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AN ICDK OUTLOOK

THE INDIAN SPACE SECTOR

SPACE-BASED TECHNOLOGY AND INFRASTRUCTURE

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ABBREVIATIONS

ISRO	Indian Space Research Organisation
DOS	Department of Space
NASA	National Aeronautics and Space Administration
ESA	European Space Agency
GNSS	Global Navigation Satellite System
PSLV	Polar Satellite Launch Vehicle
GSLV	Geosynchronous Satellite Launch Vehicle
LVM3	Launch Vehicle Mark-3
IN-SPACe	Indian National Space Promotion and Authorization Centre
SAC	Space Applications Center
PRL	Physical Research Laboratory
NSIL	NewSpace India Limited
DGFT	Directorate General of Foreign Trade
EO	Earth Observation
PNT	Positioning, Navigation and Timing
SATCOM	Satellite Communication
SMEs	Small and Medium Enterprises
FDI	Foreign Direct Investment
ISpA	Indian Space Association
MNC	Multinational Company
NGLV	Next Generation Launch Vehicle
LUPEX	Lunar Polar Exploration Mission
IoT	Internet of Things
GINP	Global Innovation Network Programme

FOREWORD

In 2024, we celebrate the silver jubilee of diplomatic relations between India and Denmark, marking 75 years of enduring partnership and collaboration.

During this special year, it is my privilege as Danish Ambassador to India to introduce this insightful report produced by Innovation Centre Denmark titled *The Indian Space Sector: Space-based Technology and Infrastructure in India.*

Our longstanding partnership, rooted in shared values and mutual respect, has paved the way for collaboration across various sectors, including the possibility of exploration of space. Against the backdrop of our Green Strategic Partnership, which underscores our commitment to sustainable development and green solutions, this report offers valuable insights into India's space sector and avenues for collaboration between our two nations.

India's achievements in space exploration are a testament to its unwavering commitment to scientific progress and innovation. From pioneering missions to Mars to the deployment of advanced satellite technologies, India has emerged as a key and cost effective player in the global space arena. Barely a year ago, the world watched in awe as India became the first to land a spacecraft near the lunar south pole. In the coming of years, India's space ambitions will leapfrog as the public as well as the private sector will invest heavily.

Despite its size, Denmark is ambitiously pursuing space exploration, recently welcoming back astronaut Andreas Mogensen from the International Space Station. Emphasising innovation and collaboration, Denmark aims for a notable global presence, leveraging expertise in satellite tech, aerospace engineering, and earth observation. Its commitment to sustainability aligns with the industry's focus on environmental stewardship, positioning Denmark as a key contributor to green technologies in space exploration.

The report timely suggests room for collaboration between India and Denmark in the space sector as Denmark is soon to announce a strategy for research and innovation within space.

As we celebrate this significant milestone in our diplomatic relations, I extend my heartfelt gratitude to all those who have contributed to the production of this report. It is my sincere hope that this document will serve as a catalyst for deeper engagement and collaboration between India and Denmark in the exciting realm of space.

FREDDY SVANE
Danish Ambassador to India
New Delhi, April 2024

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EXECUTIVE SUMMARY

This report examines the Indian space sector, focusing on the opportunities available for Danish stakeholders. As India and Denmark mark a milestone in their diplomatic relations, the report highlights the potential for collaboration in space technology. India and Denmark share common objectives, including the development of space technology for societal benefit, fostering innovation, and supporting emerging industries. Both countries value international collaboration and actively engage in partnerships with global space agencies to utilize expertise, resources, and infrastructure.

India's space program has made significant progress, including interplanetary missions and advancements in satellite technology. Concurrently, India's regulatory environment has become more accommodating to foreign participation in the space sector. Danish companies can take advantage of these regulatory changes to establish manufacturing units, collaborate with Indian entities, and participate in government tenders. The ecosystem has diversified with the emergence of private players and startups, presenting opportunities for Danish stakeholders in technology transfer, collaborative R&D projects, investment in startups, and engagement in downstream applications.

India's focus on incorporating AI and machine learning into space technology aligns with Denmark's strengths in these areas. Collaborative R&D projects can concentrate on downstream applications such as earth observation for environmental and disaster management, urban planning, agriculture management, and infrastructure development. Engaging in this sector can provide benefits, advancing space science, technology, and sustainable development while leveraging India's cost-effective innovation and large talent pool.

Denmark's advanced technologies have the potential to enhance India's capabilities, particularly in areas like miniaturized satellites. Conversely, Denmark can benefit from India's infrastructure and expertise in launching and managing large-scale space missions.

Innovation Centre Denmark, Bangalore, is prepared to assist Danish organizations in navigating these opportunities, ensuring a productive partnership in the realm of space exploration.

CHAPTER 1:
INTRODUCTION

Over the past few decades, India's space program has achieved significant milestones, including interplanetary missions and advancements in satellite technology. Moreover, the emergence of private players and start-ups in the space domain has added dynamism and diversity to the ecosystem.

This report provides an overview of the current state of the space sector in India, offering insights into key players, trends, challenges, and opportunities for Danish organisations. The report is prepared by Innovation Centre Denmark Bangalore and is based on desk research including literature reviews of key policy documents, interviews with Indian space experts and mapping activities from global databases.

With a series of pioneering missions and technological breakthroughs, India has emerged as a key player in the global space arena, captivating the attention of international partners seeking collaboration and mutual advancement (Confederation of Indian Industry (CII), 2023). Understanding the capabilities and technological advancements of India is crucial to maintain and develop a competitive edge in the space sector.

Partnerships in space research and technology have the potential to spark innovations with wide reaching effects across technology, science, and policymaking domains. For instance, the National Aeronautics and Space Administration (NASA) - European Space Agency (ESA) space cooperation, demonstrate how joint initiatives can serve as catalysts for broader collaboration in trade, technology, and diplomacy.

Reports from the Indian national space agency and the Indian Space Research Organisation (ISRO) highlight India's achievements in cost-effective space missions, reasonably self-sufficient satellite manufacturing and launch capabilities, as well as significant advancements in areas like Earth Observation (EO) and space exploration. Denmark, through its participation in ESA, has shown commitment to scientific research in space, EO and human spaceflight programs.

India's success into space exploration, with missions like Chandrayaan (moon mission) and Mangalyaan (Mars mission), has demonstrated its capabilities in interplanetary exploration and scientific research. As one of the world's leading space agencies, ISRO has developed cost-effective satellite launch systems like the Polar Satellite Launch Vehicle (PSLV), the Geosynchronous Satellite Launch Vehicle (GSLV), has embarked on ambitious lunar and interplanetary missions and has launched three space telescopes.

Denmark's strengths in the space sector lie primarily in its advanced scientific research and development capabilities, particularly in areas like astrophysics and atmospheric studies. Denmark is increasingly involved in the development and launch of small satellites, such as CubeSats and nanosatellites. These projects often involve collaboration between universities, research institutions, and private companies, and are used for various scientific experiments and technology demonstrations in space (Ministry of Higher Education and Science of Denmark, 2021).

Denmark's contribution to Earth observation and climate monitoring initiatives is significant, leveraging its expertise in environmental science. The country also plays a crucial role in human spaceflight and microgravity research, participating in ESA's missions and contributing to the broader understanding of long-duration space mission - an emerging field of interest to India with its Gaganyaan human spaceflight program.

INDIA'S SPACE SECTOR CAPABILITIES – KEY HIGHLIGHTS

- As of February 2024, India has executed 124 spacecraft missions since 1969. Between the years 1999 and 2023, India has launched 400+ satellites from 34 countries (Indian Express, 2024).
- India has four active launch platforms - PSLV, GSLV Mk II, and the Launch Vehicle Mk III (LVM3) (Agarwal, 2023), and the Small Satellite Launch Vehicle (SSLV).
- Skyroot Aerospace is the first Indian private space start-up to successfully launch a rocket into space (Sadam, 2023).

