



INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

Role Of Semiconductor Industry In Indian Economy

¹Lavita Sarma

¹Assistant Professor

¹ Department of Physics

¹ Jagiroad College, Jagiroad , Morigaon , Assam, India

Abstract: Semiconductor is the foundation of growth of almost all the economies in the world. Modern equipment and sectors like Aerospace, Automobiles, Communication, Energy, Medical devices, Information Technology, Digital Infrastructure and all the electronic devices are built on semiconductor-based chips. The Semiconductor industry will have tremendous impact on economic growth and development, technological advancements and in creating multiple job avenues for a country. Taiwan, South Korea, Japan, the United States of America, and China are currently the top producers of semiconductor chips and electronics. Regarding versatile applications of Semiconductor-based fields and their impact on sustainable development, the Semiconductor Industry also has a great potential in India. The demand for global semiconductor chip requirements is far more than its supply. India does not yet have its own semiconductor manufacturing and fabrication facility and is importing a significant quantity of microchips from other countries. With prodigious expectations India's proposed Semiconductor Industry is a key part of the vision for Viksit Bharat by 2047. India will play a role primarily in the design, assembling, testing, and packaging of semiconductors. Government of India is now initiating various programs such as the Production Linked Incentive (PLI) scheme, the Design Linked Incentive (DLI) scheme and others to make the project a successful one. But when it comes to fabrication, India's projected semiconductor industry may face many challenges like substantial capital investment, skilled manpower, ability to face robust competitors. However, effective implementation of the schemes and strong leadership will create a good ecosystem for the Semiconductor Industry in India through which India will become a global leader and superpower of the world soon.

Index Terms: Semiconductor Industry, Viksit Bharat 2047, Production Linked Incentive, Global Leader

1. Introduction

Semiconductors may form the backbone of an economy as this industry plays a vital role in producing end-user products like, automobiles, computers, mobile phones, digital cameras, televisions, home appliances like washing machines, refrigerators, LED lights, modern cars, vital medical equipment etc. In all these, semiconductor chips are the integral parts of it. Seeking the requirement for semiconductors in various essential sectors and machines, governments or industrialists all across the globe are investing more in the production of chips. The industries are growing tremendously year after year. The global semiconductor industry is projected to increase by 13.1% in 2024 and the market size was valued at \$574 billion in 2022; this is the highest annual total ever realized. To develop its own semiconductor value chain to become a global leader and to fulfil the vision of Vikshit Bharat, 2047 government of India has sanctioned number of schemes and programs. For commercializing and increasing semiconductor industries output the India government schemes have been designed strongly to focus on "Digital India". The objective of this studies is to understand the basic concept of semiconductor, upcoming semiconductor industries in India and its impact on in Indian Economy

2. Literature Review

Pranay Kotasthane and Arjun Gargeyas (2022) in their study “Harnessing trade policy to build India’s semiconductor industry” talks about the extent of trade and knowledge transfer in developing countries, which is important to assure how the semiconductor industry will be beneficial for India. The foundation of the semiconductor industry in Taiwan started with the technology transfer agreement of Taiwan with the US. 1960s Taiwan's free and open trade policies allowed state-funded foundries like United Microelectronics Corporation (UMC) and Taiwan Semiconductor Manufacturing Company (TSMC) to expand, as Taiwanese engineers gained technological expertise as a result of the agreement. As a result of continuous increase in private investment and greater access to machineries and plant supplies, Taiwan became a global powerhouse in the field of semiconductor manufacturing industry. India and other evident semiconductor manufacturing hubs can reach new heights by imitating Taiwan's semiconductor sector in the field of technology and business transfer. Study made by Himanshu Kushwaha and Anil Sethi, on “Future of Semiconductor Fabrication (FAB) Industries in India -Opportunities and Challenges (2017)” stated that, in the coming years, demand for electronics items in India is going to rise and the cost of semiconductor devices will increase to many billion dollars. At this time, many business units are engaged in design but they don’t have on-site fabrication facilities. Presently, for design projects they are mostly dependent on foreign FABs (Foreign Units). A growth-oriented and well-maintained eco-system established by the central government can help to increase manufacture semiconductor wafer fabrication and R&D units in India. Prof. Mamidala Jagadesh Kumar (2021) in his Research study “Is India going to be a major hub of semiconductor chip manufacturing?” talks about the potentiality of India to become a major centre for manufacturing of semiconductor chips. India has ability to design and produce semiconductor chips and finally meeting the demand for semiconductor chip production. It has the capability and required skills to assist in the creation of solar cells, energy needs, water availability, silicon of an electronics grade. A good cooperation between business and academia is needed. The article assures that India has the capability to become a global centre for semiconductor chip production. Effective government's policies, rising domestic demand and entrepreneurship and finally increased skilled local designers will contribute India to become a global hub and leader in the upcoming years.

