

Exhibit 50 - Apple's iPhone production in India has steadily increased

Year	Models	Global shipment share (%)
2017	iPhone SE (1st Gen)	<1%
2018	iPhone 6S	<1%
2019	iPhone 7 & XR	~1%
2020	iPhone 11, SE (2nd Gen)	<2%
2021	iPhone 12	3%
2022	iPhone 13, 14	7%
2023	iPhone 15	10%
2024	iPhone 16	~14%
2025E-30E	Latest	25%

Source: Media articles (Reuters, Bloomberg, Economic Times)

Apple suppliers have started setting up operations in India too.

Apple has about 200 suppliers globally. Several of these suppliers have also started setting up operations in India with rising mobile phone manufacturing in the country. Some of these suppliers are also looking at collaborations with Indian companies for local manufacturing. SAMIL (MOTHERSO IN), for instance, has recently started an electronics glass manufacturing facility in India, in collaboration with Hong Kong-based BIEL Crystal Manufactory, a smartphone glass-maker and an Apple supplier.

Exhibit 51 - Companies in Apple's supplier list that have a presence in India

Supplier	Location in India	Product & overview
Foxconn (Hon Hai Precision)	Tamil Nadu	Assembling iPhones; Announced multiple projects inc. $600mn project in Karnataka and $500mn project in Telangana, etc.
Tata Electronics (Tata Group)	Tamil Nadu, Karnataka	Assembling iPhones Tata also acquired Wistron India in 2023 and 60% stake in Pegatron India in 2025.
Cheng Uei Precision Industry (Foxlink)	Tamil Nadu	Cables for chargers; In process of setting up a new factory in Tamil Nadu after facing a fire issue in an earlier facility.
Flex	Tamil Nadu	Battery packs
Jabil	Maharashtra	AirPod components; In process of setting up another unit in Tamil Nadu with an investment of $238mn
Lingyi iTech / Salcomp	Tamil Nadu	Chargers,coils, power packs and magnetics
Sunwoda Electronic Company	Uttar Pradesh	Lithium-ion batteries
TDK Corporation	Haryana	Lithium-ion battery cells
Corning	Tamil Nadu	Smartphone glass; Facility is expected to be operational by second half of 2025

Source: Company, Media articles (CNBC, Reuters), Jefferies

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Chip evolution in Asian nations

Singapore: From electronics to semiconductors

Singapore was perhaps the first country worldwide to actively seek out FDI as a method of growing its GDP from the 1970s itself. It did so by providing a low tax environment, strong infrastructure and a pro-business government approach. A big vote of confidence came in the 1970s when Hewlett Packard, one of the biggest tech companies during those decades, set up multiple facilities in Singapore to manufacture calculators, semiconductors and printers.

In the 1970s, HP set up multiple facilities in Singapore to manufacture calculators, semiconductors and printers

The big base that HP set up in Singapore was key to attract other US, European and Japanese tech companies whose confidence in Singapore rose and were attracted by government support and a low tax environment. Semiconductor companies were also early investors in facilities in Singapore including Texas Instruments, Fairchild and National Semiconductor.

Confidence of other US, European and Japanese tech companies also rose in Singapore.

In the decades that followed, Singapore grew in stature and an electronics manufacturing destination, with the city state accounting for 50% of the world's production of hard disk drives for PCs and laptops in the 1990s. Major HDD companies with big manufacturing facilities included IBM, Seagate and Western Digital.

Singapore accounted for 50% of the world's production of hard disk drives for PCs and laptops in the 1990s.

The next step in the evolution of Singapore was a major move into semiconductor manufacturing by the late 1990s and into the 2000s. The Singapore government set up its own semiconductor company, Chartered Semiconductor in the late 1980s, which at one point was the third largest foundry in the world behind TSMC and UMC. It also set up a semiconductor assembly and test company, STATS. Major European, US, Taiwanese and Japanese chip companies, Infineon, STMicroelectronics, Micron, TSMC, UMC, Philips Semiconductor (now NXP) have all set up large semiconductor fabs in Singapore with many of them continuing to expand capacity.

The Singapore government set up its own semiconductor company, Chartered Semiconductor in the late 1980s, which at one point was the third largest foundry in the world.

Capital availability and stability are bigger draws for a semiconductor wafer fab than low cost manpower, and the Singapore government was one of the earliest to provide capital to semiconductor companies to attract them to the country. The availability of qualified manpower and the attractiveness of the location for expatriates also helped attract companies to set up facilities there including a number of semiconductor equipment vendors.

Capital availability and stability are bigger draws for a fab than low cost manpower.

Today, Singapore accounts for over 10% of global semiconductor production and around 20% of global semiconductor equipment production, though almost all of this is by non-Singaporean companies. While the country has had tremendous success in getting global semiconductor and semiconductor equipment companies to set up fabs and facilities in Singapore, it has had very little success in developing local semiconductor companies. Even the two companies set up by the government – Chartered Semiconductor for front-end manufacturing and STATS for packaging were unable to compete globally and were acquired by foreign companies. However, they continue to have a strong presence in Singapore.

While Singapore has had tremendous success in getting global semis and equipment companies to set up facilities in Singapore, it has had very little success in developing local semiconductor companies.

Malaysia: Following the Singapore path

Malaysia's route to becoming a major location for semiconductor manufacturing was similar to that of Singapore, and in many ways Malaysia learned from the path that Singapore had already followed. Like Singapore, Malaysia was also quick to provide tax incentives and an efficient infrastructure, especially in the Penang area.

Malaysia followed Singapore's blueprint, providing tax incentives and an efficient infrastructure.

Malaysia opened the Free Industrial Zone in Penang in the early 1970s and continued to expand this area to become a major hub of electronics and semiconductor manufacturing over the next 2-3 decades. It attracted many major global players including Intel, AMD, Hewlett Packard, Dell, Packard Bell, Osram, Hitachi, Sony, Infineon and Motorola.

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Malaysia's low manpower costs led many large semiconductor companies like Intel to set up their assembly and test facilities in the country, as assembly and test is significantly more labor-intensive and less capital-intensive than semiconductor wafer fabs. Major assembly and test facilities in the country include Intel, Infineon, STMicroelectronics, SPIL, NXP and Renesas.