CHAPTER 2:

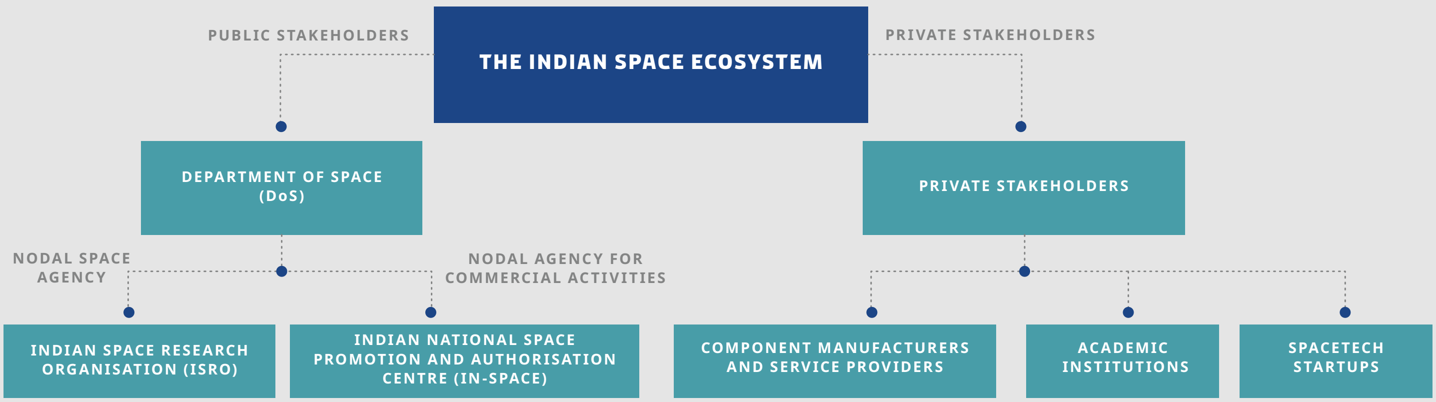
THE STRUCTURE OF THE INDIAN SPACE ECOSYSTEM

The space ecosystem in India today consists of stakeholders within government, private companies, start-ups and universities. Space research in India commenced in 1962 with the founding of the Indian National Committee for Space Research (INCOSPAR), which resulted in the establishment of ISRO in 1969. Today, ISRO anchors the core of India's space research and exploration. As the national space agency, ISRO operates under the Indian Government's Department of Space (DOS), whose primary objective is to promote the development and application of space science and technology of the country's space programme (Agarwal, 2023).

ISRO has several specialised centres like the Space Applications Center (SAC), which develop instruments and payloads and their applications for national technology development and societal benefits. Alongside these operate several autonomous bodies, chief of which is the Physical Research Laboratory (PRL), a major driver of India's planetary exploration program conducting fundamental research in astronomy, astrophysics, solar physics, planetary science, atmospheric sciences and geosciences. For an overview see Figure 1-2, and Table 1.

To spur private sector development in India, the government established the Indian National Space Promotion and Authorization Centre (IN-SPACe) in 2020, a DOS entity created to "promote, hand-hold, guide and authorise space activities" of private players in the country (ISRO, 2023) (Indian national space promotion and authorization center, u.d.). This move followed the establishment of New Space India Limited (NSIL) in 2019, which is a DOS company tasked with commercialising Indian space technologies, especially those developed by ISRO (NewSpace India limited (NSIL), 2023).

Figure 1: Key custodians of the Indian Space Ecosystem



Source: Inc42 (Agarwal, 2023)

In large planetary exploration missions, ISRO acts as the primary agency responsible for mission planning, development, execution, and management. It collaborates with various governmental and educational institutions for research and development.

In the ISRO-led Chandrayaan and Mangalyaan missions, various national and international institutions had collaborated for payloads and research. In domains like astrophysics, the Indian scientific community recommended the use of AstroSat, India's first dedicated multi-wavelength space telescope, and XPoSat, a polarimetry mission to carry out research.

ISRO has partnerships agreements with NASA and ESA and significant bilateral collaboration with France, the Netherlands and the United Kingdom. The agency has signed 283 Cooperative Documents with 61 partner countries with the aim of enhancing knowledge sharing and capacity building in the space domain (Innovation Centre Denmark Bangalore, 2024).

According to Chairman of ISRO Dr. SP Somnath, ISRO has interest in the Danish space strategy and is especially interested in collaborating with Denmark at a corporate level. As for India's academic progress in space, leading institutions like the Indian Institution of Science (IISc) and Indian Institutes of Technology (IITs) have significant space orientation.

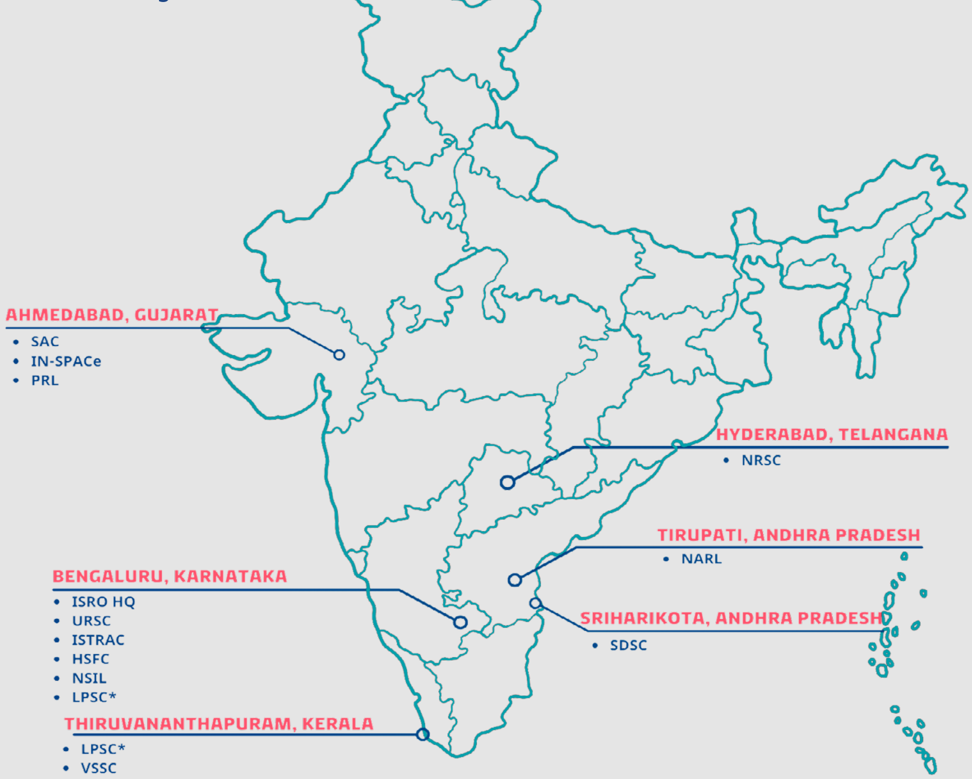
***Dr. SP Somnath** is an aerospace engineer and the Chairman of ISRO. Under his leadership, he has spearheaded multiple innovative missions, including the lunar exploration Chandrayaan-3 that made India the first to land successfully near the moon's south pole. Somnath is known for his contributions to launch vehicle design, particularly in launch vehicle systems engineering, structural dynamics and pyrotechnics.*

