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FUTURE OF SEMI-CONDUCTORS INDUSTRIES IN INDIA

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Abstract

Importing chips is a major barrier to the country's strategic sector becoming self-sufficient in the modern era. The current trend of chip development at nanoscale geometry requires significant and ongoing capital expenditure, which is not feasible at this time. The country needs to make the best use of the technology that is now available to meet its needs for achieving self-reliance in strategic sectors. The creation and implementation of such mechanisms that can lead to national independence are the main barriers in the nation. Despite the government's unwavering backing, we are still far from being able to support ourselves on the current technology node. The function of trade policy in the current Indian setting is discussed in this study. India now has a sizable domestic market but relies heavily on imports of semiconductors. The nation has a small number of semiconductor manufacturing facilities despite having a strong workforce that is noted for its expertise in tech engineering and semiconductor design. There is plenty of space to expand the domestic ecosystem and raise India's standing internationally. This article will highlight the foundry complexity, the country's current situation, remedial procedures, and a suggested framework for developing a semiconductor-friendly environment in the nation.

Keywords: *Semiconductor industry, Self-Relaince, Fables Foundary, Technology Upgradation*

INTRODUCTION

The Integrated Circuit (IC) gadgets play very essential function in present day society of electronics device design, from business packages along with pc managed software and operated equipment to mechtronics, microwave telecommunication, and every day computing needs. In today's world we can't think for a single minute without semiconductor chips embedded gadgets in our day-to-day life by making it pleasant, smooth, safer and healthier. The integrated circuits penetrated in our daily lives such as cell phone, DTV, notebook, tablet, digital camera, LED. Electronics consumption worth 37 billion dollar (58%) is imported by the country where major part is of semiconductor devices. Countries such as China and Taiwan are the hub of manufacturing with over 60% share in the world market but India is way behind as we are operating with fables foundries. Despite the fact that the country has 120 chip design companies, 20,000 chip designers, and 2,000 chips that are designed domestically, the fabrication of these chips is done by an outside foundry. Under the recently introduced Make in India initiatives by the Indian government, the current Semiconductor Policy is anticipated to encourage players to invest in semiconductor fabrication. The growth of both the FAB and the ecosystems unit is outlined in this policy. For its space programme and defence, India has so far relied on chips produced by Bharat Electronics, Hyderabad's Gallium Arsenide Enabling Technology Centre, and Mohali's Semiconductor Complex Ltd (SCL). GaAs chips are provided by the DRDO lab GAETEC for extremely specific radio frequency communication applications. The development of high-end ASIC and FPGA, which are prerequisites for building high-end circuits, is primarily being driven by silicon foundries.

LITERATURE REVIEW

1. **Data processing marketing Scenario**

   Good software design has always been produced in India, which is why so many investors come here. India also holds a dominant position in the lucrative data processing business which attracts significant investment.

2. **Computer Chip Technology**

   Today, employing technology is practically necessary for survival, and every piece of modern facilities has a chip installed in it somewhere. They are extremely small integrated circuits, sometimes known as wafers, that serve as memory units and information processors. In addition to being utilised in phones, cars, televisions, GPS systems, ID cards, and even people's hands, computer chips are also being implanted in order to do household activities like opening a safe or the wine cellar. Due to the way transistors function in microchips, which act as little electrical switches to turn a current on or off, several activities are possible (Kohls et al. 2020). Depending on the number of microchips are within a computer (or phone, or car, etc.), the processing power is determined. The processing power in a computer (or phone, or car, etc.) is decided. They are the epitome of something small but mighty, and Moore's Law states that they will only continue to get smaller. This is significant because it means that, when they halve in size, twice as many chips may now fit into the same area.