Malaysia's low manpower costs led many large semiconductor companies to set up assembly and test facilities.

This vast array of major foreign technology and semiconductor manufacturers setting up facilities in that region also resulted in a number of local ancillary companies being set up to provide support to them. This includes a number of semiconductor assembly and test facilities such as Carsem, Unisem, Inari Amertron, etc. The Malaysian government also invested in the setting up of semiconductor foundry, Silterra, but with uneven success.

The Malaysian government also invested in the setting up of semiconductor foundry, Silterra, but with uneven success.

China: The growing powerhouse of mature logic chip production

In 2015 the China government announced its "Made in China 2025" initiative, aimed to lift the country's chip production from less than 10% of demand at that time to 40% in 2020 and 70% in 2025. Since then, although the country has fallen well behind on these ambitious targets, it has made a significant amount of progress with chip sufficiency currently estimated at around 30%.

China's chip sufficiency has risen from just 10% in 2015 to currently estimated at around 30%.

While there are some fabs and assembly and test facilities owned by foreign semiconductor companies in China, such as TSMC, Samsung Electronics, SK Hynix, Infineon and STMicroelectronics, the vast majority of Chinese semiconductor production is being done by local companies in both the public and private sectors. This includes both foundries and integrated device manufacturers (IDMs) that have their own fabs, as well as fabless companies that outsource their manufacturing to foundries. Some of the major Chinese semiconductor companies include: SMIC - Foundry, Hua Hong - Foundry, YMTC - NAND flash, CXMT - DRAM, Omnivision - CMOS image sensors, Unisoc - Smartphone basebands and processors, GigaDevice - MCUs and NOR Flash, HiSilicon - Smartphone, PC and server chips, Silan - Power discretes, and StarPower - Power discretes.

Majority of Chinese semiconductor production is being done by local companies in both the public and private sectors.

However, since 2019 the US government has imposed a large number of restrictions on the shipments of advanced semiconductor equipment to China, which has severely limited the ability of the country to make advanced logic or DRAM chips. Some key limitations include the restriction of EUV and high-end immersion lithography equipment, as well as metrology and design tools.

US restrictions on shipments of advanced semi equipment to China since 2019 has limited its ability to make advanced logic or DRAM chips.

China has, therefore, been mainly focused on the manufacture of mature node semiconductors at 28nm and below, in areas like micro-controllers, power discretes and analog. The country has also been investing in silicon carbide and gallium nitride chip production.

China, hence, mainly focused on mature nodes in micro-controllers, power discretes and analog.

In 2023 China accounted for around 30% of global semiconductor equipment purchases, while in 2024 this number rose to 40%. The massive investment in both DRAM and mature node logic chips by Chinese companies in recent years has led to significant concerns on oversupply and pricing pressure in these product categories. China has also been ramping up its design capabilities in semiconductors for applications like AI, robotics and self-driving cars.

China has also been ramping up its design capabilities in semiconductors for applications like AI, robotics and self-driving cars.

China has also made significant progress towards self-sufficiency in all areas of semiconductor equipment outside of lithography. Chinese companies like Naura, AMEC and ACMR are significant sources of deposition, etch and cleaning equipment for Chinese semiconductor companies.

China has also made progress towards self-sufficiency in all areas of semiconductor equipment outside of lithography.

Case study: India's big leap in auto

The journey of auto industry in India provides a remarkable case study on how the country, with prudent policies and rising demand, could establish manufacturing ecosystem in a sector where it was lagging by decades.

Auto provides a remarkable example of how prudent policies and rising demand helped create an ecosystem.

India sold just 41K passenger vehicle (PVs) in 1980 with only three companies manufacturing cars who were languishing for need of better technology. Demand outstripped supply and consumers had to wait long to own a vehicle.

India sold just 41K PVs in 1980 with three OEMs languishing for need of better technology.

In early 1980s, the government embarked on a new plan to modernize the automobile industry, incorporated Maruti Udyog Limited, and started the process of finding a foreign collaborator who could provide technology, especially to meet the growing demand of affordable and efficient cars. The response from global OEMs was uninspiring though, with only a handful of companies showing initial interest, none of which materialized. The government made further attempts to attract carmakers from Europe and Japan, but struggled to find much interest.

In early 1980s, Indian govt embarked on a plan to modernize the auto industry, but struggled to find a global OEM who could partner to provide technology and manufacturing know-how.

In 1982, Suzuki Motor agreed to provide the technical support to manufacture a small car in India, and entered into a joint venture agreement taking up an initial 26% stake in Maruti. Maruti Suzuki rolled out its first car called Maruti 800 in December 1983. Maruti soon became the dominant player in Indian passenger vehicle market, and has held that position for more than three decades.

In 1982, Suzuki Motor agreed to provide the technical support to manufacture a small car in India.

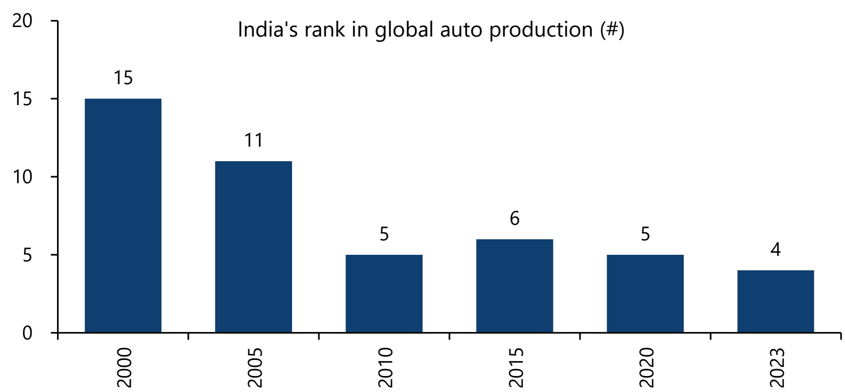
The 1990s marked another turning point for the industry with economic liberalization and globalization. Improved income levels, a burgeoning middle class, and easy access to finance fueled consumer demand for automobiles. International OEMs such as Hyundai, Honda, Toyota, and Ford entered the Indian market in this period. Hyundai, in particular, focussed on the small car segment, which was more relevant for the Indian market. Indian OEMs like Tata Motors and Mahindra also expanded their product portfolios.

