Semiconductor Partnership with Singapore

For Prelims: **Semiconductor Manufacturing**, **Integrated Circuit (IC)**, **Wafer Fabrication Park**, **AI**, **STEM**, **Semiconductor Supply Chain and Innovation Partnership**, **European Commission**, **India Semiconductor Mission (ISM)**, **Production Linked Incentive (PLI) Scheme**, **Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors (SPECS)**, **Quantum Computing**, **5G**, **SEZs**.

For Mains: Significance of semiconducting devices in the Indian economy, Challenges and way forward.

Source: TH

Why in News?

During his recent visit to India, the **President of Singapore** announced plans to explore initiatives such as **semiconductor manufacturing** and developing a **semiconductor ecosystem** in India apart from participating in the creation of a **new generation of technological solutions.**

How is Singapore's Semiconductor Landscape?

- **Economic Contribution:** Singapore's semiconductor sector contributes about **8% to its GDP.**
  - It produces around **10%** of the world's **semiconductor output**, **5%** of global **wafer fabrication capacity**, and **20%** of **semiconductor equipment production**.
- **Global Semiconductor Presence:** Major global semiconductor companies have established significant operations in Singapore, covering the **entire semiconductor value chain** from **integrated circuit (IC) design to assembly,** packaging, testing, and **wafer fabrication**.
  - Singapore's four major **wafer fabrication parks** span 374 hectares and are equipped with **cutting-edge facilities.**
- **Challenges:** Singapore's semiconductor industry specializes in **mature-node chips (28 nm and above)** for automotive and consumer electronics, but **hasn't yet entered** high-end logic chips for **AI and advanced computing (7 nm and below).**

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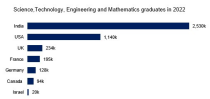
What are Key Points about India's Semiconductor Industry?

- **Market Value**: According to Indian Electronics and Semiconductor Association (IESA), in 2024, India's semiconductor market was valued at **USD 52 billion**, with projections to grow to **USD 103.4 billion** by 2030.

- **Import Dependence**: India heavily relies on imports for semiconductor devices, with imports in 2022 at **USD 5.36 billion**, compared to **USD 0.52 billion** in exports.
    - Around **85%** of India's semiconductor demand is met through **imports**.
- **Positive Factors:**
    - **Skilled Workforce**: India produces a large number of **STEM graduates**, providing a ready workforce for semiconductor **manufacturing, design, and R&D.**



    - **Cost Advantage**: India offers a significant **cost advantage** for semiconductor manufacturing due to lower labor and operational costs.
    - **Global Supply Chain Diversification**: The shift away from China, influenced by **geopolitical tensions**, has opened opportunities for **India** to become a **preferred destination** for semiconductor manufacturing.
- **Foreign Partnerships:** India has actively engaged in international collaborations to advance its semiconductor development. E.g.,
    - MoU on **Semiconductor Supply Chain and Innovation Partnership** with US.
    - Memorandum of Cooperation (MoC) on the **Japan-India Semiconductor Supply Chain Partnership** with Japan.
    - MoU between **India and European Commission.**
    - **Powerchip Semiconductor (Taiwan) and Tata Group** have partnered to build a semiconductor facility in **Dholera, Gujarat.**
- **Government Initiatives:**
    - **India Semiconductor Mission (ISM)**
    - **Semiconductor Fab Scheme** and **Display Fab Scheme**
    - **Semicon India Program**
    - **Scheme for Promotion of Manufacturing of Electronic Components and Semiconductors (SPECS)**

How Singapore can Help Develop India’s Semiconductor Industry?

- **Expanding Manufacturing Capabilities:** Indian companies can partner with Singaporean firms to **outsource assembly and testing**, reducing costs for Singapore and enabling India to adopt **advanced manufacturing technologies.**
- **Talent Development:** Singaporean universities offer programs in **microelectronics and semiconductor engineering**, and Indian institutions can **collaborate** for research, **student exchanges, and PhDs** to build a **skilled workforce** for India’s semiconductor goals.
- **Industrial Park Development:** On the lines of **Wafer Fab Parks** (industrial zones specifically designed for semiconductor manufacturing) in Singapore, India can establish similar industrial parks for **attracting global players.**
    - Partnerships with Singaporean firms can provide Indian companies access to **advanced semiconductor technologies** and essential materials for **chip production.**

India-Singapore Relations

- **Background:** India was one of the first countries to **recognise Singapore's independence in 1965.**
    - Relations date back to **Stamford Raffles** establishing a **trading post in Singapore** in **1819,** which became a **British colony** governed from **Kolkata until 1867.**
- **Trade and Economic Cooperation:** The **Comprehensive Economic Cooperation Agreement (CECA)** between India and Singapore was signed in **2005.**
    - Singapore is India’s **6th largest trade partner (FY24),** accounting for 3.2% of India’s overall trade.
    - India is Singapore’s **12th largest trade partner** with a 2.3% share in Singapore’s overall trade.
    - Singapore is India’s **largest trade partner in the ASEAN region**.
- **Security Cooperation:** Military exercises between India and Singapore include **SIMBEX (Navy), SINDEX (Air Force), and Bold Kurukshetra (Army).**
- **Culture:** Singapore's four official languages are **Malay, Mandarin, Tamil and English**. As per the data of government of Singapore, ethnic Indians constitute about **7.6%** of the resident population of 4.18 million in Singapore.