3. **Semiconductor Manufacturing in India**

   Despite having a weak fab infrastructure, India is a frontrunner in semiconductor R&D. A huge, reliable power supply, a lot of water, and the availability of essential elements like silicon are all needed for fabs. India has chosen to concentrate on R&D and semiconductor design due to a lack of essential resources and inadequate infrastructure. A multi-billion dollar semiconductor design sector has been nurtured in India attributable to a sizable talent pool of IT design and R&D engineers. To be competitive on a global level, the Indian government is planning to make significant investments in the semiconductor industry. Because building fabs requires a lot of resources, the Indian government is searching for foreign funds to finance new fab operations in India (Kapur 2021).

   India only has a few state-owned manufacturing units that serve the demands of the defence and space industries, despite numerous attempts to establish fabrication facilities there. The SCL plant has upgraded to manufacture the 8" wafer fab to create 180nm chips with assistance and investment from Israel's Tower Semiconductor. 29 However, the lack of private funding to build a semiconductor manufacturing facility shows that incentive-based policies have not been successful. There are still concerns about whether a foreign semiconductor foundry would be prepared to invest in a fab in the nation even with the new package of regulations for the semiconductor industry.

   There are now three government-owned fabrication plants in India that only produce materials for space and defence applications. The current policy is focused on improving chip production because it is trailing in commercial applications. The Indian government has taken measures, such as giving early funding and developing investment incentives, to promote growth in semiconductor design and manufacture (Mamidala 2021). A recent Expression of Interest (EOI) was released by the Ministry of Electronics and Information Technology to encourage the expansion of fabs within India and the purchase of fabs outside of the nation.

The EOI requests applications for projects to establish or grow fabs in India or to enable the purchase of facilities outside of India (Kapur 2021).

4. **Import Restrictions**
   Many economies, including India, still impose import limitations. The Indian Cellular and Electronics Association, a business organisation made up of the heads of significant domestic companies, reminded the public after the government announced the semiconductor package that import tariffs for semiconductors continue to be high and that there are still some restrictions in the form of sensitive technologies and high tariffs. Thus, emerging semiconductor producers face the challenge of balancing domestic firms and acquiring state-of-the-art equipment and technologies by facilitating imports.

5. **Communication Industry**
   The fast expansion of the laptop and cell phone markets is also beneficial to the production of semiconductors. The host firms are in need of skilled FABs and chip designers. In order to provide innovative and cutting-edge features in their goods, manufacturers of electronics and mobile devices have expanded the complexity of chip design.

6. **Automotive Industry**
   The development of smart vehicle applications by automakers has accelerated the semiconductor content per vehicle growth in the automotive sector. Automotive integrated design has a sizable number of foreign clients. Additionally, because the automotive industry is so large, it will always be a valued partner.

7. **Aspects for Semi-conductor Ambience**
   The nation's semi-conductor fab situation needs to be completely overhauled. The following are some of the various impairments in this area:

- Recurrent breakdown of the tools;
- Specific raw materials;
- Raw material expiration due to low volume;
- Awaiting for raw material;
- Disposable of Hazardous Waste;
- Maintenance and upkeep;
- Low yield;
- Improper documentation and record;
- Clarity and planning;
- Guidance and team building effort;
- Working environment;
- Targeted goal towards self-reliance;
- R and D activities and initiation of new developments;
- Other obstacles that impede the development of the semiconductor environment in the nation include a lack of indigenization activities, repair skills for tools, and a careless attitude to planning and implementation.

OBJECTIVES

- To promote establishment of FAB units in the country.
- Challenges faced by semiconductor FAB industries.

TO PROMOTE ESTABLISHMENT OF FAB UNITS IN THE COUNTRY

Wafer design industry key drivers

India has a tough challenge ahead of it: demonstrating its dedication to developing the semiconductor industry. Capital-intensive industrial policies may encourage bids and investments, but advantageous trade policies and a supportive business environment can ensure that the projects are completed and produce the desired results. This strategy may eventually draw additional foreign semiconductor companies. India can achieve its objectives by implementing the following policy suggestions.