Maruti soon became the dominant player in Indian passenger vehicle market and has held that position for more than three decades.

From selling less than 100K units and struggling to attract a global OEM in the 1980s, India has now become the fourth largest passenger vehicle producer by volumes and an attractive market for most carmakers. India also exported over $8bn of PVs in FY24. The early entrants and domestic companies continue to enjoy a dominant 80%+ share in the market. By collaborating early with the Indian government and participating in the Maruti project, Suzuki recognized the immense potential of the Indian market, ultimately becoming the leading auto manufacturers in the country for decades.

India is now the fourth largest PV producer by volumes; the early entrants and domestic companies continue to enjoy a dominant 80%+ share in the market.

Exhibit 52 - India's big leap in auto production

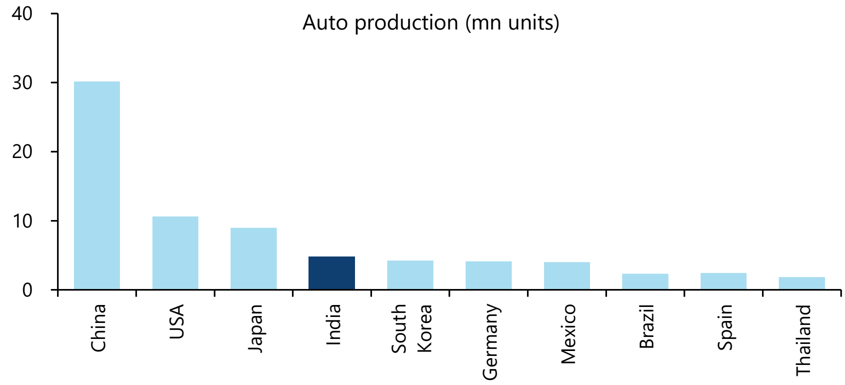


Source: Bloomberg, Jefferies

India leapfrogged from 15th position in passenger vehicle manufacturing in 2000 to 5th by 2010.

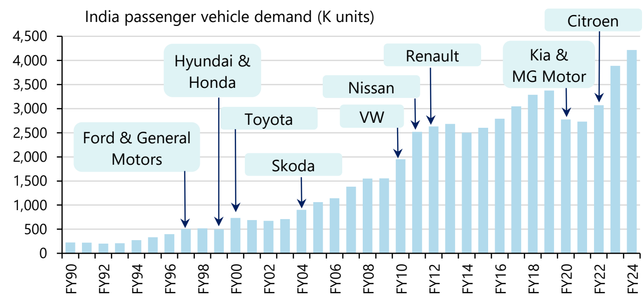
From selling less than 100K units and struggling to attract a global OEM in the 1980s, India has now become the fourth largest passenger vehicle producer by volumes and an attractive market for most carmakers.

Exhibit 53 - India is now #4 in PV production by volumes globally



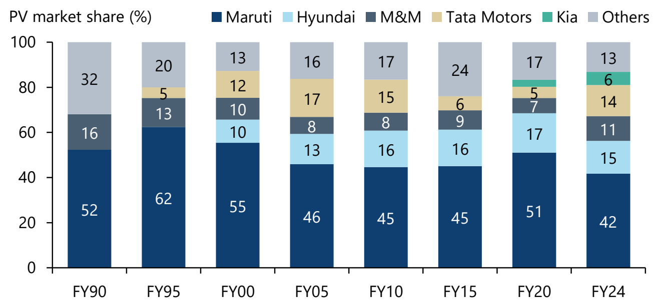
Source: Bloomberg, Jefferies

Exhibit 54 - Many global OEMs entered India as demand started to pick up



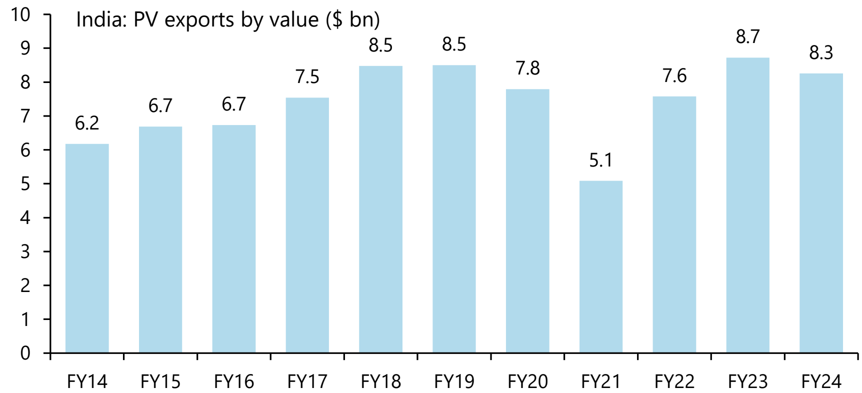
Source: CMIE, Jefferies

Exhibit 55 - Early entrants and domestic OEMs enjoy 80%+ market share



Source: CMIE, Jefferies

Exhibit 56 - India exported $8bn+ of passenger vehicles in FY24



Source: CMIE, Jefferies

Potential hurdles on the road

While India possesses several key ingredients for success in semiconductors, the industry also needs to navigate through the challenges of an undeveloped supply chain, limited specialized manufacturing talent, stiff global competition and rapidly evolving technology.

Limited supply chain for silicon wafers, high purity gases, specialty chemicals and ultrapure water, which are required for chip manufacturing.

India has a limited supply chain for silicon wafers, high purity gases, specialty chemicals and ultrapure water, which are required for chip manufacturing. While India has a strong manufacturing cluster for chemicals and bulk gases in regions such as Dahej in Gujarat, companies would need to enhance capabilities to manufacture semiconductor-grade raw materials. The government also has a strong focus on building the full semis ecosystem in the country, with emphasis on establishing the entire supply chain, including chemicals, gases and equipment.

Need to develop the specific skill set for chip manufacturing and testing.