What is the Significance of Semiconductors for India?

- **Industrial Development:** The global semiconductor industry is poised for a decade of growth and is projected to become **a trillion-dollar industry by 2030**, and India aims to capture a significant share.
    - The Indian semiconductor market was worth **USD 15 billion in 2020** and is estimated to reach **USD 63 billion by 2026.**
- **Technological Sovereignty:** By developing domestic semiconductor capabilities, India can ensure a **stable supply for critical defense systems** and secure communication networks.
- **Global Supply Chain:** India's participation in the semiconductor sector can **boost global supply chain** influence, attract investments, and enhance its **strategic geopolitical role.**
- **Digital Transformation**: Semiconductors are key to **AI, quantum computing, and 5G,** making domestic development crucial for India's digital and technological progress.
    - It will support **data centers, communication networks, and smart cities**, aiding national growth.
- **Skill Development:** The semiconductor industry's demand for **specialized skills** will boost **STEM education and research** in Indian institutions.

What are the Challenges in Semiconductor Manufacturing?

- **Capital and Investment:** Semiconductor manufacturing is **extremely capital-intensive,** with significant investments required in both **R&D and infrastructure.**
    - The import semiconductor manufacturing **price index grew by 4.9% in 2021 and an additional 2.4% in 2022.**
- **Talent Shortage:** The industry faces a significant **talent gap**, with **over 1 million skilled professionals needed by 2025.**
    - India faces a shortage of skilled workers capable of **operating fabrication plants.**
- **Limited Access to Advanced Technology:** The dominance of countries like **Taiwan and South Korea** in the semiconductor ecosystem which have **exclusive access** to critical technologies limits India's ability to scale its capabilities swiftly.
- **Environmental Concerns:** The semiconductor industry is **energy-intensive** and contributes **31% of global greenhouse gas emissions.**
- **Competition from Other Emerging Markets:** India faces competition from emerging markets like **Vietnam, Malaysia, and Indonesia**, with **Malaysia** successfully attracting companies like **Infineon** in the first wave of semiconductor investments.

Way Forward

- **Education and Training**: Expand semiconductor programs at **universities**, partnering with global companies for **industry-relevant curricula and practical training**. **Example: IISc Bengaluru collaborating with TSMC (**Taiwan's semiconductor company)**.**
- **Indigenous Chip Design**: Establish chip design centers in tech hubs like **Bengaluru and Hyderabad.** E.g., **IIT Madras' Shakti processor.**
- **Supply Chain**: Build a comprehensive **supply chain** within India, attracting investments in raw materials to advanced packaging.
    - Establish **SEZs** for semiconductor development.
- **Sovereign Semiconductor Fund**: Create a sovereign fund for semiconductor investments, prioritizing technologies like **3nm and 2nm fabrication**.
- **Chip Diplomacy**: Leverage India's geopolitical position to secure **technology transfers** through strategic partnerships with countries like **Japan**.
- **Green Semiconductor Initiative**: Position India as a leader in **sustainable semiconductor manufacturing,** focusing on reducing water usage, energy consumption, and chemical waste.

Drishti Mains Question:

Discuss the significance of semiconductors for India's development? How can India capitalize on this opportunity in the coming decades?

UPSC Civil Services Examination, Previous Year Question (PYQ)

Prelims

Q. With reference to solar power production in India, consider the following statements: (2018)

1. India is the third largest in the world in the manufacture of silicon wafers used in photovoltaic units.
2. The solar power tariffs are determined by the Solar Energy Corporation of India.

Which of the statements given above is/are correct?

(a) 1 only

(b) 2 only

(c) Both 1 and 2

(d) Neither 1 nor 2

Ans: (d)

Q. Which one of the following laser types is used in a laser printer? (2008)

(a) Dye laser

(b) Gas laser

(c) Semiconductor laser

(d) Excimer laser

Ans: (c)

Mains

Q. How is science interwoven deeply with our lives? What are the striking changes in agriculture triggered by science-based technologies? (2020)

Q. What do you understand about nanotechnology and how is it helping in the health sector? (2020)