Photo Credit: NASA/Bill Ingalls

Table 1: An Overview of Government Agencies

NAME	FIELD OF EXPERTISE
ISRO (Indian Space Research Organisation)	India's national space agency, responsible for planning and executing space missions, developing technology, and promoting space science
NSIL (NewSpace India Limited)	Focuses on scaling up industry participation in Indian space programs and exploiting space resources commercially.
IN-SPACe (Indian National Space Promotion and Authorization Centre)	Promote, authorize, and monitor private sector activities in the Indian space sector. Regulatory body to private industry's participation and compliance with space-related norms and standards.
National Atmospheric Research Laboratory (NARL)	Conducting basic and applied research in atmospheric and space sciences, leveraging advanced ground-based observational facilities.
Physical Research Laboratory (PRL)	Research in Astronomy, Astrophysics, Space and Atmospheric Sciences, and Geosciences.
Space Applications Center (SAC)	Specializes in designing payloads and developing applications for communication, meteorology, and remote sensing satellites.
Vikram Sarabhai Space Centre (VSSC)	Focuses on the development of satellite launch vehicles and associated vehicle technologies crucial for India's space missions.
Satish Dhawan Space Centre (SDSC)	ISRO's primary launch center. Responsible for satellite vehicle launches and testing, serving as the central hub for ISRO's launching operations.
U R Rao Satellite Centre (URSC)	Lead center of ISRO for the design, development, and integration of satellite technology.
Liquid Propulsion Systems Centre (LPSC)	Center focusing on the development and testing of liquid propulsion systems for space launch vehicles and spacecraft.
National Remote Sensing Centre (NRSC)	Satellite data acquisition and processing in applications related to agriculture, water resources, urban planning, and disaster management.
Human Space Flight Centre (HSFC)	Develop and implement the technology needed for human spaceflight including the ambitious Gaganyaan project.
ISRO Telemetry, Tracking and Command Network (ISTRAC)	Support for satellite and launch vehicle missions through ground stations. Responsible for telemetry, tracking, and command operations essential for space mission management and satellite tracking.

Figure 2: Location of Goverment Agencies



Private companies are increasingly involved in ISRO's EO missions, initially as component and technology suppliers and eventually as key development partners. However, there is no plan yet to carry instrumentation from private companies on India's national space science missions (European Space Policy Institute (ESPI), 2021). For an overview, see Appendix 1. Several European companies have worked with the Indian Space Research Organisation (ISRO), showcasing a robust history of collaboration between Europe and India in space technology, see Appendix 2.

The Indian aerospace sector is linked to the outer space sector through development, manufacturing, and deployment of technologies and systems that support space exploration and satellite communication. Key players in the Indian aerospace industry, including public sector giants like ISRO and private enterprises like L&T, Godrej Aerospace, and HAL, contribute significantly to space missions by providing expertise, infrastructure, and manufacturing capabilities including production of launch vehicles, satellites, and ground systems. This collaboration not only enhances India's capabilities in space but also in international aerospace and defence markets.

The vendor and supplier network in the Indian space ecosystem is vital for the successful execution of space missions and has multiple levels. At the primary level are large companies and research institutions that provide major components and technologies for spacecraft and develop structures for launch vehicles. These entities often work closely with ISRO to develop mission-critical technology. The secondary level includes smaller companies that supply specialised components, software and services. These entities are crucial in providing innovative solutions and niche products that contribute to the efficiency and effectiveness of space missions. Start-ups are also expected to start contributing to national missions at this level. Finally, there are numerous tertiary suppliers that provide generic components and services. While their products may not be specific to the space industry, they are essential for the overall functioning of space missions. From a strategic standpoint, this expansion of India's space capabilities to the private sector is expected to aid India's journey towards self-reliance in space (ANI, 2023).

INDIA'S REGULATORY ENVIRONMENT

The Indian space sector's regulatory landscape has undergone significant changes, with an increased focus on facilitating and managing the participation of non-Indian entities. These changes are a part of India's broader initiative to integrate its space sector with global markets and encourage international collaboration. This strategic approach seeks to foster private capital infusion and harness global proficiency. Every proposition undergoes meticulous scrutiny, evaluated individually with regard to factors such as national security and technological intricacy (Chaudhry, 2023).

"The cost effectiveness of Indian space technology development combined with the recent opening up of Foreign Direct Investment in the private space sector opens up new avenues for foreign companies, including those from Europe, to have business arms in India."

– Krishna Reddy, Manager at KaleidEO and SatSure.

Krishna Reddy *is the business development manager at KaleidEO, and marketing manager at KaleidEO's parent company SatSure working on advances in satellite remote sensing, machine learning, big data analytics and cloud computing. Krishna has consulted several foreign startups and enterprises in understanding the Indian space sector. He has previously been a space tech correspondent for YourStory Media.*

India's policy on foreign investment in the space domain encompasses satellite establishment and operations, contingent upon governmental sanction. In February 2024, the government announced that it had amended its FDI policy allowing 100 per cent investment in the space sector (Press Information Bureau of India , 2024). The liberalised entry routes under the amended policy are aimed at attracting potential investors to invest in Indian space companies. This move is anticipated to spur job creation, facilitate the assimilation of cutting-edge technologies, and foster self-sufficiency within the sector. Companies will have the opportunity to establish manufacturing units domestically, thereby bolstering the 'Make in India' and 'Atmanirbhar Bharat' (self-sufficient India) initiatives endorsed by the Indian Government.

The regulatory environment for non-Indian players in the Indian space sector is guided by a blend of national policies and international commitments (See Table 2). Understanding these regulations is crucial for foreign entities aiming to collaborate or invest in India's space industry. Non-Indian entities must navigate through a network of regulatory authorities:

- **DOS:** The primary government body overseeing space activities, including policy formulation and international collaboration.
- **IN-SPACe:** Facilitates and regulates private and international participation in India's space sector.
- **Directorate General of Foreign Trade (DGFT):** Regulates the import of space-related technology and components.

LICENSING AND APPROVALS: Non-Indian entities seeking to engage in space activities within India require specific licenses. The process involves obtaining approvals from various government bodies, including the DOS and IN-SPACe. These licenses are subject to regulations that ensure compliance with national and international space laws. India is a signatory to several international treaties like the Outer Space Treaty, which govern the activities of states in the exploration and use of outer space. Non-Indian players must ensure that their activities comply with these treaties and India's commitments under them.

RESEARCH AND DEVELOPMENT: Regulation in technology transfer and collaboration is designed to safeguard national security while promoting international cooperation.

- Technology Transfer Regulations: The transfer of space technology to India is subject to scrutiny. Technologies with potential dual-use applications are regulated under the Wassenaar Arrangement, to which India is a signatory. Such transfers require clearances from the DOS and sometimes from the Ministry of Defence.

- Collaborative R&D Regulations: Collaborative projects between Indian and foreign entities in space research and development are encouraged but require approval from the DOS, and the terms of collaboration must align with India's space policy and its international obligations.

CUSTOMS AND IMPORT: The import of space-related products and components by non-Indian entities is regulated under the Directorate General of Foreign Trade (DGFT). The import process involves:

- Customs and Trade Policies: Importers must comply with India's customs laws and trade policies. Import tariffs, customs duties, and other levies are determined based on the nature of the imported goods.

- Licensing Requirements: Items with dual-use potential require specific import licenses. The DGFT, in coordination with the DOS, oversees these licenses to ensure that imports do not compromise national security or India's international commitments.

Essential considerations under which criteria ISRO considers its foreign suppliers, are outlined in Appendix 3.