India has a strong engineering talent pool and houses ~20% of the world's semiconductor design workforce. However, the country still needs to develop the specific skill set required for chip manufacturing and testing. Companies are already working towards bridging this gap. For instance, Tata Electronics and Kaynes have signed MoUs with ASMPT of Singapore which includes workforce training. Micron has also entered into a MoU with the New Age Makers Institute of Technology (NAMTECH), an ArcelorMittal Nippon Steel India (AM/NS India) education initiative, to partner on advancing the development of a talent pipeline for semiconductor industry in India. The government is also collaborating with industry as well as universities to create a course curriculum across design, fab and ATMP aligned with the requirements of the industry.

Competition from countries that have spent decades building electronics and semiconductor ecosystems.

India faces stiff competition from countries such as China, Singapore, Malaysia, South Korea, and Taiwan that have spent decades building electronics and semiconductor ecosystems. With the rising strategic importance of semiconductors and vulnerable supply chains, the world is also witnessing a subsidy race to incentivize chip manufacturing.

Risks of ramp-up issues, quality control and eventual yield to achieve appropriate economies of scale.

While the government has been able to kick-start investments by providing large incentives, ramping up any large-sized technologically-advanced manufacturing facility comes with certain risks of teething issues, quality control and eventual yield to achieve appropriate economies of scale. Off-take agreements and demand for chips produced from the Indian facilities, both in domestic and export markets, would be key.

Rapidly evolving technology.

While India is still in the process of setting up its first fabrication facility, global semiconductor players have been constantly pushing the limits of miniaturization (the minimum size of the key component of the chip that can be produced with a particular process technology). As a late entrant into the ecosystem, Indian companies engaging in fabrication might have to incur high capital investment to keep pace with the industry.

Conclusion

Electronics and semiconductors have become critical for economic progress and national security.

Electronics, and semiconductors as its building blocks, have become critical not only for the economic progress of a country but also for its national security. AI-related demand is expected to accelerate global semiconductor growth rates over the next six years, with the industry expected to reach revenues of over $1 trillion by 2030. Semiconductor industry, however, is concentrated with US, a handful of European nations, Japan, South Korea, Taiwan and China together having a dominant position in almost every part of the supply chain.

India's electronics production has grown at 15% CAGR over FY16-24 to $115bn in FY24, and the government has set a target of quadrupling this to $500bn by FY31.

India's electronics demand is accelerating, led by rising incomes and digital adoption. Net electronic imports rose to $60bn in FY24, forming 25% of country's trade deficit, next only to oil (39%). Recognizing the rising economic and strategic importance of the electronics sector, the Indian government has embarked on a path to promote electronics manufacturing in the country through incentives such as PLI. India's electronics production has grown at 15% CAGR over FY16-24 to $115bn in FY24, and the government has set a target of quadrupling this to $500bn by FY31.

India launched a $10bn incentive scheme in 2021 to develop semiconductor and display manufacturing ecosystem.

While electronics manufacturing is picking up in India, boosted by favorable government policies and geopolitical tailwind, domestic value addition has remained low at 18-20%, which the govt intends to raise to over 35% by the end of the decade. In December 2021, the government introduced a new incentive scheme, with an initial outlay of ~$10bn over six years, for the development of semiconductor and display manufacturing ecosystem. The government recognized the large upfront investments and long lead times for such projects, and hence decided to provide fiscal support of 50% of the approved project cost on pari-passu basis, i.e. at the same rate as investments by a company. Certain states offer further ~20% incentive, taking the total benefit to ~70%.

India's big push for semiconductors is bearing fruit with $18bn of investments underway in a chip fab and four ATMP/OSAT projects.

The big policy push for semis is bearing fruit as five projects with $18bn in investments, including ~70% fiscal support, are under construction. Tata Electronics' $11bn fab for 28-110nm chips with PSMC of Taiwan is expected to start in 2026. The four OSAT/ATMP projects, expected to start over 2025-27, include: 1) Tata's $3.3bn facility for flip chip and ISIP (integrated system in packaging), 2) Micron's $2.8bn project for DRAM and NAND chips, (3) CG Power's $0.9bn plant in partnership with Renesas of Japan and Stars Microelectronics of Thailand, and (4) Kaynes' $0.4bn facility. These five projects are expected to create ~80K in direct and indirect jobs. The state of Gujarat has taken a lead, attracting four of the five projects, forming ~80% of total investments.

Focus on ecosystem expansion.

In our meeting, Mr. Ashwini Vaishnaw, the Minister of Railways, Information and Broadcasting, and Electronics and IT, highlighted govt's strong focus on building the full semis ecosystem in India, with emphasis on establishing the entire supply chain, including chemicals, gases, equipment and components, along with leveraging India's strong design capabilities.

India's manufacturing success, at least for now, may not lie in competing at the frontier of innovation, but in leveraging proven technology and creating cost-effective solutions, aligned with nation's rising demand and economic priorities.

While a 28nm fab with $11bn spend is modest vs TSMC's 2-5nm nodes and $235bn tangible gross block, ~56% of global installed wafer capacity is still 34nm-or-higher and players like GlobalFoundries and Infineon have comparable $20-35bn gross block. More importantly, India's manufacturing success, at least for now, may not lie in competing at the technology frontier, but in leveraging proven technologies and creating effective solutions, aligned with nation's rising demand and economic priorities. We see a strong parallel to India's success in autos. India, in early 1980s, struggled to kickstart auto manufacturing, but, with prudent policies and rising demand, is now #4 in production volumes, exporting vehicles and component globally, while not at the forefront of technology.

We believe India has strong potential to replicate its manufacturing success in autos to semiconductors.

We believe India possesses several key ingredients for success in semis such as large fiscal incentives, policy support, rising demand, participation of large corporates, low manufacturing cost, strong design talent, and strategic goodwill with the West. On the flip side, industry faces hurdles of undeveloped supply chain, limited chip manufacturing talent, global competition and rapidly evolving technology. With a strong policy foundation and momentum accelerating, we believe India has potential to thrive in semiconductor manufacturing.

Appendix A: Profile of select global foundries and ATMP companies

Established in 1987 in Taiwan, TSMC pioneered the pure-play foundry business model. It shipped a total of 12.9mn 12-inch equivalent wafers in 2024. It produced 28% of world's semiconductor output value, excluding memory, in 2023. TSMC operates at the leading edge of technology and generated approx. 70% of its 2024 revenues from advanced nodes (7 nm and below).

