India investing big in semiconductor manufacturing: Will this reshape global innovation and economic landscapes?

Indian Aspirations for Semiconductor Industry

In Focus

Semiconductor Aspirations

India is traditionally recognized for its excellence in software services, is now boldly venturing into becoming a prominent contender in the global semiconductor industry. With this industry projected to surpass a market size of $600 billion worldwide by 2026, it presents a lucrative opportunity for India to expand and enhance its presence in the high-tech sector.

The country has strategically forayed into semiconductor industry and at large the move is considered timely. In an era where AI is going to dominant self sufficiency in semiconductor shall serve India a world of good. Semiconductors are backbone for virtually all modern technological spaces from smart phones, wireless communication, electric vehicles to AI and the demand shall be consistently building up and reach a high in coming few years. The supply-chain disruptions are the biggest challenge for the world in production & distribution of semiconductors and currently with more geopolitical tensions in fray, India’s entry into the sector could bolster the technological sovereignty and easily position itself as a leading and crucial player in the industry. venturing into becoming a prominent contender in the global semiconductor industry. This transition from software to hardware and services to manufacturing could mark a significant turning point in India’s technological and economic trajectory.

Challenges for Semiconductor Industry in India – Semiconductor Productization

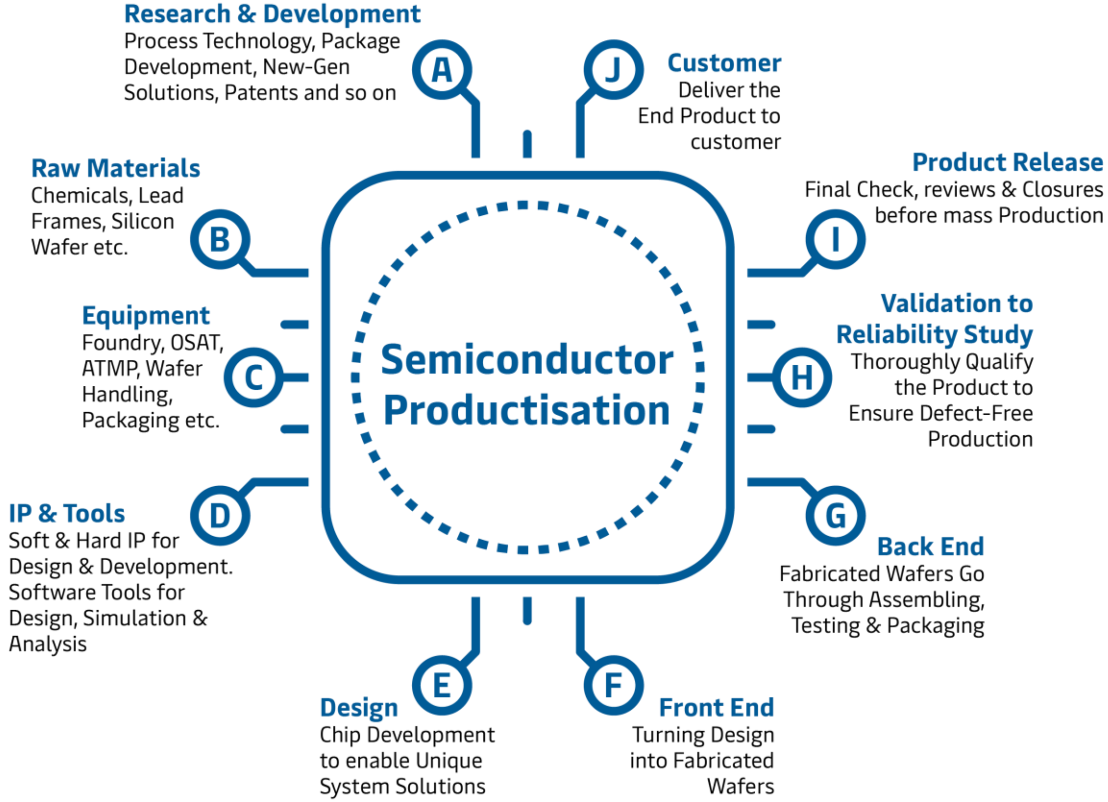
India has been home to semiconductor design center's, including startups catering quite well in research & development especially with respect to design aspect. Yet, creating a semiconductor product entails numerous stages. It requires the transformation of a silicon concept into a manufacturable product, involving various critical phases of development to guarantee a defect-free design during mass production. Ultimately, a country that can manage all these stages for 100% of the productization process domestically will spearhead semiconductor technological progress. There are multiple compelling reasons why developing a comprehensive semiconductor productization ecosystem in India is crucial for economic progress. Such an initiative would promote self-sufficiency by minimizing reliance on semiconductor imports, covering aspects from fabrication, assembly, and testing to post-tape out services. This entails providing all requisite technical support throughout these essential phases. In essence, establishing a semiconductor productization chain in India serves as a diverse catalyst for economic growth. It boosts technological autonomy, drives job creation by aligning with evolving career options beyond traditional chip designing, safeguards national interests, and positions India as a global leader in the semiconductor industry by managing the entire process domestically, from ideation to delivery.