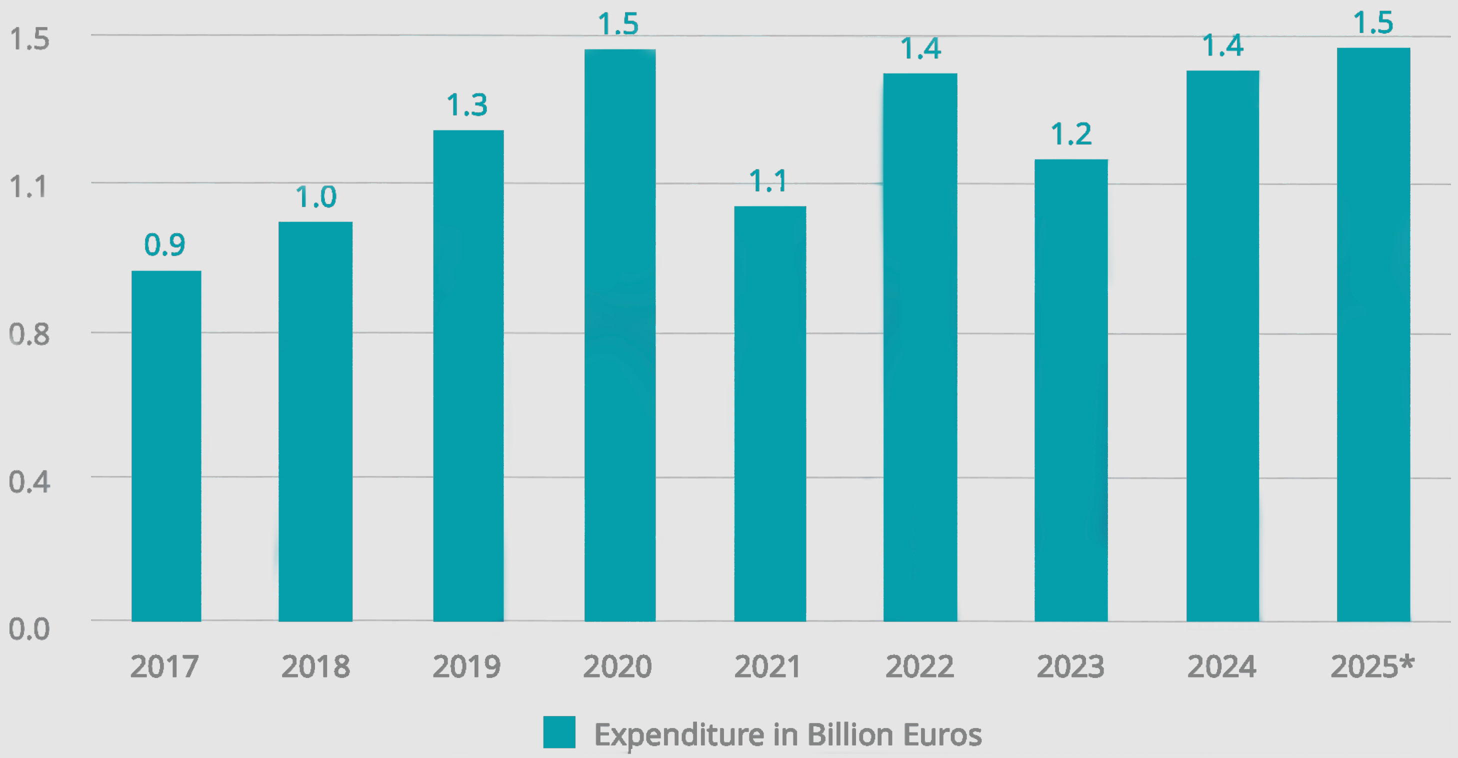
CHAPTER 3:
THE INDIAN SPACE POLICY

The recent Indian Space Policy 2023 has contributed largely in guiding India's space economy by presenting a multifaceted terrain of both opportunities and hurdles for international enterprises and research bodies. India's space ambitions are also reflected in the increase in government spending in the space domain (an overview in Figure 3).

While the policy advocates for increased involvement of non-governmental entities in space endeavours, thereby fostering international collaboration, it also demands cautious manoeuvring within a novel and potentially uncertain market landscape (ISRO, 2023).

Following the touchdown on the Moon by Chandrayaan-3, ISRO plans to expand its human spaceflight program by creating an Indian Space Station in Earth orbit by 2035. This would be followed by sending the first Indian to the Moon by 2040. To realise these ambitions, the DOS and ISRO are developing a roadmap for lunar exploration, which will comprise a series of Chandrayaan missions, the development of a partially reusable Next Generation Launch Vehicle (NGLV), a new launch pad, and more.

Figure 3: Indian government expenditure on space



Source: Statista (Statista , 2023); Union Budget India (Department of Space, 2024)

NB: The Indian financial year begins in April and ends in March. For example, Financial Year (FY) 2024 started in April 2022 and ended in March 2023.
*Funds allocated in India's interim budget for the current financial year 2024-2025.
1 EUR = 88.90 INR (as of 12 April 2024 on XE.com)

"With ISRO's human spaceflight program Gaganyaan, there's a strong focus on growing and extending indigenous capabilities, which includes sourcing components and manufactured modules from Indian private entities."

– Lt. General (Retired) Anil Bhatt, Director-General of the consortium Indian Space Association (ISpA).

Lt. General Anil Kumar Bhatt *is the Director-General of the Indian Space Association, an industry association formally representing Indian startups and satellite manufacturing companies, and which acts as a key advisory to ISRO and IN-SPACe.*

For its next Moon mission launch before the end of decade, India is partnering with Japan to have the LUPEX rover directly study the nature, abundance, and accessibility of water ice on the Moon's south pole. This will provide critical information for the ongoing global rush to the Moon, which has sustainable crewed missions and habitats as the end goal, and towards which the European Space Agency is also working via the US-led Artemis missions. India is also planning to launch Chandrayaan-4 before the end of decade. It's a sample return mission, expected to provide a bounty of lunar science. At the same time, Chandrayaan-4 will demonstrate several technologies needed for a future crewed mission to the Moon and back.

Like previous Chandrayaan missions, ISRO-affiliated institutions like PRL and SAC will provide key scientific instruments for LUPEX and Chandrayaan-4. Data from all of ISRO's space science missions is available freely on the dedicated website for the purpose: www.issdc.gov.in. In December 2023, ISRO opened up access to 5-metre resolution remote sensing data from 44 of its satellites, making it among the highest resolution datasets of its kind in the world available to the public.

Table 2 provides a comparison of the strategic priorities outlined in the Danish National Space Strategy (2021) and the focus areas designated by the Indian Government in the Indian National Space Policy (2023). There are promising areas for collaboration, such as sustainability, which aligns with the existing Green Strategic Partnership between Denmark and India, as well as research and development (R&D), which is a cornerstone of the Danish space sector and a key focus area for India (Denmark, 2024).

Table 2: A Comparison of the Danish and Indian Space Policies

DENMARK	INDIA
• **Sustainability:** Space-based infrastructure and data should contribute to more and better knowledge about climate, the enviroment, nature, and biodiversity. • **Urban infrastructure:** Space-based infrastructure and data data should contribute to smarter and more sustainable cities. • **Public services:** Space-based infrastructure and data should contribute to better and more efficient public services. • **Security:** Space-based infrastructure and data should contribute to increase and imporved security and preparedness.	• **R&D:** Encouraging advanced Research & Development in the space sector to sustain and augment the space programme. • **Public Goods:** providing public goods and services using space technology for national priorities. • **Regulation:** Creation a stable and predictable regulatory framework to provide a level playing field to Non-Goverment Entities in the Space sector through IN-SPACe. • **Education and innovation:** promoting space-related education and innovation, including support to space-sector start-ups. • **Tecchnological development:** Using space as a driver for overall technology development, nurturing scientific temperament in the society, and increasing awareness on space activities.

The downstream space technology value chain in India covers sectors such as Earth Observation (EO) and analytics, Positioning, Navigation and Timing (PNT), and Satellite Communication (SATCOM). Opportunities entail adapting to a market distinct from Europe in terms of regulatory frameworks, business practices, and consumer demands. Danish firms specializing in satellite components, manufacturing, and communication systems could discover openings here, but achieving success will likely demand substantial market analysis and establishment of local partnerships to navigate the distinctive features of the Indian market.

India's emphasis on incorporating AI and machine learning into space technology dovetails with Denmark's expertise in these domains. Companies such as SkyServe and SatSure are pioneering edge computing for satellites and already have established European collaborators.

Regarding privately developed launch vehicles like those by Skyroot Aerospace and Agnikul Cosmos, inherent technical complexities suggest that achieving the extensive track record and stability typically sought by Danish companies in international partnerships might be several years away. Upstream solutions (satellites, rockets, rocket fuel, propulsion systems) from the private sector require substantial capital, which has not been a primary source in India's DOS thus far. The transition from operational viability to commercial viability also entails a lengthy timeline. Consequently, in the short term, downstream solution providers with quicker maturity timelines will likely serve as more suitable partners.