Global Foundries, headquartered in the US, shipped ~2.1mn 12-inch equivalent semiconductor wafers in 2024 from its four manufacturing sites in Dresden, Germany; Singapore; Malta, New York; and Burlington, Vermont.

ASE Technology Holding, headquartered in Taiwan, is a leading provider of chip assembly and testing services. It employs more than 95K employees across the world, and operates manufacturing facilities in 15 countries including Taiwan, China, South Korea and United States.

Amkor Technology, headquartered in Arizona, US, is a leading OSAT player globally. Amkor has ~30K employees across 20 manufacturing locations in 11 countries.

Exhibit 57 - Key financials for foundry and ATMP companies

	Foundry		ATMP		
	TSMC	Global Foundries	ASE	Amkor	Powertech
Market cap ($ bn)	820	21	23	5.2	2.9
Bloomberg ticker	2330 TT	GFS US	3711 TT	AMKR US	6239 TT
Key financials (CY24, $ bn)					
Wafers shipped (mn 12-inch eq.)	12.9	2.1			
Revenue	90.1	6.8	18.5	6.3	2.3
Gross profit	50.6	1.7	3.0	0.9	0.4
Operating profit	41.2	0.7	1.2	0.4	0.3
Net profit	36.7	0.7	0.8	0.4	0.3
Gross block (CY23)	235	35	24	10	5.0
Capex	29.8	0.6	2.4	0.7	0.4
Key ratios (%)					
Gross margin (%)	56.1	24.5	16.3	14.7	19.1
Operating margin (%)	45.7	10.8	6.6	6.9	12.8
Net margin (%)	40.8	10.0	4.5	5.6	11.6
Gross Fixed asset turnover (%)	38.4	19.3	78.7	63.5	45.4
Capex as % of sales	33.0	9.3	13.2	11.7	15.5

Source: Bloomberg, Jefferies

Appendix B - What is a semiconductor chip

A semiconductor chip is the brain of an electronic device, and the transistors are the gray cells.

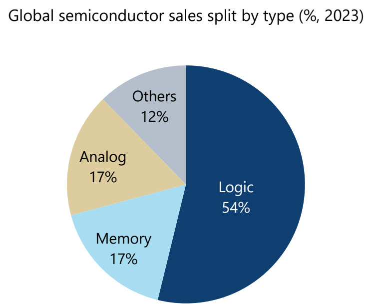
A semiconductor chip or an integrated circuit (IC) is a small electronic component that can sense, store, process and transfer data or signals. It is effectively the brain of an electronic device. A chip is composed of up to several billion transistors, which work as the gray cells of the electronic brain, joined together with metal connections, or the white matter. Semiconductor chips are categorized based on their function as: 1) logic (data processing), 2) memory (data storage), 3) analog (transmission and sensing), and 4) optoelectronics, discrete (e.g. power) and others.

Exhibit 58 - Types of semiconductor chips

Type	Description	Companies	Applications
Logic	Brain of computing devices. Includes microprocessors and graphics processors.	Nvidia, Intel, AMD, Qualcomm, Broadcomm	Computers, smartphones
Memory	Data storage. Includes dynamic random access memory (DRAM) and NAND flash storage.	Samsung, SK Hynix, Micron	Computers, smartphones, data centers
Analog	Process analog (continuous) signals for communication and power management.	Texas Instruments, Analog Devices, Skywork Solutions	Consumer electronics, Electric vehicles, Military applications
Others	Optoelectronics (image sensors, lasers, LED), sensors and discrete.	Infineon, STMicroelectronics	Consumer electronics

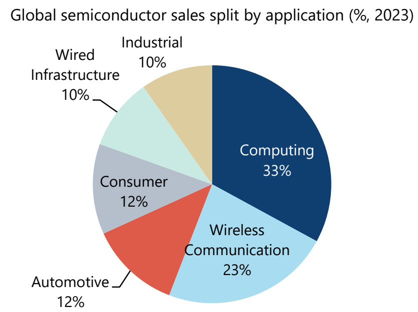
Source: Jefferies

Exhibit 59 - Logic & memory chips form ~70% of total sales



Source: Bloomberg, Jefferies

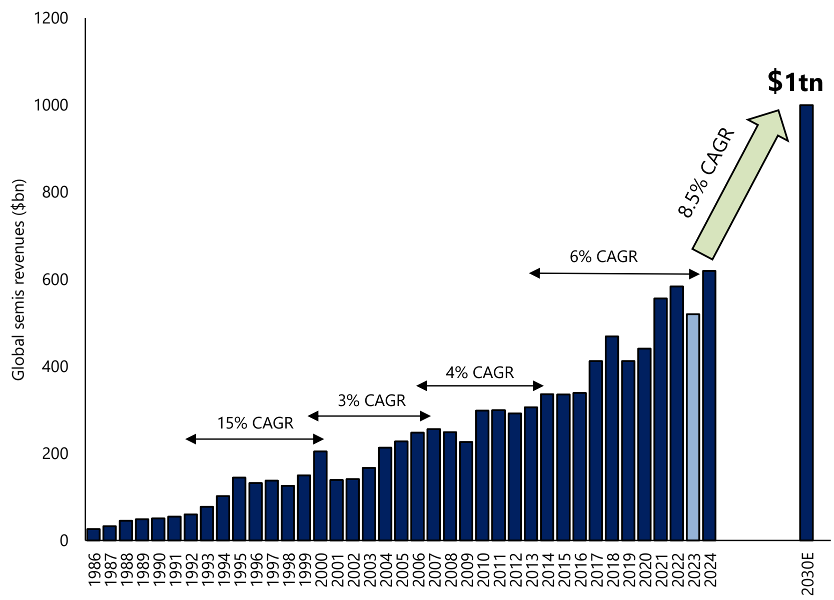
Exhibit 60 - Computing & communication form ~60% of demand



Source: Bloomberg, Jefferies

Exhibit 61 - Industry growth rates are steadily accelerating; we model $1tn by 2030 at 8% CAGR

AI-related demand is expected to further accelerate global semiconductor growth rates.