3. Objective of the study

To discuss about technological fragment of Semiconductor and Semiconductor Industry

- To discuss how semiconductor industry will work as a milestone for Vikshit Bharat,2047
- To study the impact of semiconductor on economic growth and development, technological advancement and creation of multiple job avenues of a country.
- To learn about the schemes and initiatives taken by the government of India to promote the semiconductor industry in India.
- To identify the challenges that industries will have to overcome

4. Research Methodology

This research paper is purely based on the available secondary data. Data is collected from various publications of the central government, state governments, various publications of foreign governments, international bodies and their subsidiary organizations, previous research paper, articles, magazines and the data available from authentic websites and published data available in open sources.

5. Discussion

5.1 Technological fragment of Semiconductor and Semiconductor Industry.

To capture global marketing domain, all product from semiconductor-based materials processed in semiconductor industry should have low power consumption, smaller in size, high speed, lightweight and cost-effective devices based on integrated circuit. This integrated circuit consist of semiconductor materials. A substance which has the conductivity range in between conductors and insulators is known as semiconductor material. They may be pure substances like silicon or germanium or may be the mixtures like gallium-arsenide, or cadmium-selenite, etc. Although these materials are insulator in room temperature but conductivity of these materials can be manipulated by different processes according to applications. Usually current is carried by free electrons in case of conductor in a circuit. In case of semiconductor due

to its crystalline nature it can be made as intrinsic (electron and hole as charge carrier) or extrinsic nature where holes as charge carrier in p-type and electrons as charge carrier in n-type by adding pentavalent and tetravalent material with pure silicon and germanium or other semiconductors. For one-directional current passing, response to heat and light, a semiconductor can be used in diode, transistor, integrated circuit, light emitting diode, solar cell, storage device, communication ICs, microprocessors. Semiconductor manufacturing processes are involved in Wafer Fabrication, packaging and assembly. Silicon wafers are transformed through processes like photolithography, etching, and doping to create complicated patterns and layers to form integrated circuits. The photolithography process is used to draw the circuit pattern on the wafer's surface followed by selectively remove unwanted materials from the wafer surface by etching. After that Physical vapor deposition and/or Chemical vapor deposition Techniques are used to form transistor and other components on the wafer surface. Ion Implantation process is used to modify silicon's electrical properties by doping. To remove imperfections and excess material Chemical/Mechanical Polishing is used. For this fabrication part Government of India has established three units in Gujarat under Viksit Bharat. Finished chips connected to external circuit and packaged properly. To ensure quality product Packaging, an assembly and testing unit is established in Jagiroad, Assam. To maintain quality control there will be need of skilled manpower specially cleanroom technician, process engineer, lithography engineer, quantum computing engineer, skilled manpower on AI, ML etc. and researcher to adopt fast changing technology specially nanotechnology in global platform and marketing potential. Moreover, high capital investment is required for establishing clean room for fabrication. At present cost of ISO 6 Clean Room is about Rs 4000/square feet.