Semiconductor Productization – What is it?

Productization of semiconductors plays a pivotal role within the silicon technology value chain by converting theoretical and technical prowess into concrete semiconductor products. This intricate process necessitates seamless collaboration among engineering, manufacturing, marketing, supply chain management, and various other domains. The goal of productization is to create semiconductor products that are not only commercially viable and responsive to market demands. As an understanding we have enlisted all the processes encompassing different stages for productization:

- ✓ **Silicon Design:** Crafting the chip's architecture, balancing performance, power, and area for targeted applications
- ✓ **Samples:** Creating initial chip prototypes for testing design theories and functionalities using the defined fabrication, assembly, and testing flow plan
- ✓ **Equipment & Hardware:** Procuring all equipment & hardware needed to validate the product including fabricated (SMT) hardware from scratch
- ✓ **Silicon Bring-up:** Initial testing of silicon prototypes to debug and optimize designs
- ✓ **Characterization:** Detailed analysis of chip performance under varied process, temperature, voltage & current profiles
- ✓ **Validation:** Rigorous specification-based testing to ensure the chip meets all specified functional requirements
- ✓ **Qualification/Reliability:** Testing for reliability under different stress conditions and lifespans
- ✓ **Compliance:** Ensuring the chip adheres to industry standards and regulatory requirements
- ✓ **Production Release:** Finalizing design and specifications for manufacturing readiness, and ensuring fabrication and testing flow in place

