Green Hydrogen

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Why is in news? Why green hydrogen presents both major opportunities and significant challenges

The Ministry of New and Renewable Energy (MNRE) has announced a Rs-496-crore (until 2025-26) scheme to **support pilot projects** that **either test the viability of green hydrogen as a vehicle fuel or develop secure supporting infrastructure** such as refuelling stations.

Big Indian commercial vehicle manufacturers such as Tata Motors, Volvo Eicher, and Ashok Leyland are doubling down on efforts to develop hydrogen-powered trucks and buses by ramping up research and development, and building manufacturing capacities.

Indian energy companies too are **trying to scale up production of green hydrogen** and bring down costs to make it affordable enough to compete with other fuels.

Hydrogen is **expected to be used widely in the transportation sector** in the coming years, and as a large and growing market for both vehicles and energy, India stands to gain significantly from the large-scale adoption of green hydrogen as vehicular fuel.

<u>About the MNRE scheme:</u>

The major objectives of the MNRE scheme, guidelines for which were issued in February, include -

- Validation of technical feasibility and performance of green hydrogen as a transportation fuel,

- Evaluation of the economic viability of green hydrogen-powered vehicles, and

- Demonstration of safe operation of hydrogen-powered vehicles and refuelling stations.

The **Ministry of Road Transport & Highways** will **appoint a scheme implementation agency** that will invite proposals for pilot projects. The selected company or consortium will be the project's executing agency.

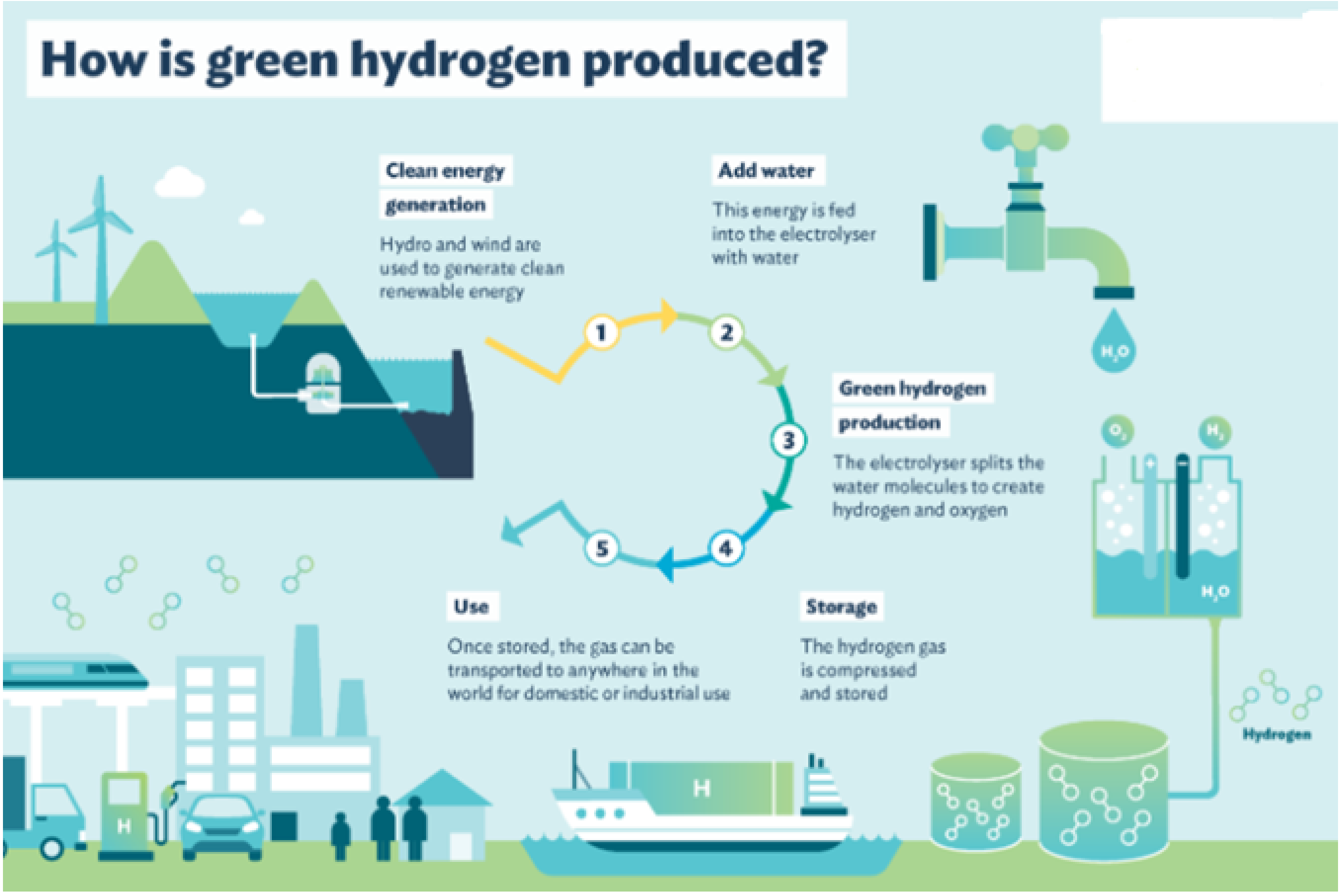
Based on the **recommendation of a Project Appraisal Committee**, the MNRE will **approve viability gap funding** (VGF) for the project.