CHAPTER 4:

INDIA'S SPACE START-UP ECOSYSTEM

In recent years, there has been a notable rise in the number of private players in the Indian space ecosystem (see Table 3), a clear sign that they are increasingly complementing the efforts of the government in diversifying the indigenous space sector's capabilities. A wide array of companies – specifically start-ups and SMEs – aim at providing end-to-end solutions in areas ranging from hyperspectral imaging to launch capabilities (AFP, 2023) (Singhal, 2022). The policy frameworks that enable their role in the space ecosystem, however, are new or still under development.

In 2023, there were registered 190 Indian start-ups operating in the space sector, a figure approximately the double of the previous year. Additionally, various tangential companies, including Amazon Web Services, are venturing into space with specialized offerings. With the booming start-up and SME ecosystem, coupled with the liberalisation of FDI, a surge in investments and international partnerships is anticipated (The Mint, 2023).

Table 3: An Overview of India's Start-Up/ SME Ecosystem

SCOPE	AREAS OF EXPERTISE (2022)	INVESTMENTS
190 registered space start-ups in 2023 - twice as many than 2022	• Satellite / spacecraft subsystem: 39% • Satellite applications: 32% • Education: 11% • Launch vehicles: 7% • Others: 11%	• 133.5 million USD private investments in Indian Space start-ups from April to December 2023. • 77% increased nivestment from 2021-2022 • 200+ million USD in VC funding from 2011-2023

Space start-ups like Skyroot Aerospace and Agnikul Cosmos are pioneering the development of private satellite launch vehicles. Others such as Dhruva Space and Pixxel Space are focusing on satellite manufacturing and space-based applications. There are also downstream companies like SatSure, which make public EO data actionable with data analytics suites tailored for sectors including agriculture, banking and infrastructure (see Table 4).

Table 4: Selected Indian Space Start-Ups and Areas of Expertise

NAME	FIELD OF EXPERTISE
Pixxel Space	Nanosatellite constellation for hyperspectra imagery and data analysis tools
Dhruva Space	Small satellite platforms
Skyroot	Space-launch vehicle design and building, especially small-lift launch vehicles
Bellatix Aerospace	Propulsion systems for satellites
Agnikul Cosmos	3D-printed small-lift launch vehicles
Satsure	Utilises satellite data for decision intelligence services within for example agiculture and infrastucture
Azista-BST	German-Indian collaboration to develope a fleet of commercial EO satellites.
Tata Advanced Systems Limited	Partnered with Satellogic to build sub-matter resolution EO satellites in India for commercial as well as national defence applications
PierSight Space	Building a constellation of SAR satellites aimed at providing a high 30-minute interval monitoring for the maritime industry.

Most space start-ups in India primarily concentrate on satellites, particularly the advancement of nano- and micro-satellites. An important characteristic among satellite-oriented start-ups in the country is their adeptness in recognizing market voids, distinguishing themselves based on critical factors like measured light spectrum and pioneering inventive products. As the Indian space program expands, numerous entities are becoming more open to leveraging third-party platforms, thereby creating avenues for start-ups and SMEs to adopt a more significant role.

Other than enabling the private space sector via policy and regulations, the Indian government extends some support to start-ups chiefly via IN-SPACe. The organisation provides up to 120.000 USD in seed funding to start-ups with innovative ideas. IN-SPACe also offers a Design Lab for new space start-ups to access comprehensive, high-performance space simulation suites without having to invest in their own. ISRO and IN-SPACe struck a deal with Amazon Web Services to offer free cloud computing services to start-ups and research institutes. Notably, IN-SPACe also conducts technology transfers from ISRO to start-ups and companies, presenting a good vector for international companies seeking to collaborate on specific areas of mutual interest.

"With large traditional contractors like Larsen & Toubro (L&T) moving into satellite manufacturing, opportunities are growing for European and other foreign start-ups to enter the supply chain via specialised components."

– Narayan Prasad, COO of the global space-based marketplace Satsearch.

Narayan Prasad *is the COO of Satsearch, the world's largest supply chain platform in the space industry with customers in over 35 countries. Narayan co-founded Spaceport SARABHAI, India's first think tank dedicated to catalyzing the fledgling Indian space economy and giving India an international voice. He is also the host of the NewSpace India podcast, a revered talk show exclusively focusing on India's space activities.*

India's space start-ups have seen a significant increase in investment by multinational companies. Notably in 2023, Microsoft announced its collaboration with ISRO to empower space tech start-ups with the apt technology tools and platforms, support towards market entry and mentoring to facilitate their growth and readiness for enterprise-level operations (Stories, 2023). Similarly, Google has invested USD 36 million in a Series B funding round in Pixxel Space (Bhattacharjee, 2023).

The Indian space start-up ecosystem actively pursues international collaborations and leans on its successful track-record for cost-effective innovation. Consortiums like the Indian Space Association (ISpA) have teamed up with the French Aerospace Industries Association (GIFAS) to catalyse business ties between the respective swarms of Indian and French space companies. Other foreign space agencies have also shown a keen interest in working with Indian space start-ups, notably the Australian Space Agency, which provided USD 20,7 million in funding to Australian businesses and research organisations for conducting joint technology projects with Indian space entities.

However, there are large gaps in the Indian space sector that require a reliance on imports. Furthermore, a large number of Indian companies involved in the commercial development of parts for ISRO operate at tier-2 and tier-3 levels, meaning that they are in the lower end of the supply chain. As start-ups/SMEs fill out some gaps within the sector, providing innovative solutions, they are arguably a positive element for the sector to stay up-to-date with global tech trends. However, as the ecosystem is still nascent, this potential is still to be fully realised and policy frameworks are yet to be fully developed. Table 5 shows a SWOT analysis of the Indian start-up space ecosystem.

For Danish SMEs and startups looking to enter the Indian space market, there are several avenues to consider, depending on their sector focus:

- **Work directly with ISRO:** Companies can engage with ISRO by responding to tenders, known as 'Announcement of Opportunities,' either independently or in collaboration with an Indian partner such as a company or university. Partnering with an Indian entity often streamlines the process.

- **Subcontract for a large Indian company:** Another entry route is to provide technology or services to established Indian firms in the sector. These companies are adept at securing major government tenders and also undertake significant private sector projects.

- **Use a local partner:** Utilize market assistance programs or conduct independent research to identify and collaborate with local partners who understand the nuances of the Indian space ecosystem.

- **Collaborate with universities:** Explore research collaboration opportunities with universities actively involved in SpaceTech solutions development. This can foster innovation and provide access to cutting-edge research and talent.

- **Participate and collaborate with space tech accelerator programs,** e.g. AIC T-Hub which has empowered over 1,100 start-ups by providing them with technology, talent, mentorship and resources. The program focuses on helping SpaceTech start-ups commercialize their innovations by delivering market insights, aiding in business plan development, and facilitating access to growth resources.

Table 5: SWOT Analysis of the Start-Up Ecosystem in India

STRENGHTS	WEAKNESSES
• Cost-effective innovation that can fill the gap in the Indian space sector • Access to India's large engineering talent pool • Strong focus on satellites - especially development of nano - and micro satellites • Lower cost for developing and launching satellites • Application in other areas, in terms of satellites, minimising the digital divide in India	• Most Indian companies operate at tier- 2 and 3 levels • Demand for components providers, products and systems for present and upcoming space missions - with 70% - 80% imported showing reliance on other countries • Lack of sufficient domestic expertise in manufacturing electronic components and systems • Demand for semiconductors as a result of the demand fro satellite-enabled services.
OPPORTUNITIES	**THREATS**
• Increasingly favouritable policy environment • Application in other areas - in terms of satellites - minimising the digital divide (area of expertise for majority of start-ups) • International recongnition on the Indian star-up ecosystem • Lower cost for developing and launching satellites (area of expertise for majority of start-ups) • Start-ups can fill out gaps within the space sector by innovative solutions and cost effectiveness of a specific product • Understanding of gaps in the local market	• Lack of access to capital • Preference for investment in the downstream segments • Perception of long gestation period of investment • Lack of diverse bussiness models • Start-up ecosystem is still in an early phase

CHAPTER 5:

ACADEMIC COLLABORATION

The collaboration between the EU and India, particularly under the Copernicus Earth Observation and Monitoring program, exemplifies significant international cooperation. In 2018, the European Commission and India's Department of Space agreed to share satellite EO data, aiming to contribute to the United Nations' Sustainable Development Goals. This partnership facilitates mutual access to data from the EU's Sentinel satellites and India's EO satellites, enhancing global product development and addressing key issues such as climate change adaptation, disaster risk reduction, and natural resource management.