Overhaul of trade policies

India's must change its approach with foreign trade policy and make it more accommodating to the technology sector. It is necessary to end current mercantilist and trade practices that jeopardise the principles of industry-wide, competitive markets. This may involve lavish domestic sector subsidies that impede foreign businesses from making investments in the nation. Furthermore, participation in international forums and multilateral trade organisations that might promote the expansion of the semiconductor industry requires government involvement. These organisations consist of:

The World Semiconductor council (WSC)

The WSC is an international forum bringing together semiconductor leaders and technical experts to address global issues concerning the industry. To be heard among the world's leading manufacturers of semiconductors, India should join the Council. The Council strongly supports free trade and is governed by the values of justice, adherence to market norms, and conformity to WTO regulations. The WSC also acknowledges the significance of open markets free from discrimination and holds that the main determinant of business success and global commerce should be the competitiveness of firms and their products.

Any aspiring member must meet one of the two criteria regarding tariff elimination. The first is the complete abolition of tariffs. Second, a commitment to eliminate all tariffs on semiconductors or to suspend such levies until they are formally eliminated.

The 2015 ITA Expansion

It is in India's best advantage to formally sign the extended ITA. By doing this, the domestic sector would have access to products with zero tariffs that are relevant to the semiconductor sector. Additionally, it would aid new businesses and domestic producers in increasing their export volume. Strategic industries like semiconductors might be at the forefront of India's international trade due to the wide range of technology items offered by the ITA.

Promote a tech transfer and IP protection regime

India should lead the global semiconductor sector in establishing a mechanism for the protection of intellectual property (IP) related to the semiconductor industry and support a close-knit framework for the promotion of technology transfer agreements in the semiconductor domain. For prospective investors and the semiconductor industry giant, this would provide adequate protection. India can start by introducing and ensuring the enforcement of strict rules against IP

theft and other regulations in the semiconductor industry. Enforcement can include restricting any firm in violation of said rules and regulations from participating in the markets. Prevention of exports, restrictions on domestic operations, and levying fines or penalties for specific firms violating IP theft guidelines will ensure innovation-based competition in the long run.

Foster multilateralism as a necessity for resilience

The Indian government should have a particular area of focus to guarantee a smooth transfer of semiconductor technology, perhaps by forming industry-specific technology alliances. Technology alliances may be the future of diplomacy in the information era. Distributing semiconductor technology across several states via technology transfer agreements can mitigate current vulnerabilities as a result of supply chains experiencing bottlenecks. India may contribute to facilitating technology transfers to its domestic industry in order to strengthen its local ecosystem and the global value chain.

Availability of Electronic Grade Silicon

The simple accessibility of single crystal silicon wafers that have been purified is a major element of chip manufacturing. Other industrial uses for silicon include the casting of aluminium and refining of steel. The availability of single crystal silicon wafers will assist India in producing the solar cells necessary for our energy security in addition to chip manufacture. India imports solar cells and modules from other nations.In order to change this, India needs to produce its own pure silicon. The silica rocks needed to make silicon wafers are abundant in India. .Worldwide demand for silicon wafers is increasing and India has the potential to be a major supplier just as we are a global supplier of pharmaceutical products.

Energy requirements

The requirement for semiconductor manufacturing facilities to have a significant, uninterrupted power supply is crucial from an Indian perspective. Nearly 47.3% of India's 3,79,130 MW of installed capacity is produced by private operators. Private businesses can play a significant role in providing the necessary power supply for the semiconductor fab facilities. In India, semiconductor facilities can also use solar PV systems to produce on-site electricity to meet significant part of energy requirements.

Water

Semiconductor fab facilities are also water intensive. In India, there are roughly 4,000 billion cubic metres of precipitation each year (BCM). The estimated utilisable surface water resources, excluding groundwater, total just 690 BCM (cwc.gov.in). Our urban and rural areas are already water challenged because we only have 4% of the world's freshwater resources and have around 20% of the world's population. India's freshwater resources are utilised for agriculture to the tune of 78%. In order to address the needs for drinking, residential, and agricultural water, greater water management is consequently required while establishing semiconductor manufacturing facilities in India. State governments will need to take the initiative to save their water supplies so that enough water can be delivered to the semiconductor manufacturing facilities in their state without upsetting the local population.