Exhibit 01 Semiconductor Productization Process – Typical Flow



Source: eninrac research & McKinsey

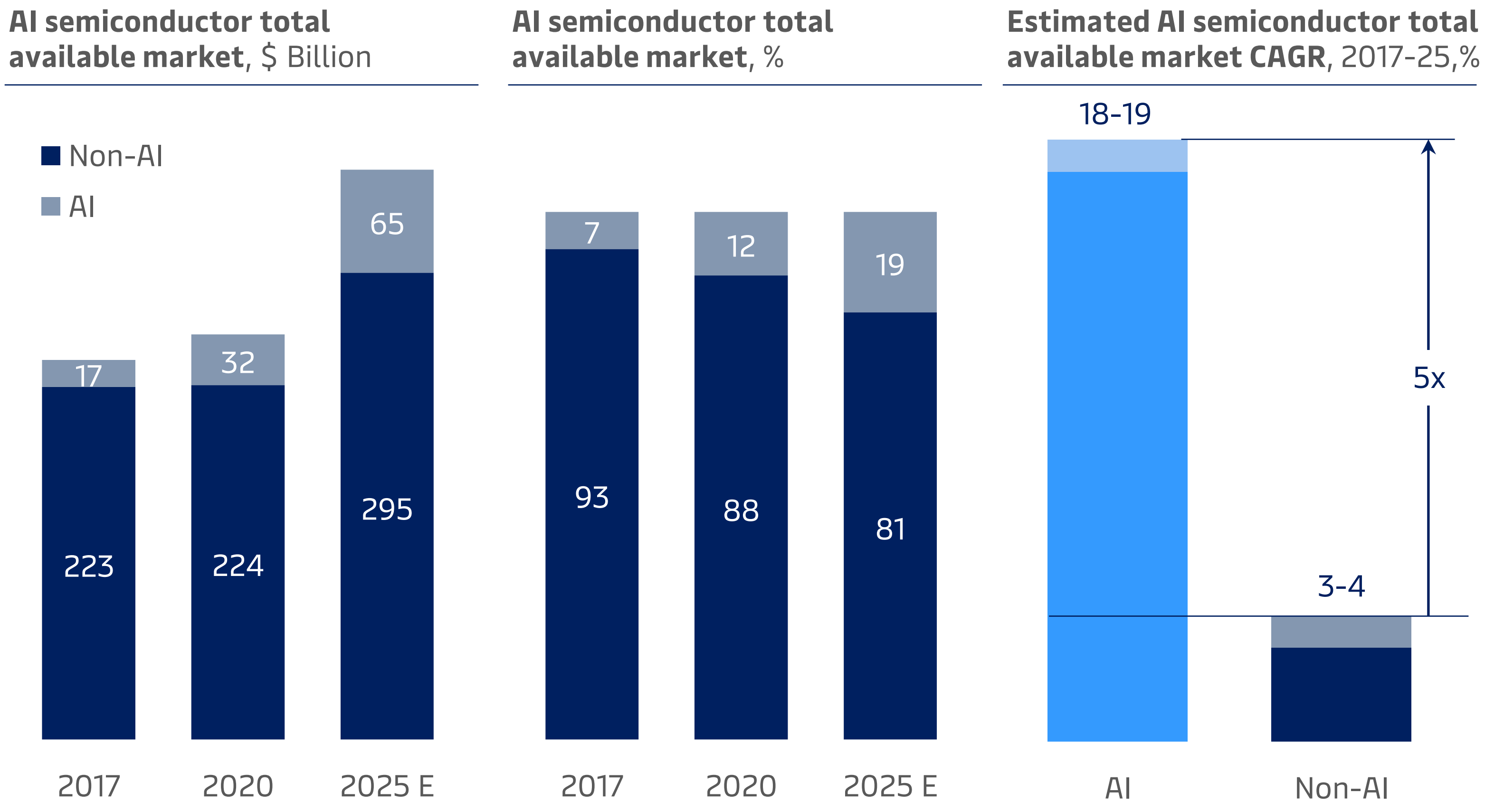
- ✓ **Mass Production:** Scaling up manufacturing for large-volume, cost-effective chip production
- ✓ **Distribution:** Efficiently distributing chips via seamless logistics flow
- ✓ **Support:** Ensuring mass-produced chips receive proper support if customers face any issues

Why AI will be the biggest driver for Semiconductor Market in India?

AI will drive a large portion of semiconductor revenues for data centers and edge

With hardware serving as a differentiator in AI, semiconductor companies will find greater demand for their existing chips, but they could also profit by developing novel technologies, such as workload specific AI accelerators. Our research revealed that AI-related semiconductors will see growth of about 18 percent annually over the next few years—five times greater than the rate for semiconductors used in non-AI applications. By 2025, AI-related semiconductors could account for almost 20 percent of all demand, which would translate into about $65 billion in revenue. Opportunities will emerge at both data centers and the edge. If this growth materializes as expected, semiconductor companies will be positioned to capture more value from the AI technology stack than they have obtained with previous innovations—about 40 to 50 percent of the total.

Exhibit 02 Growth for semiconductors related to artificial intelligence (AI) is expected to be five times greater than growth in the remainder of the market.



