



## 3D Printed Cryogenic Engine and Space Sector Privatisation

**For Prelims:** 3D Printing, Cryogenic stage rockets, Initiatives in Privatisation of the Space Sector

**For Mains:** Privatisation of space sector - India's achievements and its significance, India's self-reliance in space technology

### Why in News?

Indian private space vehicle company - **Skyroot Aerospace** - recently test-fired its **3D-printed** cryogenic engine - Dhawan II, developed for its heavier vehicle - Vikram II.

- Earlier in November 2022, Skyroot launched **India's first privately developed rocket Vikram-S.**
- This adds to the growth story of India's **space sector privatisation.**

### What is 3D Printing?

- **3D printing is also known as additive manufacturing** which uses materials such as plastics and metals to convert products envisaged on computer-aided design to real three-dimensional items.
  - It is the opposite of **subtractive manufacturing** which is cutting out/hollowing out a piece of metal or plastic with, for instance, a milling machine.
- 3D printing traditionally has been used for prototyping and **has a lot of scope in making artificial limbs, stents, dental crowns, parts of automobiles and consumer goods**, among others.

### What is a Cryogenic Engine?

- **About:**
  - A cryogenic engine/ cryogenic stage is the **last stage of space launch vehicles which makes use of Cryogenics.**
    - Cryogenics - the **study of the production and behaviour of materials at extremely low temperatures** (below  $-150^{\circ}\text{C}$ ) to lift and place the heavier objects in space.
  - It uses **Liquid Oxygen (LOx) and Liquid Hydrogen (LH<sub>2</sub>)** as propellants.
  - They are **one of the hardest to develop** and so far only 6 countries have these launch vehicles - the **US, China, Russia, France, Japan, and India.**
    - India's heaviest launch vehicles - **GSLV and GSLV Mk III** - use cryogenic fuel in the upper stage of the launch vehicle.
- **Advantages:**

- It is **more efficient and provides more thrust** for every kilogram of propellant it burns compared to solid and earth-storable liquid propellant rocket stages.
- Using a cryogenic upper stage instead of a solid fuel stage **enhances the payload carrying capacity of a rocket.**
- Both fuels (LOx and LH2) are **environment-friendly** compared to other solid, semi-cryogenic and hypergolic propellants used in the rocket industry.
- **Disadvantage:**
  - It is technically a **much more complex system** as against solid/earth-storable liquid propellant stages due to the usage of propellants at extremely low temperatures and the **associated thermal and structural problems.**

## What is Dhawan II?

- The Dhawan cryogenic engine series of Skyroot is named in honour of **Satish Dhawan, an eminent Indian rocket scientist** who played a crucial role in the development of India's space programme.
- Dhawan II builds upon Skyroot's first privately developed fully-cryogenic rocket engine - Dhawan-I, which was successfully test fired in 2021.
  - It is **completely indigenous** and used a superalloy for 3D printing the engine, which **reduced the manufacturing time by 95%.**
- It will use Liquid Natural gas (LNG) and Liquid Oxygen (LoX) as propellants.
  - **LNG is more than 90% methane** and is **considered the rocket fuel of the future.**
- The engine development was **partly supported by [NITI Ayog's ANIC-ARISE program](#)** which promotes technologies including the use of green rocket propellants.

## What are the Initiatives in Privatisation of the Space Sector?

- **IN-SPACE:**
  - **IN-SPACE** was launched to provide a **level playing field for private companies to use Indian space infrastructure.**
  - It **acts as a single-point interface** between [Indian Space Research Organisation \(ISRO\)](#), **and everyone** who wants to participate in space-related activities or use India's space resources.
- **NewSpace India Limited (NSIL):**
  - **NewSpace India Limited (NSIL)** aims to use R&D carried out by ISRO over the years for **commercial purposes through Indian industry partners.**
- **Indian Space Association (ISpA):**
  - **Indian Space Association (ISpA)** is the **apex, non-profit industry body** exclusively working towards the successful exploration, collaboration, and development of the private and public Space Industry in India.
- **Vikram Series of Skyroot:**
  - **Vikram - named after Dr. Vikram Sarabhai**, founder of the Indian Space Program - is a series of **modular Space launch vehicles** especially crafted for the small satellite market.
    - It has 4 variants: **Vikram S, Vikram, Vikram II and Vikram III.**
  - **Vikram S**, made Skyroot the **first Indian private company to send a rocket into space.**
    - **Vikram II** rocket is scheduled to become launch-ready by 2024 which will make the company the **first private launcher from South Asia.**

## How is Privatisation of the Space Sector Significant?

- The global space economy is currently valued at about USD 360.1 billion, however, **India accounts for only ~2% of the space economy.** The private players in the industry have been limited to being vendors/suppliers to the govt.'s space program.
  - Enhanced participation of **Non-Governmental Entities (NGEs)** in the space sector will

**boost India's market share in the Global Space Economy.**

- Promoting the private sector will **enable the Indian space program to remain cost competitive** within the global space market, and thus create several jobs in the space and other related sectors.
  - This will **help India to position itself as a global leader in space technology** and innovation.
- **Private players can bring in new technologies**, innovation, and management skills, leading to **cost optimisation and increased efficiency** in space-related activities.
  - This will also **free up government resources to focus on other critical sectors**.

**Note**

- **India is the 6th-largest player in the space industry** internationally, having **~3.6% of the world's space-tech companies** (as of 2021).
- The US holds the leader's spot housing 56.4% of all companies in the space-tech ecosystem followed by the UK (6.5%), Canada (5.3%), China (4.7%) and Germany (4.1%).

**UPSC Civil Services Examination Previous Year Questions (PYQs)**

**Q. With reference to India's satellite launch vehicles, consider the following statements: (2018)**

1. PSLVs launch the satellites useful for Earth resources monitoring whereas GSLVs are designed mainly to launch communication satellites.
2. Satellites launched by PSLV appear to remain permanently fixed in the same position in the sky, as viewed from a particular location on Earth.
3. GSLV Mk III is a four-staged launch vehicle with the first and third stages using solid rocket motors; and the second and fourth stages using liquid rocket engines.

**Which of the statements given above is/are correct?**

- (a) 1 only
- (b) 2 and 3
- (c) 1 and 2
- (d) 3 only

**Ans: (a)**

**Source: IE**