

DATE: 19 JULY 2026

1 Private Participation in the Space Sector and Mission Aagaman (Source: The Hindu)

PRIVATE PARTICIPATION IN SPACE SECTOR IN INDIA

PARTNERS IN INDIA'S SPACE-POWERED FUTURE

India's space sector is opening new frontiers with private innovation, investment and entrepreneurship working hand-in-hand with ISRO for a self-reliant, globally competitive space ecosystem.

WHY PRIVATE PARTICIPATION?

- Boosts innovation and competition
- Brings in investment and new technologies
- Increases production capacity and reduces costs
- Creates jobs and builds skilled talent
- Expands applications and global presence

POLICY & REFORMS ENABLING GROWTH

- IN-SPACe (Indian National Space Promotion and Authorization Centre) – Single window, handholding support
- Space Activities Authorization and supervision
- Indian Space Policy 2023 – Open, inclusive and future-ready
- Easier norms for FDI (up to 100% under automatic route)

KEY AREAS OF PRIVATE PARTICIPATION

- Launch Vehicles**
Development of small launch vehicles to meet rising demand.
- Satellites & Components**
Design, manufacturing and supply of satellites and sub-systems.
- Ground Segment & Data Services**
Ground stations, data processing, analytics and downstream services.
- Space Applications**
Solutions in communication, navigation, agriculture, disaster management, monitoring and more.
- Emerging Areas**
Space situational awareness, space exploration technologies, reusable systems and more.

GROWING PRIVATE ECOSYSTEM

- 200+ SpaceTech startups recognized by DPIIT (2024)
- Companies like Skyroot Aerospace, Agnikul Cosmos, Pixxel, Dhruva Space, Bellatrix Aerospace and many more leading the change
- Increasing private investments and VC funding
- Collaborations with ISRO, NSIL and global space agencies

IMPACT ON INDIA

- Atmanirbhar Bharat in Space
- Affordable access to space
- Global competitiveness
- Socio-economic benefits through space-based services

SUCCESS STORIES

SKYROOT AEROSPACE	Vikram Series launch vehicles
AGNIKUL COSMOS	3D-printed engines & launch vehicles
PIXXEL	High-resolution Earth observation satellites
DHRUVA SPACE	Satellite platforms & space tech solutions
BELLATRIX AEROSPACE	Propulsion systems & components

THE ROAD AHEAD

- Strengthen R&D and innovation
- Create a level playing field
- Develop infrastructure and test facilities
- Promote industry-academia collaboration
- Prepare for future opportunities in NewSpace economy

TOGETHER, LET'S BUILD A VIBRANT SPACE ECOSYSTEM
Innovate. Collaborate. Transform.
Building New India Beyond the Sky.



DATE: 19 JULY 2026

Mission Aagaman

- Mission Aagaman was a historic orbital spaceflight executed by Hyderabad-based startup Skyroot Aerospace.
- It featured **Vikram-1, India's first privately developed orbital-class rocket**, successfully lifting off from the Satish Dhawan Space Centre in Sriharikota.

2 Falkland Islands (Source: The Indian Express)

A solar storm is a disturbance in space weather caused by the Sun releasing large amounts of energy, radiation, and charged particles

Components of Solar Storms

- **Solar Flare:** A sudden burst of electromagnetic radiation from the Sun. Travels at the speed of light.
- **Coronal Mass Ejection (CME):** Massive eruption of plasma and magnetic fields from the Sun. Takes 1–3 days to reach Earth. The main cause of severe geomagnetic storms.

Impact of Solar Storms

- **Satellites & Space Infrastructure:** Energetic particles damage sensitive electronic components. Furthermore, the radiation heats and expands Earth's upper atmosphere, increasing atmospheric drag. This causes Low Earth Orbit (LEO) satellites to lose altitude prematurely.
- **Navigation and Communication:** Disruptions to the ionosphere interfere with GPS signals, satellite TV, and mobile networks. It specifically halts high-frequency (HF) shortwave radio communication used by aircraft flying over polar regions.
- **Terrestrial Power Grids:** The changing magnetic field induces Geomagnetic Induced Currents (GICs) in the ground. These low-frequency currents flow into high-voltage transmission lines, causing power grid overloads, voltage instability, and catastrophic damage to transformers (e.g., the 1989 Hydro-Québec blackout).
- **Astronaut Safety:** Space weather exposes astronauts (e.g., on the ISS) and passengers on high-altitude polar flights to elevated levels of radiation.
- **Spectacular Auroras:** Charged particles colliding with atmospheric gases create intense Aurora Borealis and Australis, pushing them down to much lower latitudes than normal.