5.2 Viksit Bharat: 2047 and Semiconductor Industry

Techade of India ensures the commitment to enter the digital age to create new job avenues, upgrade the quality of life, establish its strong presence in the global technology landscape, and ensure sustainable development. India's semiconductor industry is a key part of its vision for "Viksit Bharat" by 2047. The country is working to become a global leader in the semiconductor industry and to create a strong presence in the global technology landscape. In this regard here are some of the recent developments in India's semiconductor industry. On March 13, 2024, government of India virtually laid the foundation stone for three semiconductor projects worth about Rs 1.25 lakh crore. For this the Government of Assam and Tata Group promoted the setup of a semiconductor unit in Jagiroad in the district of Morigaon, Assam by signing a 60-year lease agreement for 170 acres of land. The Outsourced Semiconductor Assembly and Test (OSAT) facility will be located at the site of the inoperative Hindustan Paper Corporation Limited and will be known as Tata Semiconductor Assembly and Test Pvt Ltd (TSAT). The government will invest Rs 27,000 to set it up. The project is going to be completed by mid-2025, This unit is expected to produce up to 48 million semiconductor chips per day, employing advanced packaging technologies like flip chip and Integrated System in Package (ISIP). Moreover, in Dholera, (Gujarat) Special Investment Region (DSIR), Tata Electronics Private Limited (TEPL) will set up a semiconductor fabrication facility. The capacity of this facility will be 50,000 wafer per month. Thirdly, with an investment of about Rs 7,500 crore, CG Power and Industrial Solutions Limited will set up another Outsourced Semiconductor Assembly and Test (OSAT) facility in Sanand, Gujarat.

5.3 Impacts

The aim of The Indian Semiconductor Mission (ISM) is to build an environment that is sustainable semiconductor and ecosystem-based. This will rank India as a global leader in terms of electronics manufacturing as well as design. Semiconductors have a significant impact on economic growth and development, technological advancement, and the creation of multiple job avenues in a country. It helps in bringing technological advancements in many ways.

5.3.1 On technological advancement

Semiconductors are the root of all electronic components that are used in many consumer electronics items such as computers, smartphones, televisions etc. Moreover, the integration of physical and digital systems that helps to improve connectivity between machines, systems, and networks is enabled by semiconductor chips only. Semiconductors are the most required component for transistors, integrated circuits, and solar cells. The industry has seen rapid advances in computing technology. It predicts the period of time that the number of transistors on a chip will double (Moore's Law). Semiconductors support AI and machine learning algorithms which can make intelligent decisions in real-time basis. The enhancement of 5G/6G technology has increased the demand for semiconductors that can support higher data speeds and increased connectivity among various systems. Integration of physical and digital systems can be used to create smart factories. This is made possible by semiconductors. Moreover,

semiconductors have the potential to play a role in advance in quantum computing. In the medical field also, semiconductors have the possibility to play a significant role in advances in electronics. Semiconductor companies are also collaborating with various high-tech companies, automotive manufacturers, and research institutions to facilitate innovation and increase product offerings.

5.3.2 On Job Creation and Skill Development

The semiconductor industry being a capital-intensive has the potential to create high-quality jobs and drive skill development in India. More importantly, it can spur the development of a skilled workforce in cutting-edge technologies. The specialized skills areas like nanofabrication, chip design, and advanced packaging are likely to boost STEM (science, technology, engineering, and mathematics) education and research in Indian institutions as per the industry's requirements. The government of India announces a \$10 billion incentive plan to attract semiconductor manufacturing companies to India. This plan is expected to create over 50,000 jobs in the semiconductor industry in India. The OSAT, Morigaon unit beyond technological development, it will bring significant socio-economic benefits by generating 15,000 direct and 11,000-13,000 indirect jobs, contributing to regional economic growth in Assam and nearby areas. The OSAT, Gujrat facility will create up to 1,200 jobs and focus on advanced semiconductor assembly and testing. Sardar Vallabhbhai National Institute of Technology, Surat and Gujarat Technological University had collaborated with the firm to develop a skilled workforce for the sector.