India participates in various international programmes and organisations that can provide a framework for cooperation with Danish partners, e.g. the EU's framework programme for research and innovation for the years 2021-27. EU collaboration often focuses on global challenges like climate change, space traffic management, and exploration missions. This aligns with Denmark's strengths in EO and monitoring. An example is the recent Horizon Europe Call Closing the research gaps on Essential Ocean Variables (EOVs) in support of global assessments (IA) co-funded by the Indian Ministry of Earth Sciences (MoES), where the winning consortium was headed by the Danish Meteorological Institute comprising 17 European organizations and 2 Indian entities, receiving a total funding of EUR 6 million from the European Commission, with MoES contributing approximately EUR 83.000 to the Indian entities.

Innovation Fund Denmark (IFD), Indian Department of Science and Technology (DST) and the Department of Biotechnology (DBT) are bi-annually calling for Danish-Indian research projects. Since 2018, India and Denmark have funded joint initiatives totalling EUR 12 million. Each project involves at least one partner from both countries and focuses on technology with a readiness level between 3 to 7. An example of a space related project under this call is managed by the IT University of Copenhagen and the Danish Hydraulic Institute (DHI) in collaboration with the Indian Institute of Technology (IIT) Mandi. The project explores the use of remote-sensing data based on inputs from the ESA to provide irrigation advice for farmers in the Himalayan region of India. While IIT Mandi focuses on providing research based on software engineering, biology and agriculture, IOT and economy, DHI provides its expertise in satellite image analysis and the IT University of Copenhagen focuses on software engineering and user-centred design (Feedback on consultation, internal emails, 2023).

"Collaborations are usually facilitated on top of existing Indo-European bilateral agreements via Announcements of Opportunities released on a per-mission basis. Other options include funded academic workshops and collaboration on ground-based telescopes."

– Dr. Anil Bhardwaj, Director of ISRO-PRL

Dr. Anil Bhardwaj *is a renowned astrophysicist and the Director of the Physical Research Laboratory in Ahmedabad, a leading planetary science research institute in India. He is a member of the International Academy of Astronautics and the International Astronomical Union, owing to his more than 200 peer-reviewed research papers published in international journals. He contributed to the development of ISRO's planetary science*

ESA has been supporting ISRO's lunar and interplanetary missions via its Estrack ground station communications network, most recent and notable examples of which include Chandrayaan-3 and Aditya-L1, India's first space-based solar observatory. Conversely, ISRO supports ESA in other ways such as launching the upcoming Proba-3 spacecraft on the PSLV rocket later in 2024.

International collaboration is often a key part of India's space science missions. Chandrayaan-1, which discovered water ice on the Moon, had multiple European instruments. For the upcoming LUPEX rover, ESA is contributing a mass spectrometer to identify lunar polar volatiles such as water ice.

The successful demonstration of Starberry-Sense, a low-cost star sensor for CubeSats, by the Indian Institute of Astrophysics aboard a PSLV rocket fourth stage in April 2022, underscores the potential for academic-industry collaboration. Even before FDI, the Azista-BST and Tata-Satellogic collaborations provided validation of interest in having foreign space entities enter the Indian market. An overview of select Indian academic institutions working in the space sector can be found in Table 6.

Table 6: Overview of Academic Institutions

	LOCATION	FIELD OF EXPERTISE
Physical Research Laboratory (PRL)	Ahmedabad	Research in theorical physics, space and atmospheric sciences, and astronomy.
Tata Institute of Fundamental Research (TIFR)	Mumbai	TIFR has a string focus on astrophysics ad astronomy, includin theorical studies and observational sciences.
Indian Institute of Astrophysics (IIA)	Bangalore	Research in astronomy, astrophysics, and related physics.
National Centre for Radio Astrophysics (NCRA)	Pune	Part of the Tata Institute of Fundamental Research, NCRA is located in Pune and focuses on radio astronomy.
Indian Institute of Remote Sensing (IIRS) - Based in	Dedhradun	IIRS is a premiers training and educational institute functioning under the aegis of ISRO, focusing on remote sensing, geoinformatics, and satellite communication.
Inter-University Centre for Astronomy and AStrophysics (IUCAA)	Pune	IUCAA promotes nucleation and growth of active groups in astronomy and astrophysics in Indian universities.
Raman Research Insititute (RRI)	Bangalore	Based in, RRI conducts research in various areas of astronomy and antroposophysics including theoretical physics.
Indian INstitue of Space Science and Technology (IIST)	Thiruvanan-thapuram	IIST is the first university in Asia to be solely dedicated to the study and research of Outer Spcae. It offers undergraduate and postgraduate programs in space science and technology
Space Physics Laboratory (SPL)	Thiruvanan-thapuram	Part of the Vikram Sarabhai Space Centre in , SPL focuses on aeronomy and atmospheric sciences.

India produces a significant number of engineering graduates annually. According to data from the All India Council for Technical Education (AICTE), which regulates technical education in India, the country graduates over 1.5 million engineers every year from its numerous engineering institutions. This includes graduates across various disciplines, such as mechanical, electrical, electronics, computer science, and aerospace, the latter of which contributes directly to the space engineering talent pool. India's government is proactively nurturing a skilled talent pool for its expanding space sector. Educational programs at prestigious institutions like the IITs and IISc offer specialized courses in aerospace and satellite technology, equipping students for careers in space engineering.

Key research organizations such as ISRO and DRDO provide opportunities for advanced studies and practical experience in space technologies. Outreach and capacity-building programs like YUVIKA (https://www.isro.gov.in/YUVIKA.html) inspire young students to pursue space sciences. The government also invests in infrastructure at educational and research institutions, fostering an environment conducive to innovation.

International collaborations with agencies like NASA and ESA expand the global perspective of Indian space professionals.

CHAPTER 6:

OPPORTUNITIES FOR DANISH STAKEHOLDERS

Increasing possibilities for private sector participation, India's large-scale infrastructure, massive talent pool and cost-effective launch capabilities, opens opportunities for Denmark and Danish stakeholders. As mentioned in chapter 3, there are several promising areas for collaboration between India and Denmark within space, including sustainability, research and development, and public services.

India's space sector relies on 70-80% imports. The gaps in the Indian space sector include parts for ISROs satellite and rocket programs, manufacturing of electronic components and systems, as well as semi-conductors. Furthermore, most Indian companies involved in commercial development of parts for ISRO, operate at tier-2 and 3 levels, which means that they are on the lower end of the supply chain. The role of Denmark and India within the space sector are fundamentally different due to the different size and contexts of the two countries. While India has ISRO, Denmark takes part in the larger global ecosystem, through its membership in ESA, collaborations with NASA and through international exports. India relies in part on imports and has more gaps within its own space ecosystem, while Denmark to a larger extent fills out gaps within the global space ecosystem.

An overview of the strengths and weaknesses of the Danish and Indian ecosystems are given in Table 7.

Table 7: Strengths and weaknesses

	DENMARK	INDIA
Strenghts	• Know-how and expertise in advance technologies and systems • International collaborations and exports • Maturate start-up enviroment	• Cost-effective innovation • Scale • International recognition • Large talent-pool
Weaknesses	• Low investment in the space sector compared to other EU countries (Brix, 2023) • Limited talent-pool	• Mainly lower part of supply chain • Regulatory frameworks and policies are still in development • Complicated bureaucratic processes • Emerging start-up scene

Areas of particular suitability and complementarity for academic and business collaboration include, among others, satellite technology, AI and machine learning, exploration missions, and joint research facilities, particularly focusing on areas such as EO and climate monitoring. Manthan is an Indian government initiative launched by the Office of the Principal Scientific Adviser to facilitate large-scale collaboration between industry and the scientific R&D ecosystem. The platform promotes research, innovation, and technology-led solutions with a focus on social impact and sustainability, aligned with the UN's Sustainable Development Goals (SDGs).

