

# Opportunities for India Taiwan Science and Technology Cooperation

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## Introduction

There is much scope for building cooperation in science and technology between India and Taiwan. Taiwan has a well-developed economy, with a strong R & D ecosystem, and competitive advantages in several high-tech areas. In semiconductor chips, Taiwan is an important global supplier of this critical input for many industries. India has a large and growing market, high quality workforce in STEM areas, and has launched ambitious plans to strengthen its STI and educational ecosystems. These are strong pull factors which can drive India Taiwan cooperation in STI.

India is a key focus country within the framework of Taiwan's New Southbound Policy, launched in 2016. The policy was created to make Taiwan less dependent on Mainland China and to improve Taiwan's cooperation with other countries. The 18 countries targeted by the New Southbound Policy are: Thailand, Indonesia, Philippines, Malaysia, Singapore, Brunei, Vietnam, Myanmar, Cambodia, Laos, India, Pakistan, Bangladesh, Nepal, Sri Lanka, Bhutan, Australia and New Zealand.

Cooperation has assumed greater importance in view of recent events, such as rising tensions between China and the USA as well as India, Australia, etc.; perceptions of China as a threat to rule based international order, especially in the Indo-Pacific region, and diversification in economic

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dependence away from China. The Quad countries (US, India, Australia, and Japan) meeting at the October 2021 summit in Washington have agreed on several important initiatives on S & T cooperation. While these are some push factors, there is a strong pull basis for building long term science, technology and innovation (STI) cooperation between India and Taiwan based on its own merits and mutual advantages.

## Taiwan in the Global Economy

Taiwan with a population of 23.5 million, has a per capita GDP (PPP) of USD 59,000 (13<sup>th</sup> rank globally). It is well integrated into the global economy and has a foreign trade of USD 632 billion (2020), and is a member of the WTO since 2002. The total inward FDI stock in the country is USD78 billion while FDI held abroad was USD 332 billion (2017), making it a major global investor. The strongest sectors of the economy are semiconductors and ICT products. By 2020 Taiwan was the leader of the global semiconductor industry with Taiwan Semiconductor Manufacturing Company (TSMC) alone accounting for more than 50 per cent of the global market. Taiwan is the fourth largest exporter of machine tools and machine tool components in the world. Techman Robot Inc. is the world's second largest producer of cobots.

Being heavily dependent on foreign trade and markets, Taiwan has sought economic integration with various global and regional economic arrangements. In addition to the WTO, Taiwan (as Taipei, China) is a member of the Asian Development Bank, the Asia-Pacific Economic Cooperation (APEC) forum

(as Chinese Taipei), an observer at the Organisation for Economic Co-operation and Development (OECD) and is a member (as Chinese Taipei) of the International Energy Agency (IEA), a member (Chinese Taipei) of International Chamber of Commerce. Taiwan signed an Economic Cooperation Framework Agreement (ECFA) with People's Republic of China on 29 June 2010, which could allow for more than 500 products made in Taiwan to enter mainland China at low or no tariffs. Taiwan has signed free trade agreements with Singapore and New Zealand.

## STI Development in Taiwan

Taiwan's research intensity of GDP or Gross expenditure on research and development (GERD) has risen to 3.49 percent of total gross domestic product (2018) from 1.91 percent in 2000. (OECD, 2021), making it the third highest in the world, exceeded only by the Republic of Korea and Israel. In comparison, India has dropped to 0.7 per cent in 2019 from 0.8 per cent in 2005 (DST, 2020). The world average has risen from 1.51 per cent in 2000 to 1.72 per cent in 2017. Another important indicator is the human resources for R & D. The number of researchers per million population was 8180 in Taiwan (2017) and 255 in India (2020). These indicators show that Taiwan has emerged as a world leader in science and technology. On innovation, Taiwan has scored impressive results, being ranked as having the fifth-greatest potential for economic innovation in the world, according to a new index released by Bloomberg Economics. (5)

Taiwan's high-tech sector development has been fueled by the government's

generous funding of applied scientific development. Institutions such as the Industrial Technology Research Institute (ITRI), National Applied Research Laboratories and Institute for Information Industry (III) are at the heart of this sector by conducting research, aiding the private sector with R&D and exploring new technologies. Several prominent companies have grown in this ecosystem, including Taiwan Semiconductor Manufacturing Co. and United Microelectronics Corp., which are among the world's top producers of integrated circuit chips. Eight national research centers cover four major areas of science - earth and environment, information and communication technology, biomedical technology and technology policies. III leads in digital transformation, advancing ICT development, policy making and promoting talent cultivation. The Taiwan Tech Arena is a hub for innovation and startups attracting young entrepreneurs from around the world. Taiwan's network of science parks is home to clusters of companies pursuing breakthroughs in fields such as biotechnology, personal computing and peripherals, integrated circuits, nanotechnology, optoelectronics, precision machinery and telecommunications.