The VGF amount will be finalised after considering "specific needs, merits, and feasibility of each project".

The executing agency will be required to **complete the pilot project within two years**.

<u>Green hydrogen:</u>

Hydrogen is colourless, and green hydrogen is 'green' only by virtue of the way it is produced, and the source of the energy used to manufacture it.



Green hydrogen refers to **hydrogen that is produced from the electrolysis of water** — splitting it into hydrogen and oxygen — using an electrolyser powered by renewable energy.

This is considered to be a **virtually emission-free pathway** for hydrogen production — it is ‘end-to-end’ green because it is powered by green energy, uses water as feedstock, and emits no carbon on consumption.

Currently, most hydrogen produced **for industrial consumption and applications** is **‘grey’ hydrogen**, which is **produced from natural gas** through energy-intensive processes, and has high carbon emissions.

Except for a difference in the production pathway and emissions, green hydrogen is essentially the same as grey — or hydrogen categorised by any other colour.

Green hydrogen promises **significant reductions of emissions** to help slow global warming and climate change.

India sees advantages ranging from **curbing pollution and meeting its climate goals to reducing costly fossil fuel imports**, as well as a **business opportunity** to become a global hub for the production and export of green hydrogen.

Types of Hydrogen:

Colour code	The source or the process used
Green hydrogen	Produced through water electrolysis process by employing re reason it is called green is that there is no CO2 emission durin Water electrolysis is a process which uses electricity to decomp gas and oxygen.
Blue hydrogen	Sourced from fossil fuel, the CO2 is captured and store sequestration). Companies are also trying to utilise the captu capture, storage and utilisation (CCSU). Utilisation is not ess hydrogen. As no CO2 is emitted, so the blue hydrogen categorised as carbon neutral.
Gray hydrogen	Produced from fossil fuel and commonly uses steam me method. During this process, CO2 is produced and eve atmosphere.
Black/brown hydrogen	Produced from coal- the black and brown colours refer to the and lignite (brown) coal. The gasification of coal is a m hydrogen- it is a very polluting process, and CO2 and carbon m by-products and released to the atmosphere.
Turquoise hydrogen	Extracted by using the thermal splitting of methane via methan though at the experimental stage, remove the carbon in a solid f
Purple hydrogen	Made using nuclear power and heat through combined che splitting of water.
Pink hydrogen	Generated through electrolysis of water by using electricity fro
Red hydrogen	Produced through the high-temperature catalytic splitting of w thermal as an energy source.
White hydrogen	Naturally occurring hydrogen.

Significance of Hydrogen fuel cell vehicles:

A **hydrogen internal combustion engine** (ICE) vehicle utilises **hydrogen through combustion** — which is similar to cars running on diesel and petrol, except there are no carbon emissions.

A **hydrogen fuel cell electric vehicle (FCEV)** utilises **hydrogen electrochemically** by converting hydrogen stored in a high-pressure tank into electricity, leaving water as the byproduct.

Even though hydrogen ICE vehicles do not emit carbon, research suggests that **burning hydrogen** is far **less energy efficient** than converting it into electricity in a fuel cell.

Compared to battery electric vehicles (BEVs), in which the battery is the heaviest part, hydrogen FCEVs are typically **much lighter** because hydrogen is a light element, and a fuel cell stack weighs lesser than an electric vehicle (EV) battery.

This makes hydrogen fuel cell technology a viable alternative to EV battery technology, **especially for heavy-duty trucks** that can benefit from an increased payload capacity — without coughing clouds of smoke from burning diesel.

Indeed, research shows that **long-haul FCEVs** can carry freight amounts similar to diesel trucks, whereas long-haul BEVs have a weight penalty of up to 25% due to heavier batteries.

Given the need to cut carbon emissions in the transportation sector, while ensuring there is no loss in revenue-generating payload capacity, green hydrogen holds promise.

Benefits of Green Hydrogen Fuel:

Green hydrogen, being **virtually emission-free in production and usage**, significantly reduces greenhouse gases.

It aids in **combating global warming and climate change** by offering a cleaner alternative to fossil fuels.