Source: eninrac research & McKinsey

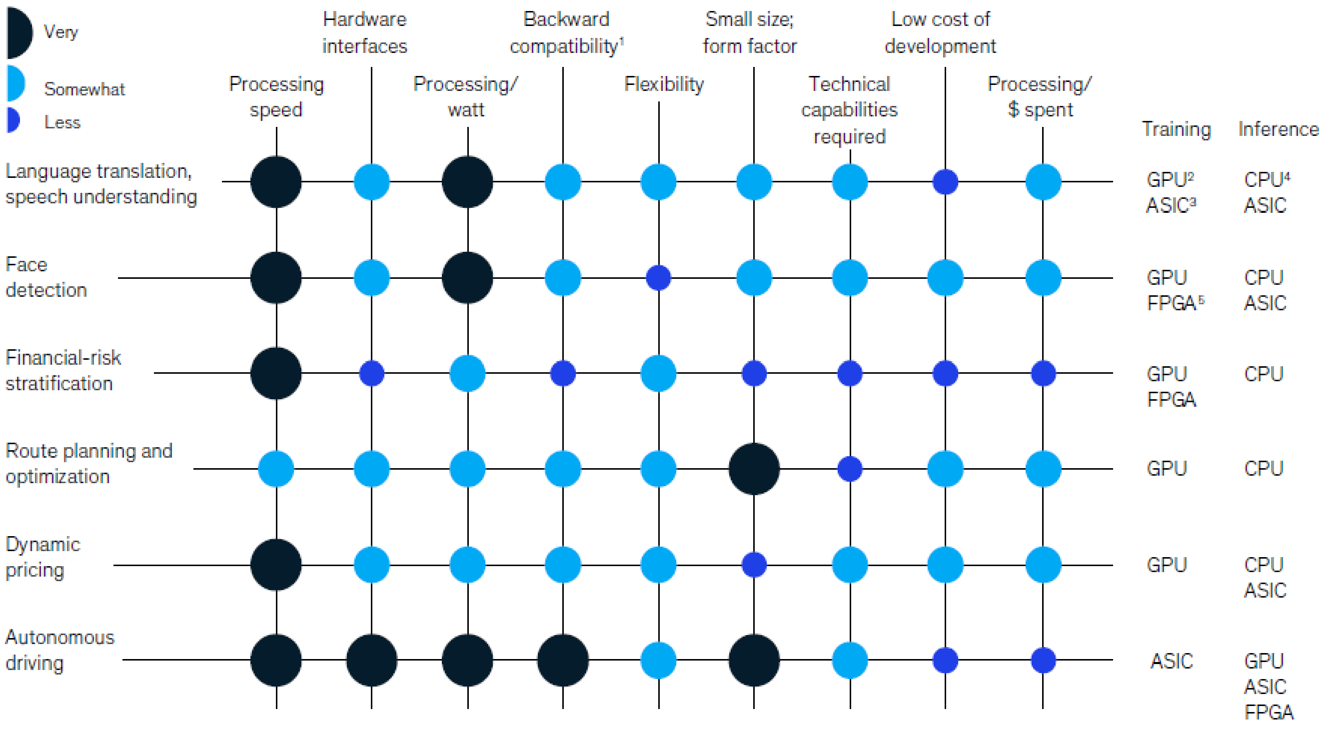
AI will drive most growth in storage, but the best opportunities for value creation lie in other segments

With respect to specific opportunities for semiconductor players within compute, memory, storage, and networking, hardware demand is evolving at both data centers and edge.

Data-center usage. Most compute growth will stem from higher demand for AI applications at cloud computing data centers. At these locations, GPUs are now used for almost all training applications. We expect that they will soon begin to lose market share to ASICs, until the compute market is about evenly divided between these solutions by 2025. As ASICs enter the market, GPUs will likely become more customized to meet the demands of DL. In addition to ASICs and GPUs, FPGAs will have a small role in future AI training, mostly for specialized data-center applications that must reach the market quickly or require customization, such as those for prototyping new DL applications.

Edge applications. Most edge training now occurs on laptops and other personal computers, but more devices may begin recording data and playing a role in on-site training. For instance drills used in O&G exploration generate data related to a well's geological characteristics that could be used to train models.

Exhibit 03 The optimal compute architecture will vary by use case



[1]Can use interfaces and data from earlier versions of the system
[2]Graphics Processing Unit
[3]Application specific integrated circuit
[4]Central Processing Unit
[5]Field Programmable Gate Array

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