## **STI Development in India**

India ranks third among the most attractive investment destinations for technology transactions in the world. It is one of the top five nations in the field for space exploration (IBEF, 2021)(6). India has developed its capacity for R & D in all aspects of the nuclear fuel cycle and reactor

technology and has a major programme for expansion of nuclear energy and applied nuclear technology. In the energy sector, India has embarked on a major programme to shift to renewable energy, especially solar energy and with France has set up the International Solar Alliance, a global collaborative platform for solar energy. Other important areas are in earth and ocean sciences including polar region science, nanomaterials, biotechnology, AI and quantum computing, cybersecurity, and aerospace. These are all areas for fruitful cooperation between India and Taiwan

The Government of India is extensively promoting research parks (RPs) and technology business incubators (TBIs), which would promote the innovative ideas till they become commercial ventures. The Council of Scientific and Industrial Research runs 37 national laboratories and 39 outreach centres. Advances are taking place in sectors such as agriculture, healthcare, space research, and nuclear power. India has a major and growing capacity in the field of production of drugs, vaccines and medical devices. It has pioneered ICT applications in diverse fields such as financial services, healthcare, education, and governance, and citizen services applied them on a massive scale. The recent Covid 19 pandemic has brought into sharp focus the need for stronger international collaboration to deal with this and future pandemics. This is a fertile field for India and Taiwan to cooperate.

India has been engaged in pursuing the SDGs through the application of STI in various sectors such as food and agriculture, water and sanitation, health,

energy, environment, ICT for development, etc. The resulting technologies and frugal innovation could be of value across the developing world. In this effort, Taiwan could offer some important contributions, based on its own experience in progressing towards the SDGs. Taiwan, while not being a member to the UN, has adopted T-SDGs aligned with the SDGs adapted to Taiwan's specific conditions, with addition of an 18th goal – a nuclear-free homeland. The National Council for Sustainable Development chaired by the Prime Minister is responsible for implementation. Taiwan's first Voluntary National Review (VNR) of the implementation of the UN's SDGs was released in September 2017. Taiwan's progress towards the SDGs was presented at a workshop in New York in September 2019 (Amcham Taiwan, 2021).

India's New Education Policy 2021, and the draft Science Technology and Innovation Policy (STIP) 2020 envisage a major qualitative and quantitative jump in R & D activity. This includes increase in R&D funding, stepping up human STEM resources, STEM diaspora integration, strengthening the Indian STI ecosystem, building stronger international cooperation with partners, participation in mega and big science projects, and tackling global challenges through STI. These developments will open up more possibilities of building cooperation.

## India-Taiwan STI cooperation

There is an India-Taiwan Joint Committee on Cooperation in Science and Technology headed at senior official level of Vice Minister. Under this Joint Committee there is a Indo-Taiwan S&T cooperation

Programme which extends financial support through Joint Calls for proposals (the most recent in 2019) to researchers in India and Taiwan to carry out research and scientific projects. Several priority areas have been listed like renewable energy, clean energy, IoT, big data, cybersecurity, micro/nano-electronics, embedded systems & sensors, biotechnology, health care including functional genomics, drug development and biomedical devices, etc under the programme. Under India's Digital India initiative, the two sides can accelerate work on the "South Asian Silicon Valley" development project.

Taiwan's National Chung Cheng University has established a research center at IIT-Ropar under the support of Ministry of Science and Technology (MoST), Taiwan, in July 2019 to work in the field of AI and related industries. Under Taiwan's New Southbound Policy, Taipei seeks to boost STI exchanges among Indian and Taiwanese academic and research institutions. According to recent pronouncements, Taiwan is keen to further advance talent exchanges through short term fellowships and work in Taiwan's science parks.<sup>1</sup> The two sides also held a virtual exhibition on Taiwan-India exchanges under the New Southbound Policy in December 2020. There is huge scope for widening and deepening such exchanges.

## Recent Developments

Several track 2 interactions have been held between Indian and Taiwanese sides on cooperation in science, technology and innovation. In February 2021, Research and Information Systems (India) and Prospect Foundation (Taiwan) had

organised a webinar focused on Sectoral cooperation in ICT and Semiconductors, Smart Manufacturing and Industry 4.0, and Cooperation with Science Parks in Taiwan. The webinar brought together stakeholders on both sides to discuss cooperation possibilities. It was suggested that India must provide an enabling ecosystem to foster market dynamics and supply chain needs to facilitate Taiwanese companies to set up their units in India. India's strength in IC design can initiate collaborative endeavors between the two countries and also offer India immense potential to develop and strengthen its ICT industries and increase its footprint in the global supply chain. Investments and infrastructural support by the Government of India for the development of ICT industries will be critical. The present crisis in China's financial system offers opportunities to attract greater investment flows into India if some necessary reforms are carried out.

