



Indian Railways Tests First Hydrogen-Powered Coach

[Source: IE](#)

Why in News?

[Indian Railways](#) has successfully tested its **first hydrogen-powered coach at the Integral Coach Factory (ICF) in Chennai**, as part of its “**Hydrogen for Heritage**” initiative.

- The project involves converting two 1600 HP diesel power cars into **Hydrogen Fuel Cell** systems and setting up a 3,000 kg hydrogen refuelling station at **Jind, Haryana**.
- The design and testing are being carried out by the [Research Designs and Standards Organisation \(RDSO\)](#).

What are the Key Benefits of Hydrogen as a Power Source?

- **High Energy Density and Versatility:** Hydrogen possesses one of the **highest energy-to-weight ratios** among known fuels, making it exceptionally well-suited for heavy-duty transportation sectors.
 - Furthermore, it **is versatile** and can be used in [fuel cells](#), **internal combustion engines**, or as a feedstock in industrial processes.
- **Zero Emission Energy Carrier:** When used in fuel cells, **hydrogen emits only water vapor as a byproduct**, making it a critical enabler of clean mobility and industrial decarbonization.
- **Supports Renewable Energy Integration:** Hydrogen acts as an **energy storage vector**, allowing excess electricity from intermittent [renewable sources](#) (like **solar and wind**) to be stored in the form of hydrogen via electrolysis.
 - This helps in **grid stabilization, peak shaving, and achieving round-the-clock (RTC) power supply**—a key requirement for energy reliability and sustainability.
- **Decarbonization of Hard-to-Abate Sectors:** [Green hydrogen](#) enables deep decarbonization of hard-to-abate sectors such as **steel manufacturing, cement production, oil refining, fertilizers, and chemical industries**, where direct electrification is either technically or economically unfeasible.

Note: **Hydrogen** is central to India’s strategy to achieve energy independence and [Net Zero emissions by 2070](#). India’s [National Green Hydrogen Mission](#) aims to make the country a global hub for green hydrogen production and export, positioning India as a key player in the emerging hydrogen economy.

- **Hydrogen Fuel Cell:** It is an electrochemical device that converts **chemical energy of hydrogen into electricity through a reaction with oxygen**, with water and heat as the only by-products.
- **Applications of Hydrogen Fuel Cell:**
 - **Transportation:** Powering cars, buses, trucks, trains, and drones.
 - **Stationary Power:** Backup and off-grid power for homes, businesses, and data centers.
 - **Portable Power:** Charging laptops, phones, and equipment in remote areas.
 - **Industrial Use:** Forklifts, cranes, and machinery in warehouses and factories.
 - **Space Exploration:** Powering spacecraft (e.g., NASA uses hydrogen fuel cells particularly in their crewed space missions like the **Apollo**).

What are the Key Technological Developments in Indian Railways?

- **Artificial Intelligence & Automation**
 - **'Gajraj' Elephant Detection System:** AI-based tool using optical fiber to detect elephant movement near tracks.
 - **AI in Namo Bharat (RRTS) Trains:** AI-enabled security surveillance and automated schedule optimization.
- **Rail Safety Technologies**
 - **Kavach (Automatic Train Protection):** Prevents signal passing at danger (SPAD) and over-speeding.
 - Uses RFID to apply brakes automatically.
 - Certified at **SIL-4 level**, error probability: 1 in 10,000 years.
 - **Ultrasonic Flaw Detection (USFD):** Detects rail cracks and flaws to prevent derailments.
 - Used for real-time track condition monitoring.
- **Signalling & Interlocking Systems**
 - **Electronic Interlocking (EI):** Widely adopted to reduce human error and automate signal control.
 - **Automatic Block Signalling (ABS):** Railway signaling system that allows for increased train traffic on high-density routes by **enabling multiple trains to operate simultaneously in the same direction.**
- **Sustainability:**
 - **Bio-toilets:** **Bio-toilets** in Indian Railways use **anaerobic bacteria** to decompose human waste in a sealed biodigester tank, converting it into **water and gases.**
 - **Developed by DRDO**, these systems prevent open discharge on tracks, improving hygiene and reducing corrosion.

UPSC Civil Services Examination, Previous Year Question (PYQ)

Q. With reference to bio-toilets used by the Indian Railways, consider the following statements: (2015)

1. The decomposition of human waste in the bio toilets is initiated by a fungal inoculum.
2. Ammonia and water vapour are the only end products in this decomposition which are released into the atmosphere.

Which of the statements given above is/are correct?

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

Ans: (d)

