# Green Hydrogen

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**Why is in news?** The country's largest fuel retailer Indian Oil Corporation (IOC) started the operational trial of green hydrogen-fuelled buses in Delhi and the nearby areas of the National Capital Region (NCR).

The trial, which was launched by Petroleum Minister Hardeep Singh Puri in the capital with two hydrogen fuel cell buses manufactured by Tata Motors, will include 15 buses by the end of the year.

**About the trail:**

As part of the trial, the buses will ply on a predetermined route of over 100 km in Delhi NCR and will clock a cumulative mileage of over 3 lakh kilometres for long-term performance and durability assessment.

The buses are fitted with four cylinders with a cumulative capacity of 30 kilograms of hydrogen at 350 bar pressure, providing a **total estimated range of over 350 km for a full refill**, which comes out to **around 12 km per kg**.

This is considerably **higher than the fuel economy** of **around 3 km per litre for diesel-powered buses**.

According to IOC officials, it **takes 10-12 minutes to fully refill one bus** with 30 kg of hydrogen.

Fuel cell vehicles are also considered **superior** to regular battery-powered electric vehicles.

Fuel cells are **highly efficient as compared to other mobility options**. Fuel cell vehicles have inherent advantages of long range and lower refuelling time as compared to battery vehicles.

The success of this project can **catapult India from being net importer of fossil energy to becoming net exporter of clean hydrogen energy**; provide global leadership to other countries in terms of technology transfer while becoming a large green hydrogen producer and supplier of manufacturing parts.

**Hydrogen:**

There are **no natural hydrogen deposits on earth**, it has to be extracted from other compounds by a chemical process.

The vast majority of industrial hydrogen is currently produced from natural gas through a process known as **Steam Methane Reforming or SMR**.

Producing hydrogen in this way is sometimes referred to as **Brown or Grey or even Blue Hydrogen**.

**Types of Hydrogen**:

**Brown Hydrogen**: Most of the gas that is already widely used as an industrial chemical is either brown, if it's made through the gasification of coal or lignite.

**Grey Hydrogen**: If it is made through steam methane reformation, which typically uses natural gas as the feedstock. Neither of these processes is exactly carbon-friendly.

**Blue Hydrogen**: Where the gas is produced by steam methane reformation but the emissions are curtailed using carbon capture and storage.

**Green Hydrogen**: Green hydrogen, in contrast, could almost eliminate emissions by using renewable energy — increasingly abundant and often generated at less-than-ideal times — to power the electrolysis of water.

**Green Hydrogen**:

Green hydrogen is a **clean energy source** produced through the **electrolysis of water using renewable energy sources** such as wind, solar, and hydro power.

It has the potential to become a key player in the transition to a carbon-free economy and can help mitigate climate change.

The hydrogen produced can be stored and used as a fuel for transportation, industry, and agriculture.

**India's Green Hydrogen aspiration**:

India has set a **target of producing 5 million tonnes per annum** (MTPA) of green hydrogen **by 2030** through the recently launched **National Green Hydrogen Mission**.

Rapid scaling up of green hydrogen projects in India would require the development of a favourable ecosystem, and a **single window clearance for green hydrogen projects** would be a key component.

In this regard, the development and harmonisation of hydrogen standards would play a critical role in making it for businesses to enter the green hydrogen market.

In addition, since India **aims to be a global hub for green hydrogen** in the coming decades, the synchronisation of standards across the value chain with global export markets is of the utmost importance.

**Measures to increase production**:

The government launched **National Green Hydrogen Mission** early this year with an aim to produce 5 million metric tonne (MMT) green hydrogen per annum with an associated renewable energy capacity of about 125 giga watt (GW) by 2030.

The **Strategic Interventions for Green Hydrogen Transition (SIGHT) programme** is a major financial measure under the mission with an outlay of Rs 17,490 crore.

The programme proposes **two distinct financial incentive mechanisms** to support domestic production of electrolysers and production of green hydrogen. These incentives are aimed at enabling rapid scale-up, technology development and cost reduction.

