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India's First Hydrogen-Powered Passenger Train Cleared

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WHY IN NEWS

> *In July 2026, the Railway Board approved India's first regular daily hydrogen fuel-cell passenger service, to run on the 89-km Jind-Sonipat section of Northern Railway's Delhi Division in Haryana, with the flag-off scheduled for around July 17, 2026.*

WHAT HAS BEEN APPROVED

The rake has been built indigenously by the **Integral Coach Factory (ICF), Chennai**. It is a **10-coach train** powered by a **1,200 kW hydrogen fuel-cell propulsion system**, with a maximum service speed of **75 kmph**. The service will operate **two round trips a day** on the Jind-Sonipat corridor, and the train emits only **water vapour and heat**, with no carbon dioxide, oxides of nitrogen or particulate matter at the tailpipe.

This is not a one-off demonstration run. It is the first time hydrogen traction enters India's regular passenger timetable, which is what makes the approval significant. The choice of route is deliberate (https://ujiyari.com/vocab/deliberate/): Jind-Sonipat is a short, largely non-electrified branch corridor, exactly the kind of line where hydrogen has a genuine engineering case.

The Programme Behind It

The service falls under **"Hydrogen for Heritage"**, announced in the **Union Budget 2023-24**, under which **35 hydrogen trains** are planned, primarily on **heritage and hill routes**. These are precisely the sections where stringing overhead equipment is either visually intrusive, topographically hard, or economically unjustifiable for low traffic density.

HOW A HYDROGEN FUEL-CELL TRAIN WORKS

A **fuel cell** is an electrochemical device, not a combustion engine. Hydrogen supplied from onboard high-pressure tanks meets oxygen drawn from ambient air across a membrane. The reaction produces three outputs: **water, electricity and heat**. The electricity drives traction motors, usually through a buffer battery that handles acceleration peaks and captures regenerative braking energy.

The key point for the exam is that a fuel cell is a **converter, not a fuel**. It has zero tailpipe emissions, but its total climate footprint depends entirely on how the hydrogen was made upstream.

Green Versus Grey Hydrogen

- **Green hydrogen:** produced by electrolysis of water using renewable electricity. Genuinely low-carbon.
- **Grey hydrogen:** produced by steam methane reforming of natural gas. Emits substantial carbon dioxide.
- **Blue hydrogen:** grey hydrogen paired with carbon capture and storage.

A hydrogen train running on grey hydrogen simply relocates the emissions from the rail corridor to the reformer plant. **A fuel cell is only as clean as the electricity feeding its electrolyser.**

THE POLICY BACKDROP

The **National Green Hydrogen Mission** was approved in **January 2023** with an outlay of about **Rs 19,744 crore** and a target of **5 million metric tonnes (MMT)** of green hydrogen production a year by **2030**. Its principal instrument is the **SIGHT programme** (Strategic Interventions for Green Hydrogen Transition), which supports domestic electrolyser manufacturing and green hydrogen production. Indian Railways, separately, has committed to becoming a **net-zero carbon emitter**.

COMPARING THE THREE TRACTION OPTIONS

PARAMETER	HYDROGEN FUEL CELL	OVERHEAD ELECTRIC (OHE)	DIESEL
Tailpipe emissions	Only water vapour and heat	None at the train	CO_2, NOx, particulates
Upstream footprint	Depends on green vs grey hydrogen	Depends on grid mix	High
Infrastructure needed	Refuelling stations, storage	Overhead wires, substations	Fuelling depots
Best suited to	Non-electrified branch, heritage and hill routes	Dense, high-traffic trunk routes	Legacy fallback
Energy efficiency	Lower (multiple conversion steps)	Highest (direct supply)	Low
Capital cost per km	High rolling stock cost	High fixed infrastructure cost	Lowest upfront
Noise	Low	Low	High

THE HONEST CASE FOR HYDROGEN IN INDIA

India has **electrified nearly its entire broad-gauge network**, which changes the argument fundamentally. Hydrogen is **not a substitute for electrification** here, and any claim that it is should be treated sceptically in an answer script. Overhead electric traction remains more energy-efficient because it delivers grid electricity directly to the motors, whereas hydrogen loses energy at every step: electrolysis, compression, storage, and reconversion in the fuel cell. This **round-trip efficiency** penalty is hydrogen's core weakness.