5.3.3 On economic growth and development

The size of the Indian semiconductor market was worth US\$21.75 billion in 2021, is estimated approximately \$38 billion in 2023, which is projected to grow to \$109 billion by 2030. The acceleration of the semiconductor industry in India may help in the reducing country's trade imbalance by increasing exports and decreasing imports. In the coming years, it is expected that the semiconductor industry will enhance more quickly due to the increasing demand from end-user sectors as the industry is expected to produce 7 crore chips per day. With the help of semiconductor manufacturing units, countries can be in a favorable position to control the supply chain. It will not only gain economic strength but also become an investment trigger and creator of high-tech jobs. Developing economies like India are positioning themselves to grab the opportunities presented by developed countries. The National Electronics Policy (NEP) aims to boost electronic hubs for electronics system design and manufacturing (ESDM), including semiconductors. With an allocation of \$363 million to the Indian Semiconductor Mission, India is poised to attract investments from global players. The unit will be designed to cover essential sectors such as automotive, electric vehicles, telecommunications, consumer electronics, etc. The project is set to become one of the country's premier manufacturing sites. It aligns with the nation's broader goal of establishing a self-sufficient semiconductor ecosystem. As a high-capacity production site, the facility's daily output will serve both domestic and international markets, establishing India as a driving force in the global semiconductor supply chain.

5.4 Government Initiatives

The rapid expansion and reduced dependence on imports, the Indian government has implemented several initiatives and schemes that are aimed at promoting the domestic semiconductor manufacturing industry. The Semicon India program was launched in 2021 with a financial outlay of Rs 76,000 crore. The program is structured to promote the domestic semiconductor industry. Beyond just fabrication facilities (fabs), this initiative supports various sectors of the semiconductor industry extended to include packaging, display wires, Outsourced Semiconductor Assembly and Testing (OSATs), sensors, and other critical components that will create a comprehensive ecosystem. The Indian government has launched several programs to support the semiconductor sector in order to reduce the trade deficit. Some of the key government initiatives include as the Make in India campaign in 2014. The campaign intends to expand manufacturing sector in India and establish India as a manufacturing powerhouse all over the world. A number of programs have been introduced to encourage semiconductor manufacturing, such as the Production Linked Incentive (PLI) program for most of the electronics industries. The program is a remarkable initiative that dispenses a \$1.7 billion incentive package to companies that set up semiconductor manufacturing facilities in India. This new law will not only encourage semiconductor manufacturing companies but also will create indirect and professional employment opportunities. As a part of this program, qualifying businesses can get paid a percentage of their increased sales as an incentive. Last year, companies like Taiwan's Foxconn and Vedanta were drawn to the production-linked incentive program with promises of multi-billion-dollar investments in the establishment of manufacturing units for chips, which are used everywhere from vehicles to mobile phones. To further support the electronic sector, the government has also launched Design Link Incentives (DLI). Objectives of this DLI Scheme is to nurture and facilitate the growth of domestic companies, start-ups and MSMEs, facilitate import substitution and value addition in the

electronics sector, the semiconductor design infrastructure for the start-ups and MSMEs to be strengthened and facilitate easy availability. DLI scheme aims to provide financial incentives to design infrastructure support across various stages of development, disposal of semiconductor design(s) for chipsets, system on chips (SoCs), Integrated Circuits (ICs), Systems & IP Cores and semiconductor linked design over a period of 5 years. Apart from this, the government has also launched other schemes such as Chip to Start-up (C2S) and Electronic Components and Semiconductor Promotion Scheme and Electronics Manufacturing Clusters (EMCs). Under EMCs programme the government of India to provide a favorable environment for semiconductor manufacturing has set up Electronics Manufacturing Clusters across different parts of the country. These clusters offer infrastructure, common facilities, and a supportive ecosystem for companies in the semiconductor industry. The government has also focused on modernizing the Semiconductor Laboratory in Mohali and implementing the Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors (SPECES) and the Production Linked Incentive (PLI) Scheme for Large-Scale Electronics. These efforts ensure support for every segment of semiconductor production, fostering an ecosystem that encompasses chip design, fabrication, testing, and assembly.