The **Green Hydrogen Consumption Obligations** proposed by the Ministry of New and Renewable Energy (MNRE) has to introduce green hydrogen consumption obligations for fertilizer and the petroleum refining industry, like the renewable purchase obligations for electricity distribution companies.

For developing **Green Hydrogen Hubs**, the Ministry of New and Renewable Energy has identified regions that can support large scale production and/or utilization of green hydrogen and develop them as green hydrogen hubs.

**National Green Hydrogen Mission**:

The National Green Hydrogen Mission was **approved by the Union Cabinet on 4 January 2022.**

It is a program to **incentivise the commercial production of green hydrogen** and make India a net exporter of the fuel.

India has set its sight on **becoming energy independent by 2047 and achieving Net Zero by 2070**. To achieve this target, increasing renewable energy use across all economic spheres is central to India's Energy Transition.

Green Hydrogen is considered a promising alternative for enabling this transition.

Hydrogen can be **utilized for long-duration storage of renewable energy, replacement of fossil fuels in industry, clean transportation, and potentially also for decentralized power generation, aviation, and marine transport**.

The mission is under the **Ministry of New and Renewable Energy**.

**Objectives**:

Making India a leading producer and supplier of Green Hydrogen in the world

Creation of export opportunities for Green Hydrogen and its derivatives

Reduction in dependence on imported fossil fuels and feedstock

Development of indigenous manufacturing capabilities

Attracting investment and business opportunities for the industry

Creating opportunities for employment and economic development

Supporting R&D projects

**Mission's outcome**:

The mission outcomes **projected by 2030** are:

Development of green hydrogen production capacity of at least 5 MMT (Million Metric Tonne) per annum with an associated renewable energy capacity addition of about 125 GW in the country

Over Rs. Eight lakh crore in total investments

Creation of over Six lakh jobs

Cumulative reduction in fossil fuel imports over Rs. One lakh crore

Abatement of nearly 50 MMT of annual greenhouse gas emissions

**Advantages of Green Hydrogen**:

The intermittent nature of renewable energy, especially wind, leads to grid instability. Green hydrogen **can be stored for long periods** of time. The stored hydrogen can be used to produce electricity using fuel cells.

In a fuel cell, a device that converts the energy of a chemical into electricity, hydrogen gas reacts with oxygen to produce electricity and water vapour. Hydrogen, thus, can act as an energy storage device and **contribute to grid stability**.

Hydrogen is a **flexible energy carrier** and can be used for many energy applications like the integration of renewables and transportation.

It is produced using RE and electrolysis to split water and is distinct from grey hydrogen, which is produced from **methane and releases greenhouse gases**.

Energy can be extracted from hydrogen through combustion or through fuel cells, which **emit only water as a by-product**.

**Global dominance increasing**: Several countries in Europe and North America are experimenting with mixing green hydrogen with PNG. The mixing is around 15-20% in some networks.

Besides, there are **various pilot projects** on hydrogen blending with PNG being tested in countries like the Netherlands, Germany, France, Australia, South Korea and Japan.

**Disadvantages**:

According to a study by the **US Energy Department's National Renewable Energy Laboratory (NREL) in 2013**, "How it (hydrogen) affects the pipelines it travels in and appliances that use it.

On the pipeline front, **hydrogen embrittlement can weaken metal or polyethylene pipes** and **increase leakage risks**, particularly in high-pressure pipes".

**Brittle**: Hydrogen embrittlement is a situation when the metal (pipeline) becomes brittle due to the diffusion of hydrogen into the material. The extent of embrittlement depends on the amount of hydrogen and the material's microstructure.

**Way Ahead**:

Renewable developers see green hydrogen as an emerging market and some have targeted the transport sector, although electric vehicles have begun to catch the imagination of consumers today.

Policymakers need to take a holistic approach to plan and analyse the best model suited to adopt green hydrogen as a primary fuel.