Design capabilities for chips

India is home to all of the top semiconductor manufacturers' fabless intellectual property (IP) and system-on-chip (SoC) design houses**.** Students who are trained in IITs and many NITs work in these

fables companies. Through the Special Manpower Development Programme, thousands of engineering students received training in VLSI design and associated fields over the past ten years (SMDP). The Government of India's Technical Education Quality Improvement Program (TEQIP) is another initiative to expand the talent pool for designers. To build a start-up culture, leading higher education institutions must create chances like the "Semiconductor Startup Incubation and Acceleration Program" and support their staff members and students with seed money and mentoring, as IIT Hyderabad has recently done. These indigenous start-up fabless businesses can be utilised to design chips for domestic consumption, which is expanding quickly due to India's burgeoning digitization.

Collaboration between Business and Academia

There is now the potential for a better symbiosis between industry and academia in designing curricula to meet the needs of semiconductor companies in India thanks to the recently unveiled National Education Policy, which places a greater emphasis on flexibility, multi-disciplinary approach, research, and innovation in India's higher education landscape**.** Many higher education institutions in India have begun offering courses in chip design and technology. However, we must involve the numerous universities dispersed around India in order to scale up this experiment.

CHALLENGES

Lack of Semiconductor Manufacturing Ecosystem

- The several electronic appliances companies have insufficient experience in the field of electronic parts manufacturing. We don't have active manufacturing corridor for ecosystem. Unless this gap is bridged, the ecosystem can't become active.
- The lack of Original Design Manufacturer or Original Equipments Manufacturer companies that can manage the in-house demand of electronics products.

Human Resource Linked Challenges

(a) Quality of engineering graduates available

- **New Engineers**: The absence of cooperation between businesses and educational institutions poses a serious issue right away. The course curriculum needs improvement in order to meet industry demands. The absence of necessary skills among engineering graduates is the outcome of this gap. This signifies more advanced training cost and the length of time it takes for a new engineer to start producing for the company. When a qualified engineer departs a company for an attractive offer, the issue gets worse.
- **Lack of technical experience**: Businesses struggle with a lack of experience when it comes to having a thorough understanding of design approaches.
- **Ease in digital design:** India has significant capabilities in digital and software technologies, but it still lacks conceptually sound engineering graduates who can achieve the same level of ease in analogue design.

(b) Lack of valuation to technical people

In India, more value is given to management people in comparison to technical sound people. This is exasperated by salary differences between technical and management staff with same length of experience**.**

Competition in manufacturing and e-design with Taiwan, China, and other nations

These nations already have a fully developed ecosystem that has grown over the past 35 years due to to a structured base of original equipment manufacturers and original design makers, strong

government support, efficient policies to prevent investment insecurity, top-notch infrastructure, uninterruptible power supplies, etc. These elements make these nations attractive to investors, even in the area of design-related businesses.

RESULTS AND DISCUSSIONS

Computer chips are crucial component of contemporary technology. Because so many common products and equipment depend on chips to operate, chip shortages have a significant impact on the whole global supply chain. Design, fabrication, and ATP are the three main stages of semiconductor production. A ready supply of silicon or other semiconducting materials, as well as dependable, ample sources of water and power, are necessary for the fabrication of semiconductors. Integrated device manufacturers (IDMs), fabless, and specialised foundries are the three processes used to make semiconductors. IDMs have struggled to expand their capacities and stay up with the specialised foundries' rapid technical advancement. The fabless-foundry concept, developed in collaboration with specialised foundries and fabless manufacturers, reduces some of the entrance hurdles for smaller design businesses.