3 Hydrogen Fuel Cell (Source: The Hindu)



HYDROGEN FUEL CELL

CLEAN ENERGY • HIGH EFFICIENCY • ZERO EMISSIONS

Powering a Sustainable Future



Hydrogen fuel cells convert hydrogen and oxygen into electricity, producing only water, heat and clean energy.

WHAT IS A HYDROGEN FUEL CELL?

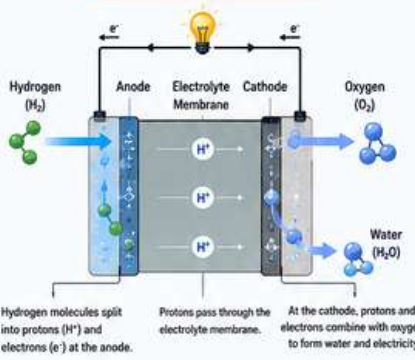
A fuel cell is an electrochemical device that generates electricity through a chemical reaction between hydrogen (H_2) and oxygen (O_2).

It is different from combustion – no burning, no smoke, only clean energy and water.



H_2O

HOW DOES IT WORK?



Hydrogen molecules split into protons (H^+) and electrons (e^-) at the anode.

Protons pass through the electrolyte membrane.

At the cathode, protons and electrons combine with oxygen to form water and electricity.

KEY FEATURES

-  **High Efficiency**
More efficient than conventional engines.
-  **Zero Emissions**
Produces only water and heat.
-  **Low Noise**
Quiet operation with minimal vibration.
-  **Quick Refuelling**
Refuel in 3–5 minutes, similar to conventional fuel.
-  **Modular & Scalable**
Can be used in small devices to large power systems.

COMPONENTS OF A FUEL CELL

-  **Anode**
Hydrogen gas enters and is split into protons and electrons.
-  **Electrolyte Membrane**
Allows only protons to pass, blocks electrons.
-  **Cathode**
Oxygen gas combines with protons and electrons to form water.
-  **Catalyst**
Speeds up the electrochemical reaction (usually platinum based).
-  **Bipolar Plates**
Distribute gases, collect current and provide structural support.

TYPES OF FUEL CELLS

Type	Electrolyte	Operating Temp.	Applications
PEMFC (Proton Exchange Membrane)	Solid Polymer Membrane	60–80°C	Vehicles, portable devices
AFC (Alkaline Fuel Cell)	Potassium Hydroxide	60–90°C	Space, military, backup power
PAFC (Phosphoric Acid Fuel Cell)	Phosphoric Acid	150–200°C	Power plants, large systems
MCFC (Molten Carbonate Fuel Cell)	Molten Carbonate	600–700°C	Power plants, industrial use
SOFC (Solid Oxide Fuel Cell)	Solid Oxide (Ceramic)	700–1,000°C	High efficiency power generation

APPLICATIONS

-  **Transportation**
Fuel cell electric vehicles (FCEVs), buses, trucks, trains, ships.
-  **Stationary Power**
Backup power, distributed generation, microgrids, remote areas.
-  **Portable Power**
Laptops, military equipment, drones, sensors.
-  **Industrial Use**
Refineries, chemicals, steel, and manufacturing units.

HOW HYDROGEN IS PRODUCED?

-  **Green Hydrogen**
Electrolysis of water using renewable energy (solar, wind, hydro).
-  **Blue Hydrogen**
From natural gas with Carbon Capture and Storage (CCS).
-  **Grey Hydrogen**
From natural gas/coal without CCS. (High emissions)

ADVANTAGES

-  Clean and sustainable energy carrier
-  High efficiency and energy density
-  Can be used in transport and stationary applications
-  Supports energy security and reduces fossil fuel dependency
-  Scalable from small devices to large power plants

CHALLENGES

-  High cost of fuel cells and catalysts
-  Hydrogen production and storage infrastructure
-  Limited refuelling stations
-  Storage and transport of hydrogen (low volumetric energy density)
-  Material durability and longevity issues

IMPACT ON INDIA



- Supports India's target of Net Zero by 2070.
- Helps decarbonise transport, industry and power sector.
- Strengthens energy security through indigenous hydrogen economy.
- Creates new opportunities for jobs, innovation and green industries.
- Aligned with National Green Hydrogen Mission (launched in 2023).

THE FUTURE IS HYDROGEN

Hydrogen fuel cells hold the key to a clean, efficient and sustainable energy future. With innovation, infrastructure and policy support, hydrogen can power India towards a self-reliant and green tomorrow.