Source: WSTS, Jefferies estimates

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A transistor is one of the most important inventions of the 20th century as it gave birth to the digital age. A transistor is like a tiny switch that can allow or break the flow of electricity (or data signals) between two points based on an independent third control. A controllable switch is at core of every calculation, decision-making and processing in an electronics device. MOSFETs are the most commonly used type of transistor where the flow of electric current between the source and drain terminals can be controlled by applying different voltages on the middle gate terminal.

A transistor is like a tiny controllable switch, which forms the core of every calculation, decision-making and processing in the digital world.

The switching ability of a transistor is its most important feature, which comes from the use of special materials called semiconductors. Semiconductor, as the name suggests, is a material with electrical properties between that of a conductor (e.g. copper) and an insulator (e.g. rubber). Semiconductors are typically made from elements such as silicon and germanium. What makes semiconductors special is that the electrical conductivity can be changed and controlled by adding impurities (calling doping) such as boron and phosphorus. A transistor is a multi-layered structure built by doping semiconductor material and putting metal connects on top.

The switching ability of a transistor is its most important feature, which comes from the use of special materials called semiconductors.

The early ICs, developed in late 1950s and early 1960s, consisted of only a few transistors; these were relatively large sized and were used in specialized applications. In the 1960s, ICs with tens to hundreds of transistors emerged, which were used in applications such as calculators, early computers, and scientific equipment. In 1965, Gordon Moore, co-founder of Intel, observed that the number of transistors on a chip was doubling roughly every year. This observation became known as Moore's Law, and it predicted the ongoing advancement of semiconductor technology, leading to smaller, faster, and more powerful devices.

In 1965, Gordon Moore, co-founder of Intel, observed that the number of transistors on a chip was doubling roughly every year. This observation became known as Moore's Law.

Medium-scale integration started by the late 1960s with ICs made of hundreds to thousands of transistors, used in industrial control systems and early microcomputers. Large-scale integration came into prominence in the 1970s, packing thousands to tens of thousands of transistors into chips used in mainframe computers. The 1980s saw the emergence of VLSI (Very Large Scale ICs), incorporating hundreds of thousands to millions of transistors and gave birth to the era of personal computers and consumer electronics. Ultra-Large-Scale Integration (ULSI) emerged in the 1990s, taking the transistor count on a single chip to billions of transistors, driving widespread usage of advanced microprocessors, memory chips, and complex system-on-chip (SoC) designs used in smartphones, high-performance computing etc.

The number of transistors on a single chip has risen from single-digits in early 1960s to billions in the 1990s.

Semiconductor industry has continuously shrunk transistor size over the past six decades, packing an increasing number of these tiny switches on a single chip, driving huge increase in computing power and decline in cost per transistor. Billions of such switches, turning on and off billion times a second, perform the heavy lifting inside an Nvidia GPU or an Apple iPhone.

Billions of minute transistor switches, turning on and off billion times a second, perform the heavy lifting inside a Nvidia GPU or an Apple iPhone.

Exhibit 62 - An exponential rise in transistors per chip has fueled the digital age

Time Period	Event	Transistors per chip	Applications
1947	Invention of transistor at Bell Labs		
Late 1950s & early 1960s	Early ICs: The first ICs were developed by Jack Kilby (Texas Instruments) and Robert Noyce (Fairchild Semiconductor)	< 10	Specialized applications
1960s	Small-scale integration (SSI) & Moore's Law: In 1965, Gordon Moore, co-founder of Intel, observed that the number of transistors on a chip was doubling roughly every year	10s to 100s	Calculators, early computers, and scientific equipment
Late 1960s	Medium-scale integration (MSI)	100s to 1,000s	Industrial control and early microcomputers
1970s	Large-scale integration (LSI)	1,000s to 10,000s	Mainframe computers
1980s	Very large-scale integration (VLSI)	100,000s to Millions	Personal computers and consumer electronics
1990s	Ultra large-scale integration (ULSI): Widespread use of advanced microprocessors, memory chips, and complex system-on-chip (SoC)	Billions	Smartphones, high-performance computing

Source: Jefferies

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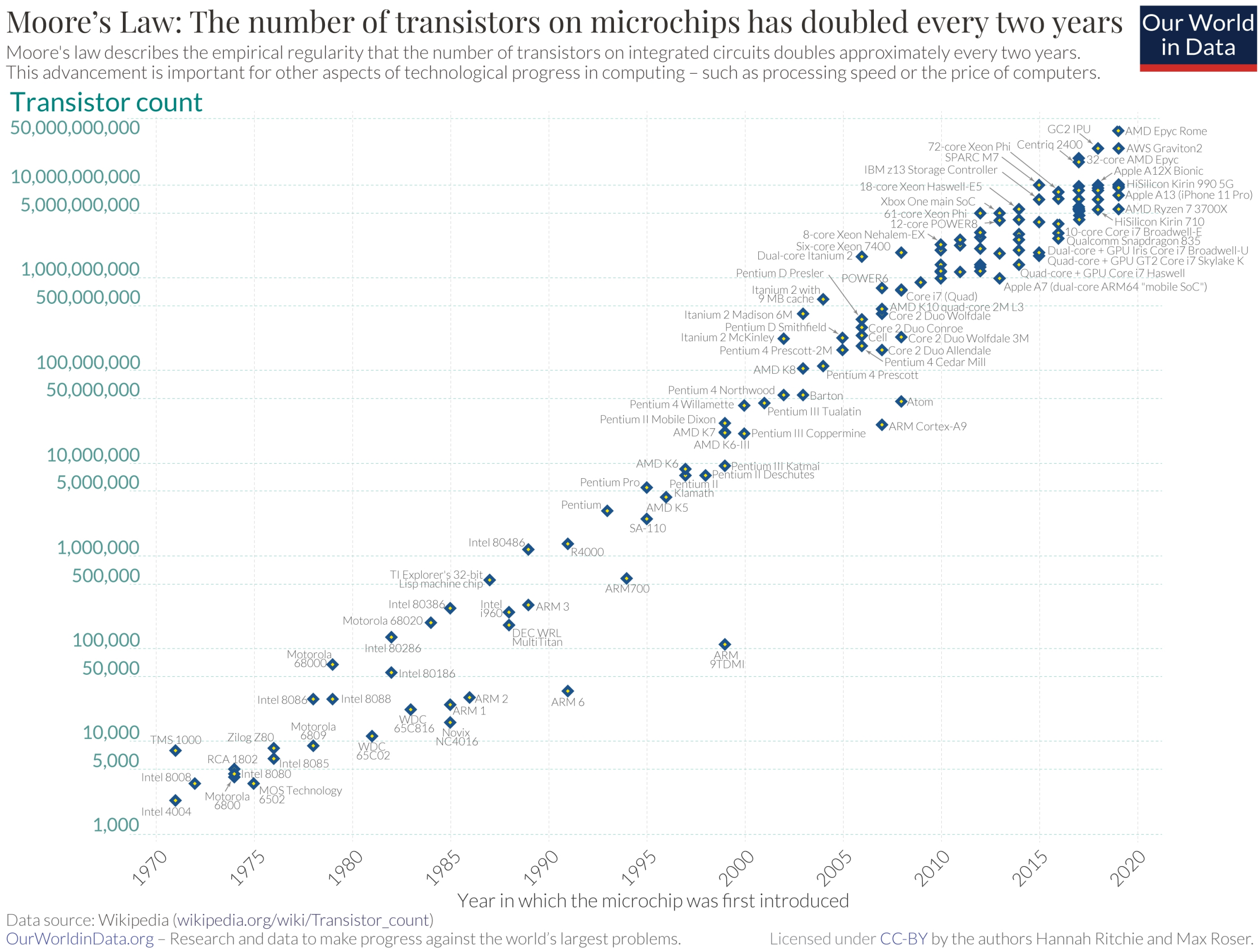
Exhibit 63 - Continuous reduction in transistor size led to rising computing power and falling cost per transistor