The defensible case for hydrogen traction therefore rests on **niches**:

1. **Non-electrified heritage and hill routes**, where overhead wires are impractical or aesthetically damaging.
2. **Low-density branch lines**, where the fixed cost of electrification cannot be recovered from traffic.
3. **Heavy-haul freight and shunting**, where energy density matters and duty cycles are long.
4. **Industrial demand aggregation**, where rail offtake helps build the hydrogen ecosystem that steel, refining and fertiliser sectors will need anyway.

Challenges to Watch

- **Cost per passenger-kilometre** is currently far above electric traction, and viability depends on green hydrogen prices falling.
- **Storage and refuelling safety:** hydrogen is stored at very high pressure and has a wide flammability range, requiring rigorous station design and codes.
- **Refuelling infrastructure** is capital-heavy and, at present, has almost no network effect.
- **Feedstock** (https://ujiyari.com/vocab/feedstock/) **risk:** without assured green hydrogen supply, the environmental gain is notional.

ANALYSIS AND WAY FORWARD

The Jind-Sonipat service is best read as a **capability-building exercise** rather than a decarbonisation (https://ujiyari.com/vocab/decarbonisation/) breakthrough. It gives ICF a working platform, gives Indian Railways operational data on refuelling, safety and reliability, and gives domestic industry an anchor customer. The way forward is to be clear-eyed: keep electrification as the backbone, deploy hydrogen where wires cannot go, tie every hydrogen rake to a **green** hydrogen supply contract rather than grey feedstock, and publish transparent cost-per-passenger-km data so that the technology is judged on evidence rather than symbolism.

Globally, the template exists. Germany's **Coradia iLint**, built by **Alstom**, became the **world's first hydrogen passenger train in 2018**, and its subsequent operational experience, including its partial rollback in favour of battery trains on some routes, is itself an instructive lesson in matching technology to route.

UPSC RELEVANCE

GS Paper 3: Science and technology, indigenisation (https://ujiyari.com/vocab/indigenisation/) of technology; infrastructure (railways); energy; environmental pollution and conservation; climate change mitigation and clean-energy transition.

Prelims pointers:

- India's first hydrogen fuel-cell passenger service runs on the 89-km Jind-Sonipat section, Northern Railway, Delhi Division (Haryana).
- The rake was built by the Integral Coach Factory (ICF), Chennai: 10 coaches, 1,200 kW fuel-cell propulsion, maximum service speed 75 kmph, two round trips a day.
- The programme is "Hydrogen for Heritage", announced in Budget 2023-24, with 35 trains planned on heritage and hill routes.
- A fuel cell combines hydrogen and oxygen to give water, electricity and heat, with zero tailpipe CO_2, NOx or particulate matter.

- The National Green Hydrogen Mission was approved in January 2023, outlay about Rs 19,744 crore, target 5 MMT of green hydrogen a year by 2030, supported by the SIGHT programme.
- Indian Railways targets becoming a net-zero carbon emitter.
- The world's first hydrogen passenger train was Germany's Coradia iLint (Alstom, 2018).

Mains question: "Hydrogen traction is a niche decarbonisation tool for Indian Railways, not a substitute for electrification. Critically examine this statement, considering round-trip energy efficiency, green versus grey feedstock, and cost per passenger-kilometre." (15 marks, 250 words)

FACTS CORNER

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Route: Jind-Sonipat, 89 km, Northern Railway, Delhi Division, Haryana.

Rake: built by Integral Coach Factory (ICF), Chennai; 10 coaches; 1,200 kW hydrogen fuel-cell propulsion.

Operations: maximum service speed 75 kmph; two round trips a day; flag-off around July 17, 2026.

Emissions: only water vapour and heat; no tailpipe CO2, NOx or particulates.

Programme: "Hydrogen for Heritage", Budget 2023-24; 35 trains planned on heritage and hill routes.

National Green Hydrogen Mission: approved January 2023; outlay about Rs 19,744 crore; target 5 MMT a year by 2030; SIGHT programme is the key instrument.

Railways goal: net-zero carbon emitter.

Global first: Germany's Coradia iLint (Alstom), 2018.

Sources: Ministry of Railways, Ministry of New and Renewable Energy, Business Standard

Source: India's First Hydrogen-Powered Passenger Train Cleared — Ujiyari.com | Free UPSC & State PCS Current Affairs

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