Establishing personal relationships with key players in India's space sector, such as ISRO and emerging space start-ups, is essential (Somanath, 2022). Engaging in policy dialogues to address regulatory barriers and promote joint ventures is another action, which entails comprehending the legal and bureaucratic landscapes of both nations.

There is both bilateral and multilateral funding for research partnerships with Indian universities and research institutions, including joint research projects, exchange of students and faculty, and shared facilities.

Participation in global space forums and conferences serves as an excellent method for Danish stakeholders to expand their networks, explore collaborative opportunities, and stay updated on the latest advancements in the Indian space sector. The biggest event is the Bengaluru Space Expo, which is a biennial event providing a platform for over 100 companies and organizations from around 15 countries, and is organized by the Confederation of Indian Industry in collaboration with ISRO, IN-SPACE and NSIL.

The Global Innovation Network Programme (GINP) supports networking activities between Danish and international research and innovation institutions around the world. The programme is part of the Ministry of Higher Education and Science's efforts to internationalize Danish research and innovation, and enables applicants from Denmark to establish partnerships and carry out networking activities with relevant stakeholders primarily from non-European countries including India.

The key benefits for Danish organizations engaging with the Indian space sector include:

- Technology transfer and co-development - particular in the area of nano-satellites.
- Collaborative R&D projects in downstream applications, i.e. earth observation for environmental and disaster management applications as well as space-based applications, such as improved urban planning, agriculture management, and infrastructure development.
- Export components for the Indian supply chain for satellite and rocket manufacturing in India, which heavily relies on imports.
- Tap into India's tech talent pool and extent joint educational and capacity-building programs that leverage Danish expertise in higher education and research.
- Explore investment opportunities for Danish investors and businesses to engage with and invest in India's booming space start-up ecosystem, which has seen rapid growth and innovation.
- Using platforms like the Bengaluru Space Expo to network with key players in the Indian space sector, explore collaborations, and stay updated on industry trends.

With its growing space program, India offers a wealth of expertise and resources that synergize effectively with Denmark's innovative initiatives in space research and technology. Danish parties interested in exploring the Indian space domain can contact the Innovation Centre Denmark (ICDK) based in Bangalore, India. As the official Danish presence near ISRO, ICDK is primed to aid the right connections with federal and state government incubators, start-ups, VCs and universities with strong space research departments.

APPENDIX 1: INDIAN COMPANIES WITH SPACE ACTIVITIES

NAME	FIELD OF EXPERTISE
Larsen & Toubro (L&T)	An indian multinational conglomerate, manufacturing critical components and systems for satellites and launch vehicles. Collaborates with ISRO on production of missile systems and cryogenic engines.
Godrej Aerospace	Manufacturing precision components and assemblies for spacecraft and launch vehicles. Involved in projects that include making liquid propulsion engines, thrusters for satellites, and parts for launch vehicle assemblies.
Tata Elxi	Provides software and system engineering services for satellite communication and navigation, supporting space exploration, satellite broadcasting, and related applications.
Tata Advanced Systems Limited	Collaborates on defense and aerospace projects, including building subsystems for missile systems and contributing to satellite and radar projects in partnership with global and Indian space agencies.
Ananth Technologies	Satellite assembly, integration, and testing, along with manufacturing subsystems and components for satellites. Additionally, they develop software for satellite ground stations and contribute to launch vehicle operations, playing a key role in several ISO missions.
MapMyIndia (public)	Specializes in providing advanced digital mapping, geospatial software, and location-based IoT technologies. They utilize satellite imagery and data to offer detailed and precise digital maps, navigation, and location-based services across various platforms and applications.
Elena Geo Systems	Provides software and analytical tools, focusing on satellite imagery analysis and geographic information systems (GIS) for applications such as agriculture, urban planning, and environmental monitoring.
Alpha Design Technologies	Specializing in the design, development, and manufacture of satellite subsystems and components. Provide services in assembling, integrating, and testing of satellites, supporting various space missions and satellite communication projects.
Centum Electronics	Manufactures advanced electronic systems and components for the aerospace and defense sectors, including frequency control products and F assemblies used in satellites and space missions. Their offerings support critical applications in communications, navigation, and satellite systems.
Hindustan Aeronautics Limited (HAL)	A state-owned aerospace and defense company involved in the design, fabrication, and assembly of aircraft, jet engines, helicopters, and their spare parts, serving both domestic and international markets.

APPENDIX 2: SELECTED EUROPEAN COMPANIES WITH SPACE ACTIVITIES

NAME	COUNTRY	FIELD OF EXPERTISE
Airbus Defence and Space	France	Collaborated on various satellite projects, including the W2M satellite platform.
Thales Alenia Space	France	Involved in multiple ISRO satellite projects, providing equipment and technology for communication satellites.
SNECMA	France	Collaborated on the development of the Vikas engine, now part of Safran Aircraft Engines.
RUAG Space	Switzerland	Supplied payload fairings for ISRO satellites.
TAS-I (Thales Alenia Space)	Italy	Partnered in radar and optical satellite systems.
DLR (German Aerospace Center)	Germany	Collaborated on scientific projects including the Chandrayaan-1 mission, providing a stereo camera.
OHB System	Germany	Engaged in satellite development and space technology projects with ISRO.
Surrey Satellite Technology United Limited	United Kingdom	Collaborated in developing small satellites and technology sharing.
Arianespace	France	Provided launch services for several ISRO satellites.
Swedish Space Corporation	Sweden	Supported ISRO with telemetry, tracking, and command services.
QinetiQ	UK	Provided scientific instruments and technology.
CGI	UK	Worked on software and data-handling systems for ISRO's satellites.
Airbus Defence and Space	Netherlands	Contributed technology and components for satellite and launch vehicle projects.
ISIS - Innovative Solutions in Space	Netherlands	Specializes in small satellite systems, potential collaborator Space for satellite deployment.
TNO (Nethearlands Organisation for Applied Scientific Research)	Netherlands	Engaged in research and technology projects potentially involving ISRO, especially in optics and technological sectors used in space applications.

APPENDIX 3: KEY CRITERIA FOR FOREIGN SUPPLIERS

Although recent regulatory changes in India have increased accessibility to the space sector for foreign entities, Danish companies must anticipate bureaucratic obstacles and policy shifts that could impact their operations. The key criteria for ISRO to engage with partners are the following:

- Experience in previous missions
- Quality of products
- Certification and inspection by industry bodies, or testing agencies
- Track record of on-time delivery
- Proof of Concept of functioning in real environments
- Willingness of commitment in securing the purchase order

ISRO is typically quite flexible on order and/or batch sizes. This is especially true in imports involving common parts such as capacitors and resistors. Timelines could be fairly long as ISRO has requirements for multiple approvals at various levels. A time period of 3-6 months is preferable for new potential supplier(s). ISRO offices are spread across 20+ locations and cities in India. The five key locations are: Bangalore, Hyderabad, Sriharikota, Thiruvananthapuram and Ahmedabad. Most private sector space companies and start-ups are located in and around Bangalore and Hyderabad, in South India. The list below outlines the typical steps when initiating collaborations with ISRO:

1. Register on ISRO Website
2. Initiate contact with ISRO (with Technical / Systems / Marketing team)
3. Share information on your offerings and company profile with ISRO
4. Share data sheets and/or, Proof of Concept
5. In case of interest/queries, answer queries and request for calls / virtual demos
6. Explain offerings over virtual meetings
7. Follow-up for further interest
8. Schedule physical meeting(s) and showcase offerings, in case of further interest
9. Meet ISRO officials in person (preferably, at an external venue)
10. Follow-up on sustained interest
11. Participate in bid / tender process (in most cases)
12. Provide quotations for purchase order(s)
13. Provide products / services (if selected for purchase order)

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BIBLIOGRAPHY

- AFP. (2023, October 01). *India's private space sector skyrockets.* Retrieved from Economic Times: https://economictimes.indiatimes.com/tech/startups/indias-private-space-sector-skyrockets/articleshow/104081004.cms

- Agarwal, M. (2023, September 19). *Inside India's spacetech boom*. Retrieved from Inc42 Media: https://inc42.com/features/inside-indias-spacetech-boom/

- ANI. (2023, March 28). *Allowing private players in space sector gave shape to new startups: Sunil Bharti Mittal.* Retrieved from Telecom*, E. T.*: https://telecom.economictimes.indiatimes.com/news/portal-in-portal/satcom/allowing-private-players-in-space-sector-gave-shape-to-new-startups-sunil-bharti-mittal/99047977

- Bangalore, I. (2023). *SPACE SECTOR IN INDIA Report and Overview by ICDK Bangalore.* ICDK Bangalore.