There's potential for India to become a global hub in the production and export of green hydrogen, fostering **new business opportunities.**

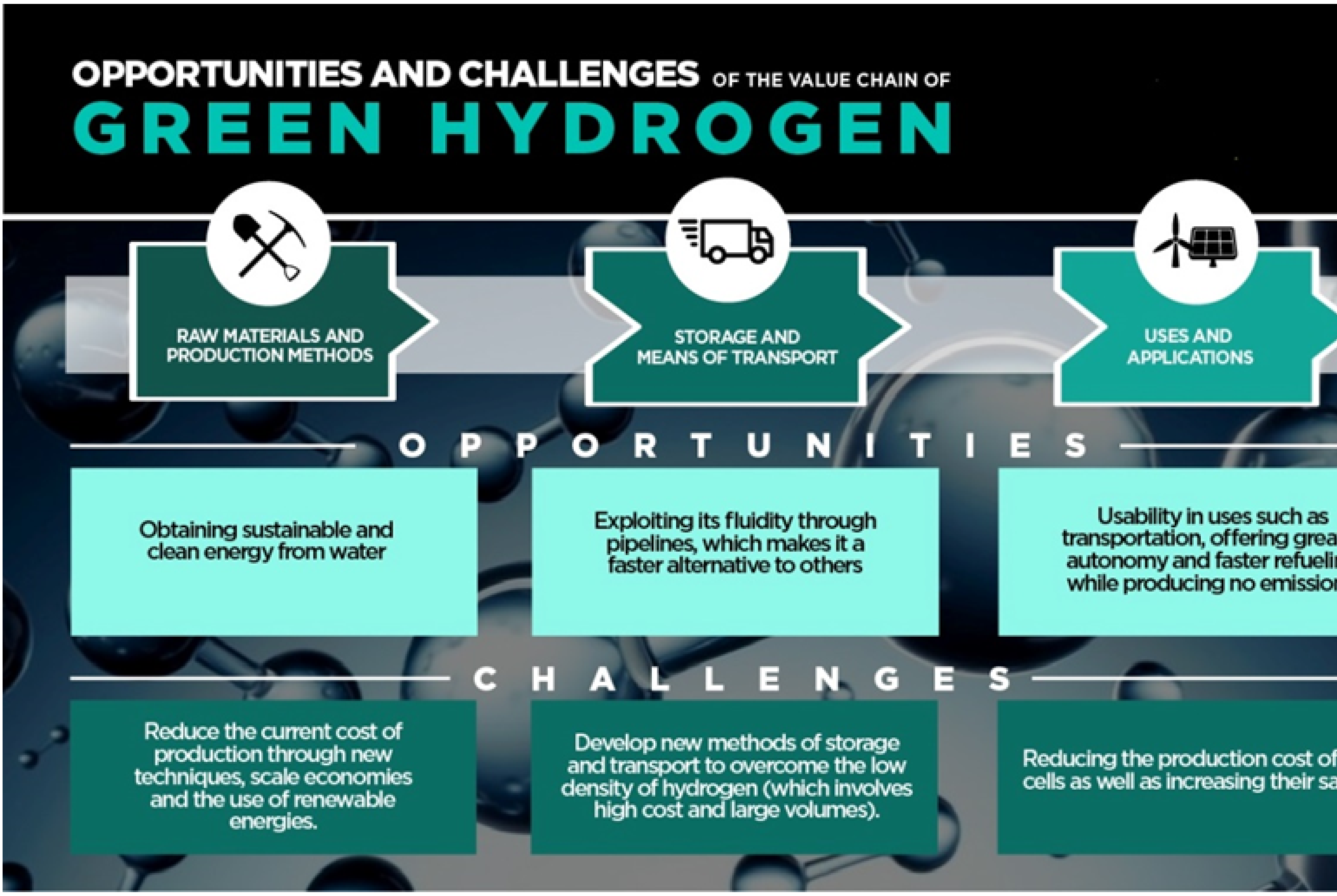
India could **reduce its dependence on costly fossil fuel imports**, contributing to energy security.

Green hydrogen production advances renewable energy **technologies** and **supports the shift towards sustainable energy practices.**

It's a **promising solution for the transportation sector**, particularly for heavy-duty vehicles like trucks and buses, where it can replace diesel, reducing pollution.

Challenges:

There are significant challenges to the large-scale use of green hydrogen in the transportation sector.



Storage and Transportation Challenges: Hydrogen is extremely flammable, which means that special care would be needed in handling the fuel. Developing **specialized cylinders** capable of safely storing high-pressure green hydrogen is essential. Existing cylinders designed for compressed natural gas (CNG) are not suitable for hydrogen storage

Safety Concerns: Hydrogen is **highly flammable**, necessitating robust safety standards and protocols for handling and storing the fuel at refuelling stations.

Competition and Market Readiness: Electric vehicles (EVs), particularly with advancements in battery technology, pose a competitive challenge. Green hydrogen-powered vehicles are yet to gain widespread acceptance as an alternative to battery electric vehicles (BEVs) for personal transportation.

Conclusion:

Green hydrogen offers zero emissions, energy efficiency, and diversification in energy sources for transportation. However, challenges like storage, infrastructure costs, and safety concerns hinder widespread adoption, despite MNRE's support scheme.