## Semiconductors

In the semiconductor industry Taiwan occupies a leading role. The Taiwan Semiconductor Manufacturing Company (TSMC) is a global giant in semiconductor manufacturing and technology. TSMC has an equity base of \$53 billion and over 56000 employees and has substantial in-house R & D capabilities. TSMC plans to start production of 3 nanometre chips in 2022. India has about 10 companies engaged in the industry.

The oldest institution, now called (since 2006) Semi-Conductor Laboratory (SCL), under Department of Space, Government of India; is engaged in Research & Development in the area of

microelectronics to meet the strategic needs of the country. SCL has integrated facilities / supporting infrastructure all under one roof and undertakes activities focused on Design, Development, Fabrication, Assembly & Packaging, Testing and Quality Assurance of CMOS and MEMS Devices for various applications. SCL is also engaged in Fabrication of Hi-Rel Boards, Radio Sonde Systems and indigenisation of electronic sub systems. It operates a 8 inch Wafer Fabrication Facility (2021 SCL), and uses 180 nanometer CMOS Process for Fabrication of products in Digital, Mixed Signal and Analog domains.

In the private sector, there are some interesting players. ASM Technologies Limited set up in 1992, is a publicly-listed company in India with global presence in USA, Singapore, UK, Canada, Mexico and Japan. ASM has been providing world class consulting and product development services for its global clientele. Continental Device India Pvt. Ltd., (CDIL) is a Semiconductor Manufacturer since 1964, producing various semiconductor devices for industrial applications. The other companies are engaged in engineering and R and D in semiconductors, but not in manufacturing. Clearly, the Indian semiconductor industry is in an early stage, with limited capacity for wafers and chip manufacturing.

The 180 nanometre level technology used by SCL was developed in 1999. The technology has advanced rapidly from 90 nm in 2003 to 5 nm in 2020. Semiconductor fab facilities require very large investments typically of the order of US\$ 20-50 billion. Such large investments in India will require major government support,

but can be of strategic value. Can both sides join together and become a reliable global supplier of semiconductor chips? This is indeed a challenge. In December 2021, the Indian government launched a USD 100 billion initiative to develop its semiconductor ecosystem (2021, PIB) This should provide many opportunities for future collaboration between Indian and Taiwan entities.

The top ten companies in Taiwan in the semiconductor sector are detailed below (9). Most of them are listed in Taiwan Stock Exchange (TSE) and NASDAQ.

Apart from semiconductor chips, the two sides can collaborate in manufacture of silicon wafers, solar cells and modules. The demand in this sector is likely to

increase greatly as India steps up its solar energy programmes in the near future.

### Agriculture

Taiwan and India signed a memorandum of understanding on agricultural cooperation in September 2016 covering planning, production, processing, distribution and marketing of aquaculture, farm, fishery, horticulture and livestock products. The two sides will also bolster cooperation across several fields including agricultural finance, farmers' associations, environmental sustainability, genetic resources and production materials such as fertilizers and seeds through personnel exchanges and joint academic research. Cooperation in Agricultural research

**Table 1: Top Ten Companies in Taiwan in The Semiconductor Sector**

Company	Products	Revenue (US\$ billion)
TSMC (Largest Semiconductor Manufacturer in the World)	Manufacture of Integrated Circuits and related services	47.85
ASE Technology	Semiconductor Assembly, Testing & Packaging	12.5
AU Optonics	Display panel, Transportation, Health, Solar energy, and smart manufacturing service.	10.5
MediaTek	Semiconductor, Processor, Semiconductor Equipment, Electronics.	8.5
LITE-ON Technology	Computer components, Consumer electronics	7.5
United Microelectronics	Semiconductor, Semiconductor Equipment, Electronics	5
Nanya Technology	Semiconductor, DRAM, Memory Chip	3
SPIL	Semiconductor, Testing & Packaging	2.8
EDOM Technology	Semiconductor, Semiconductor Equipment	2.7
Sino-American Silicon Products	Solar brick, Wafer, Solar cell, Solar module, and Solar system	2.4

Source: Retrieved from [www.electronicandyou.com/blog...](http://www.electronicandyou.com/blog...)[Last Reference]

could be explored between the Indian Agricultural Research Institute and the Taiwan Agricultural Research Institute on basic and applied research for agronomic and horticultural crops, biotechnology, soils fertility and plant nutrition, diseases and pest managements, farm machinery, meteorology, agricultural economics, and extension. Taiwan is a leader in high quality rice production and produces a wide variety of fruits and vegetables of interest to Indian consumers.