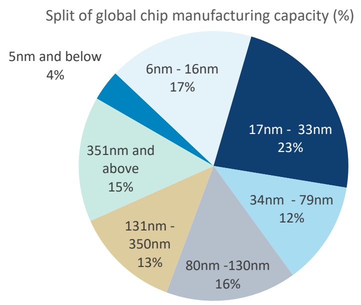


Source: OurWorldInData.org, Jefferies

Technology node, also called process node, represents the level of miniaturization or advancement in semiconductors. It usually refers to the minimum size of the key component of the chip that can be produced with a particular process technology. As process nodes shrink, the gate length decreases, allowing for smaller and more densely packed transistors on a chip. A wide range of nodes are in production ranging from state-of-the-art 3nm (nanometer) to mature nodes up to 350nm. While newer nodes provide higher transistor density and are primarily used in processors and memory, mature nodes are still used for microcontroller, connectivity, sensors, power management, etc. About 56% of global wafer capacity is still 34nm & higher, 23% is 17-33nm, and 21% is 16nm or below. TSMC operates at the leading edge with ~70% of its 2024 revenues from 7 nm and below.

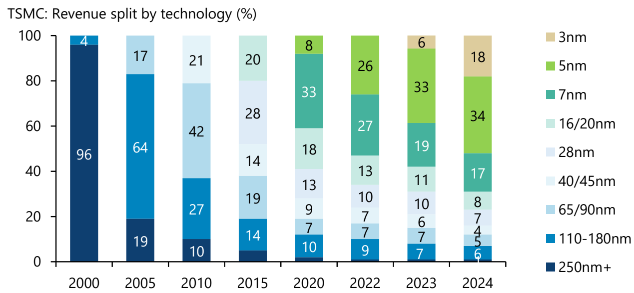
Technology node represents the level of miniaturization or advancement achieved in chip manufacturing. A wide range of nodes are in production ranging from state-of-the-art 3nm (nanometer) to mature nodes up to 250nm (or 0.25 micron).

Exhibit 64 - 56% of global wafer capacity is still 34nm and above



Source: SEMI

Exhibit 65 - TSMC's ~70% of 2024 revenues from 7nm and below



Source: Company data, Jefferies

Chip manufacturing process

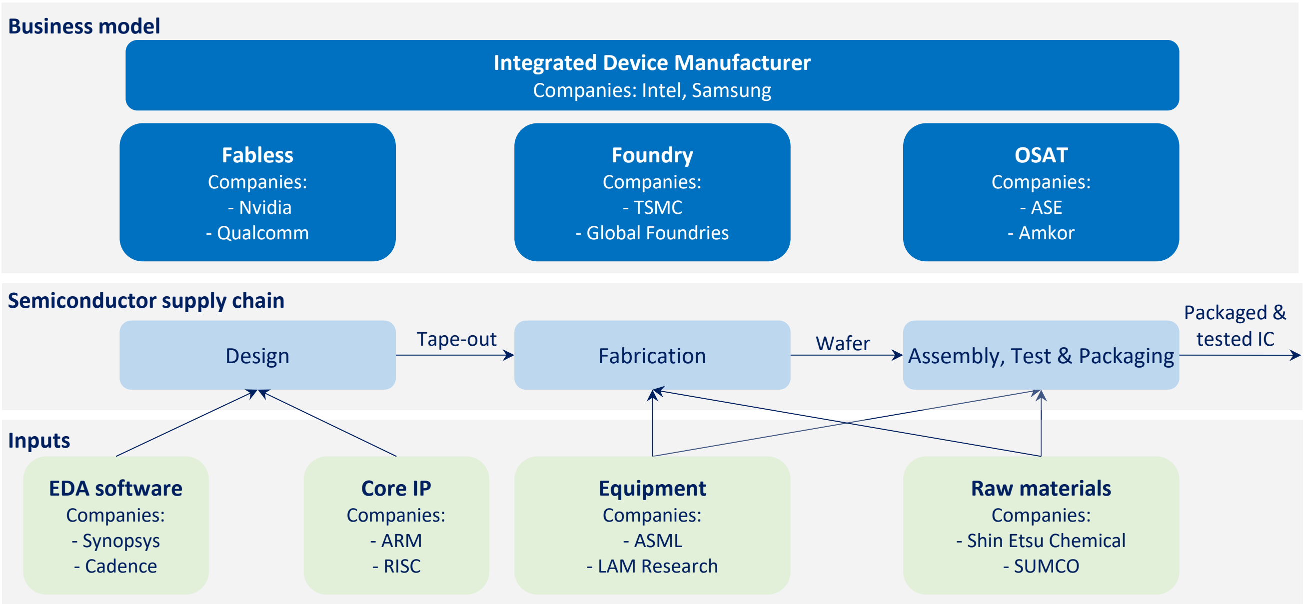
Semiconductor chip manufacturing process can be split into three main activities: 1) design, 2) fabrication, and 3) assembly, testing and packaging (ATP). The production process also relies on several key inputs: 1) semiconductor manufacturing equipment, 2) raw materials such as wafers, chemicals and gases, and 3) electronic design automation (EDA) software and core IP designs.