India is a nation that is on the rise in the semiconductor industry. India has a robust R&D and IT sector that is a global leader in semiconductor design, much like the United States. Insufficient infrastructure prevents India from supporting fab plants. However, with a stronger legislative emphasis on fostering the expansion of the semiconductor industry, India's government is emerging as a potential role model for other nations lacking in fabs. In an effort to establish India as a significant role in the future of the semiconductor industry, the Indian government is providing significant incentives for foreign investment to create a more robust fab infrastructure.

Reshoring production is one way to enhance the semiconductor supply chain. Chip fabrication has benefited from low manufacturing costs abroad from both IDMs and fabless businesses. Less vertically integrated supply chains, on the other hand, may struggle to maintain a consistent supply of chips during times of global crisis because their manufacturing is spread abroad. Mathematical models have been considered as a more analytical method of examining the frequency of shortages. By using mathematical models, supply chain design can be improved while shortfall frequency is reduced.

CONCLUSION

India is now the third-largest market in the world for electrical goods. The market for electronic goods has exceeded all expectations. Over the past twenty years, the market for computers and smartphones has experienced significant expansion**.** The Government of India has recently approved setting up of two Semiconductor Wafer Fabrication Manufacturing facilities in India with the help of two business consortia. This phase is a motivating element in the Indian industry's roadmap to become a centre for semiconductor manufacture as far as the seeds of manufacturing are concerned. Recently, the Singapore Semiconductor Industry Relationship and the India Electronics and Semiconductor Association (IESA) signed a Memorandum of Understanding (MoU) to establish and grow a commercial and technical association between the two nations. In the global EDSM industry, Singapore and India are both regarded as significant markets, and businesses from both nations are interested in setting up production facilities here. India has three government-owned, modest fabs: SITAR in Bengaluru, the DRDO-owned Gallium Arsenide Enabling Technology Centre (GAETEC) in Hyderabad, and the Department of Space's Semi-Conductor Laboratory (SCL) in Chandigarh. These laboratories create chips only for the demands of the

military and the space industry. India, meanwhile, is stepping up efforts to grow its semiconductor industry as a strategic necessity and hopes to become an electronics manufacturing hub worth $400 billion US by 2025. By offering incentives for the establishment of foundries in India, India is diligently working to expand its capacity in the chip design and production ecosystem through its National Policy on Electronics (NPE2019). The Ministry of Electronics and Information Technology has released an Expression of Interest (EoI) for the establishment of chip manufacturing facilities in India as well as the acquisition of such facilities abroad. It is a good moment for Indian business leaders to take advantage of this opportunity and team up with foreign partners to build such facilities in India. A recent example is the joint attempt by Tata Group and Apple to establish a facility in Tamil Nadu for the fabrication of phone components by utilising the government's production-linked incentive (PLI) programme, which was revealed last year.

Understanding the importance of trade and knowledge transfer in developing semiconductor industry will be beneficial for India. The technology transfer agreement with the US served as the semiconductor industry in Taiwan's foundation. Taiwan's liberal and open trade policies in the 1960s allowed state-funded foundries like United Microelectronics Corporation (UMC) and Taiwan Semiconductor Manufacturing Company (TSMC) to expand as Taiwanese engineers gained technological proficiency as a result of the agreement. Taiwan became a superpower in the semiconductor industry due to a gradual rise in private investment and greater access to foundry supplies and machinery. India and other emerging semiconductor powers can achieve greater heights by imitating Taiwan's semiconductor sector in the areas of commerce and technology transfer.

India is seeking solar energy as the future of the world. To address the needs of the nation's economic and strategic needs, solar cells require a semiconductor fab. The isolated fabs ought to join the group so that knowledge may be shared.
To summarise, The road to India's success as a global hub of semiconductor chip manufacturing looks promising and within reach thanks to the government of India's supportive policies, rising domestic demand for electronic products, rising number of entrepreneurs in the area of fabless semiconductor companies, and availability of a large pool of local design talent. The government's backing and effective policies will be combined with our efforts to establish a welcoming environment for all investors and technology partners. A thriving electronics manufacturing industry in India would boost our economy and position our country as a global leader in the industry.

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