### Space

In the field of space research, the Indian Space Research Organization and the National Space Organization of Taiwan could work together in areas such as launch vehicle development, satellite payloads, remote sensing and space applications, and tracking of space objects. Taiwan has recently passed legislation in 2021, opening up the space sector to private participation, similar to what India has also done.

### Atomic energy

In the field of atomic energy, Taiwan has a special status as a non party to the NPT, but is covered under a trilateral agreement with the US and the IAEA to safeguard its nuclear facilities. Taiwan generates 10 per cent of its electrical energy from nuclear sources, with two nuclear plants operating at present, with several others shut down or cancelled in view of the Fukushima nuclear accident of 2011. There is considerable public support for nuclear power, though the official policy is to phase it out by 2025.

However, a referendum held on 18

December 2021, seeking to unseal and restart work on Taiwan's Fourth Nuclear Power Plant failed to pass, with 52.3 percent voting against it. Pro-nuclear activists had argued that the country's energy shortage and the need to keep greenhouse gas emissions in check made reopening the plant a necessity. Coal-fired plants accounted for 44.95 percent of Taiwan's electricity mix.

The main agencies are the Atomic Energy Council (AEC), and the Institute of Nuclear Energy Research (INER). There is some potential for cooperation with India in areas such as nuclear safety and monitoring, applications of radioisotopes in medicine, agriculture and food preservation, etc. The National Center for Theoretical Sciences (NCTS) in Taiwan carries out frontier research in physics, including areas such as particles and fields theory; condensed matter physics; atomic molecular and optical physics, and Soft Matters, Bio-Physics and Complex Systems. Cooperation with some Indian research institutions such as the Indian Institute of Science and Tata Institute of Fundamental Research could be mutually beneficial.

Cooperation in fields of biotechnology and nanomaterials between institutions on both sides could also be explored.

### Energy

In the field of energy, there are avenues for cooperation. Both sides are heavily dependent on imported fossil fuels and have ambitious targets for cutting greenhouse gas emissions, ramping up renewable energy and the associated energy storage systems. The negative result

of the recent referendum on restarting a nuclear power plant makes technology for solar energy and renewables, and carbon capture use and sequestration (CCUS) technology more important in the future. This also includes going in for hydrogen based energy systems, involving massive production of hydrogen from renewable energy excess generation, storing and reconvertng hydrogen into energy when needed. This is a complex effort requiring dovetailing of various sectors of the economy. India has launched a National Hydrogen Mission in August 2021, while Taiwan has also launched a Hydrogen Energy Promotion Alliance. These initiatives can lead to increased cooperation in the Hydrogen energy sector.

### **Biotechnology**

In the field of biotechnology, some notable institutions are - Agricultural Biotechnology Research Center (ABRC) of Academia Sinica, Taiwan which does basic research in agricultural biotechnology; National Biotechnology Research Park (NBRP) which is ecosystem platform for biomedical research; Institute of Biotechnology, National Taiwan University, which specializes in bioinformatics, nano-biomedical research, tissue engineering and regenerative medicine, genomics and proteomics. These are all areas of interest to R & D institutions in India's biotechnology sector, and cooperation could be pursued.

### **Medical research**

In medical research, the National Health Research Institutes (NHRI), a non-profit foundation established by the government

conducts mission-oriented medical research in basic biomedical sciences, as well as specific diseases. These range from the common problems such as aging, cancer, infectious diseases, mental disorders, occupational diseases, to health policy. This organisation could be a useful partner for the Indian Council for Medical Research (ICMR). Collaboration in the areas of COVID-19 and control of future disease outbreaks, especially in areas such as epidemiology, diagnostics, vaccines, and therapeutics could be mutually beneficial.

### **Nanomaterials**

In nanomaterials science, some important institutions in Taiwan are - (1) Taiwan Nanotechnology Research Center (of the University system of Taiwan) (2) Taiwan Nanotechnology Industry Development Association (TANIDA) (3) Center of Applied Nanomedicine (National Cheng Kung University), and several other research laboratories working in a wide range of areas. This offers a rich scope for collaboration with Indian institutions.

### **Conclusion**

There is a vast scope for building cooperation between Indian and Taiwan in various fields of science and technology, for mutual benefit and for tackling global challenges. Much attention has been focused on the semiconductor sector, but other areas also offer potential benefits. Several of these have been outlined in this article. The growth of Taiwanese investment and technology collaborations around the Chennai-Bengaluru corridor could lead to benefits for both sides. Increased exchanges of



researchers between higher educational institutions on both sides could also generate more cooperation. Greater stakeholder awareness on both sides needs to be stimulated. Strengthening cooperation with Taiwan is also important in the context of the geopolitical situation.

### Endnote

<sup>1</sup> Taiwan science parks and Indian Institute of Technology Hyderabad sign MOU, Taiwan News, 18 April 2017. Retrieved from <https://www.taiwannews.com.tw/en/news/3143427>.

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