- Bhattacharjee, N. (2023, June 7). *Google in funding round for Indian space startup Pixxel.* Retrieved from Reuters: https://www.reuters.com/technology/google-leads-funding-round-indian-space-startup-pixxel-2023-06-01/#:~:text=Alphabet%20Inc%27s%20(GOOGL.,its%20privatisation%20policy%20in%20April.

- Brix, L. (2023, Maj 19). *Kritik: Danmark står på sidelinjen under økonomisk rumfartseventyr.* Retrieved from Videnskab.dk: https://videnskab.dk/rummet/kritik-danmark-staar-paa-sidelinjen-under-oekonomisk-rumfartseventyr/

- Chaudhry, M. (2023, February 24). *India's race to Space: New Heights of Exploration.* Retrieved from Gov.In.: https://www.investindia.gov.in/team-india-blogs/indias-race-space-new-heights-exploration

- Confederation of Indian Industry (CII). (2023, September 13). *Accelerating Growth of India's Space Sector Accelerating Growth of India's Space Sector.* Retrieved from Confederation of Indian Industry: https://www.ciiblog.in/accelerating-growth-of-indias-space-sector/

- Denmark, M. o. (2024, Januray 9). *Green Strategic Partnership.* Retrieved from Indien.um.dk: https://indien.um.dk/en/denmark-in-india/green-strategic-partnership

- Department of Space. (2024, February). *Notes on Demands for Grants, 2024-2025 Department of Space.* Retrieved from Union Budget: https://www.indiabudget.gov.in/doc/eb/sbe95.pdf

- Elizabeth, S. (2023, December 4). *Govt wants private sector to invest in space; companies wait to see commitment from govt.* Retrieved from The Hindu: https://www.thehindu.com/news/cities/bangalore/govt-wants-private-sector-to-invest-in-space-companies-wait-to-see-commitment-from-govt/article67597972.ece

- European Space Policy Institute (ESPI). (2021). ESPI Report 77 - *New Space in Asia - Full Report.* European Space Policy Institute (ESPI).

- Feedback on consultation, internal emails. (2023). ICDK Bangalore.

- Indian Express. (2024, February 28). *Indian Space Missions 2024: Full list of significant space missions by ISRO.* Retrieved from Indian Express: https://indianexpress.com/article/trending/isro-india-space-missions-full-list-9183521/#:~:text=The%20Indian%20Space%20Research%20Organisation%20(ISRO)%20has%20been%20at%20the,and%20432%20-foreign%20satellites%20launched.

- *Indian national space promotion and authorization center.* (n.d.). Retrieved December 18, 2023, from (IN-SPACe). (n.d.). Gov.In.: https://www.isro.gov.in/IN-SPACe.html

- Innovation Centre Denmark Bangalore. (2024, March 8). Meeting with ISRO officials in Bangalore during the visit of the Danish Parliamentary Committee on Higher Education and Research. Bangalore, Karnataka, India.

- ISRO. (2023). *Indian Space Policy - 2023.* Retrieved from https://www.isro.gov.in/media_isro/pdf/IndianSpacePolicy2023.pdf

- Ministry of Higher Education and Science of Denmark. (2021, June). *Denmark's National Space Strategy: Update of strategic objectives.* Copenhagen: Ministry of Higher Education and Science of Denmark. Retrieved from https://ufm.dk/en/publications/2021/files/denmarks-national-space-strategy.pdf

- *NewSpace India limited (NSIL).* (2023, December 18). Retrieved from Gov.In.: https://www.isro.gov.in/NSIL.html

- Parbat, K. (2023, September 25). *India set to relax FDI norms in space sector in bid to give a boost to satcom.* Retrieved from Economic Times: https://economictimes.indiatimes.com/industry/telecom/india-set-to-relax-fdi-norms-in-space-sector-in-bid-to-give-a-boost-to-satcom/articleshow/103914063.cms

- Pramanik, R. K. (2020, January 10). *India's lack of electronics manufacturing ecosystem is hurting Isro's space plans.* Retrieved from The Economic Times: https://economictimes.indiatimes.com/news/science/indias-lack-of-electronics-manufacturing-ecosystem-is-hurting-isros-space-plans/articleshow/73182823.cms

- Press Information Bureau of India . (2024, February 21). *Cabinet approves amendment in the Foreign Direct Investment (FDI) policy on Space Sector.* Retrieved from Press Information Bureau of India: https://pib.gov.in/PressReleasePage.aspx?PRID=2007876

INNOVATION CENTRE DENMARK

- Sadam, R. (2023, October 30). *Skyroot raises $27.5 mln, heating up India's private sector space race.* Retrieved from Reuters: https://www.reuters.com/world/india/skyroot-raises-275-mln-heating-up-indias-private-sector-space-race-2023-10-30/

- Singhal, P. (2022). *The dawn of the space economy in India. Ernst and Young.* Retrieved from Www.ey.com; EY: https://www.ey.com/en_in/aerospace-defense/the-dawn-of-the-space-economy-in-india

- Somanath, I. w. (2022, November 17). *ISRO working closely with space sector startups in India: Chairperson S Somanath.* Retrieved from The Indian Express: https://indianexpress.com/article/cities/bangalore/isro-space-sector-startups-india-chairperson-somanath-8274533/

- Space Foundation. (2023). Space Report 2023 Q2. Space Foundation.

- Space, D. (2023). Email Interview. (J. Stafford, Interviewer)

- Spangsmark, J. (2020, March 4). *The new center will turn the space into a growth adventure in Denmark (Nyt center skal gøre rummet til væksteventyr i Danmark).* Retrieved from DTU.dk: https://www.dtu.dk/nyheder/alle-nyheder/nyhed?id=%7b727c5322-7758-499c-ae02-6fcf0a15294a%7d

- Stafford, J. (2023). Space Tech Trends. Presentation at Global Tech Trends. ICDK Bangalore .

- Statista . (2023, October 2023). *Government expenditure on space sector in India from financial year 2017 to 2024.* Retrieved from Statista: https://www.statista.com/statistics/1220036/india-public-expenditure-on-space-sector/

- Stories, M. (2023, January 5). *ISRO and Microsoft collaborate to support space-tech startups in India.* Retrieved from Microsoft Stories India: https://news.microsoft.com/en-in/isro-and-microsoft-collaborate-to-support-space-tech-startups-in-india/

- The Hindu Bureau. (2023, October 10). *India's space economy has potential to reach $44 billion by 2033 with about 8% global share '.* Retrieved from The Hindu: https://www.thehindu.com/sci-tech/science/indias-space-economy-has-potential-to-reach-35200-crore-44-billion-by-2033-with-about-8-of-global-share/article67403193.ece

- The Mint. (2023, December 14). *Indian space startups got over ₹1,000 cr private investment since April: Report.* Retrieved from Mint: https://www.livemint.com/news/india/indian-space-startups-got-over-rs-1-000-cr-private-investment-since-april-report-11702529514424.html