Semiconductor chip manufacturing process can be split into three main activities: 1) design, 2) fabrication, and 3) assembly, testing and packaging.

The industry has two business models: 1) IDM (Integrated Device Manufacturer) where a single company handles the entire process including design, fabrication and ATP, and 2) fabless model where a company focuses on design of the chip, but outsources the fabrication to specialized manufacturing companies called foundries. Intel and Samsung are the leading IDMs. Examples of fabless companies include Qualcomm, NVIDIA and AMD, which outsource chip fabrication to foundries such as TSMC and Global Foundries. OSAT (Outsourced Semiconductor Assembly and Test) companies such as ASE and Amkor handle assembly, testing and packaging of chips.

Two business models: 1) IDM where a single company handles the entire process, and 2) fabless where a company focuses on design, but outsources fabrication and testing.

Exhibit 66 - Chip manufacturing process and business models



Source: Jefferies. Note: Companies mentioned are a sample set and not an exhaustive list

Fabrication, in simplistic terms, can be thought of as making photocopies of a master design on to a silicon wafer by shining light. The actual process is a lot of more complicated, which could involve several hundred steps. Typically, front-end fabrication of dies takes 8-28 weeks, the back-end processes of assembly and packaging 4-10 weeks, and testing ~2 weeks. Overall, producing a semiconductor could take up to 6 months. It is not only a capital intensive process but also require specialized equipment, chemicals and software working at nanometer precision, supported by uninterrupted power and water supply.

Chip manufacturing, in simple terms, is like making photocopies of a master design on to a silicon wafer by shining light. The actual process is highly complex with several hundred steps an cycle time of up to 6 months.

Chip making is complicated for multiple reasons. First and foremost is the unending miniaturization, i.e. the drive to shrink transistor size and increase the transistor count per chip, as predicted by Moore's Law, which requires increasing precision at nanoscale level. Fabrication involves a series of complex and interdependent steps, such as photolithography, etching, doping, and deposition, each requiring precise execution.

The continuous miniaturization requires rising precision at nanoscale level, making chip fabrication increasingly complicated.

Exhibit 67 - From sand to silicon to system

Source: Government of India, Jefferies

Semiconductor manufacturing needs a cleanroom environment with stringent standards as even the smallest particles of dust or contaminants can adversely affect chip quality and yield. Working with materials such as silicon wafers, photoresists, chemical compounds, and metal layers necessitates specialized expertise and research to achieve the desired electrical properties and reliability.

Fabrication needs a cleanroom environment with stringent standards.

Foundries also requires significant capital investment, including expensive equipment and cleanroom infrastructure. A leading node technology fab can cost $10-20bn, although a mature node facility can be set up at less than half the investment. Lastly, the industry is characterized by rapid technological advancements and companies need to continuously improve processes, and adopt new techniques and materials to keep pace with the market.

A leading node technology fab can cost $10-20bn, although a mature node facility can be set up at less than half the investment.

Exhibit 68 - An overview of semiconductor chip manufacturing process

Design	The process begins with defining the functionality and interfaces of a chip, followed by a high level design in specialized programming languages such as Verilog, and subsequently the translation of high level design into a layout of transistors using EDA tools.
Wafer Preparation	Wafers, made by slicing high-purity silicon cylinders, are used as the substrate for chip manufacturing. Multiple chips can be fabricated on a single wafer.
Photolithography	Photolithography is a key step that involves transferring the chip's transistor design onto the wafer. A photosensitive material, called photoresist, is applied to the wafer's surface. The wafer is then exposed to ultraviolet light through a mask that contains the desired circuit pattern.
Etching	After photolithography, the wafer undergoes etching to remove the exposed parts of photoresist. Etching can be either a chemical or physical process, selectively removing materials from the wafer to create the desired pattern.
Doping	Doping is the process of introducing impurities into the silicon wafer to modify its electrical properties. Depositing specific atoms onto the wafer's surface creates regions with different conductivity, which is crucial for the functioning of a transistor.
Deposition	Deposition involves depositing thin layers of various materials like metal, oxide, or polysilicon to create interconnects, insulating layers, or transistor gates.
Metallization	Metallization is the process of creating metal interconnects to connect different components on a chip.
Testing and Packaging	After fabrication, each chip on the wafer undergoes tests to ensure functionality and performance. The tested chips are then cut or sawed from the wafer, and placed in packages that provide protection and electrical connections. Packaged chips undergo further testing to verify functionality before getting shipped.

Source: Jefferies

Chip testing is undertaken after fabrication to ensure that the manufactured chips meet the required functional and performance specifications. Testing involves subjecting the chips to a series of electrical and functional inputs to check for defects, measure electrical characteristics, and verify proper functionality. Different testing techniques, such as wafer-level testing and final package testing, are employed. Chip packaging is the process of enclosing the semiconductor chip in a protective package. The package serves multiple purposes such as protecting the chip from physical damage, providing electrical connections to external circuit, dissipating heat generated by the chip, and facilitating easy integration into electronic devices.

Testing is employed after fabrication to ensure the manufactured chips meet required specifications; packaging enclosed the chip in a protective package, which provides electrical connectivity to external circuit.

Testing and packaging operations, while a critical part of chip manufacturing process, are relatively less complex and faster than fabrication. The scope of operations is fundamentally easier as these involve verifying the functionality and performance of already manufactured chips compared with much more intricate manufacturing steps of photolithography, doping and etching. The equipment and skills required for testing are also more easily accessible.

Testing and packaging, while a critical part of chip manufacturing, are less complex and faster than fabrication.

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Recommendation Published	March 3, 2025 , 07:37 ET.
Recommendation Distributed	March 3, 2025 , 07:37 ET.

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