5.5 Challenges

India has a large force of skilled engineers and technical professionals who help in making it a favorable destination for the semiconductor manufacturing industry. India's growing electronics and mobile device markets create a substantial market demand for semiconductor products, increasing the potential for local fabrication. Government of India programs like the "Make in India" initiative, PLI and DLI schemes have been launched to promote domestic manufacturing, including semiconductor fabrication. Moreover, rising Investments made by several Indian companies and global semiconductor players have shown interest in setting up fabrication units in India, which can lead to prosperity in the industry. Despite of having tremendous potential, when it comes to fabrication, India's semiconductor industry faces several challenges. First, the semiconductor industry particularly its production requires substantial capital investment. To attract large domestic or foreign firms; strong government support is essential. Till today, India lacked a dedicated policy to incentivize domestic companies or to attract foreign investment for setting up semiconductor fabrication facilities. Second, it lacks workers with experience in semiconductor manufacturing, creating a significant skill gap. It is estimated that there will be required around 30,000 skilled professionals in areas of chip fabrication, VLSI design, ATMP process and advanced packaging professional. Third, India faces tough competition from established semiconductor powerhouses like Taiwan, South Korea, and China, which have built robust ecosystems of suppliers and customers. The dominance of major players like TSMC, NVIDIA, Intel, and Samsung, makes it difficult for new entrants to break into the market. Finally, the supply of critical minerals like gallium and germanium, which are crucial for semiconductor production, also poses a challenge. China controls 98% of the global supply of gallium and 68% of germanium. India will need to explore alternative materials and secure resources as part of its long-term strategy.

6. Conclusion

Despite these challenges, there is growing domestic and international demand for semiconductors, driven by the rapid expansion of information and communication technologies and the changes they have brought to our everyday lives in terms of the products and services we now consume. The geopolitical tensions surrounding Taiwan's relationship with China and the Western world's concerns about China's influence, coupled with the experience of supply chain disruptions during the Covid-19 pandemic, present an opportunity for India to position itself as an alternative semiconductor supplier. All phases of the semiconductor value chain such as research, design, manufacturing, assembly, and packaging occur in a globally integrated network. Semiconductors are highly complex products to design and manufacture and rely on a complex and global supply chain for raw materials, equipment, research and development (R&D), technology, human talent, testing, and distribution. This is a key aspect of the industry's success.

REFERENCES

- [1] Ahirwar, Atul Kumar and Jangde Virendra. 2024. A Comprehensive study on Indian Semiconductor Industry. International Research Journal of Modernization in Engineering Technology and Science, 6(2):1055-1059.
- [2] Kushwaha, Himanshu and Sethi, Anil. 2015. Future of Semiconductor Fabrication (FAB) industries in India opportunities and challenges. International Journal of Research in Engineering and Technology, e ISSN: 2319-1163.
- [3] Kotasthane, Pranay and Gargeyas, Arjun. 2022. Harnessing trade policy to build India's semiconductor industry, hinrich foundation.
- [4] Kumar, Mamidala Jagadesh. 2021. Is India going to be a major hub of semiconductor chip manufacturing? IETE Technical Review, 38(3):279-281.
- [5] Rahman, Atikur. 2014. A Review on Semiconductors Including Applications and Temperature Effects in Semiconductors. American Scientific Research Journal for Engineering, Technology, and Sciences, Volume 7(1):50-70.
- [6] Singh, Joginder and Vaid, Sourabh. 2024. The Semiconductor Industry in India - IP and Policy Updates. LeXOrbis 2024:1-40.
- [7] Nath, Hiranya K. 2005. The Rise of an Enclave Economy: India's Northeast: Development Issues in a Historical Perspective.
- [8] <https://ism.gov.in/>
- [09] <https://www.semiconindia.org/>

