



Hydrogen Fuel Cell

For Prelims: Hydrogen fuel cells, Green hydrogen, Brown hydrogen, Grey hydrogen, Blue hydrogen, National Hydrogen Energy Mission (NHM).

For Mains: Significance of Hydrogen Fuel Cell.

Why in News?

Recently, Germany launched the **world's first fleet of fully hydrogen-powered trains, these are emissions-free trains** that can reach speeds of 140 kilometres per hour and can run about 1,000 km before the tank runs dry.

What are the Key Points of Hydrogen Fuel Cell?

▪ About:

- Hydrogen fuel cells are a **clean, reliable, quiet, and efficient source of high-quality electric power.**
- They use hydrogen as a fuel to drive an electrochemical process that produces electricity, with water and heat as the only by-products.
 - **Hydrogen** is one of the most abundant elements on earth for a **cleaner alternative fuel option.**

What are the Types of Hydrogen based on the process of its formation?

- **Green hydrogen** is produced by **electrolysis of water using renewable energy (like Solar, Wind)** and has a **lower carbon footprint.**
 - Electricity splits water into hydrogen and oxygen.
 - **By Products:** Water, Water Vapor.
- **Brown hydrogen** is produced **using coal** where the emissions are released into the air.
- **Grey hydrogen** is produced from **natural gas** where the associated **emissions are released into the air.**
- **Blue hydrogen** is produced from natural gas, where the **emissions are captured** using carbon capture and storage.

▪ Significance:

- **Best Zero Emission Solutions:** It is one of the **best Zero Emission solutions.** It is completely **environment friendly with no tailpipe** emissions other than water.
 - **Tailpipe emissions:** Emission of something such as gas or radiation into the atmosphere.
- **Quiet operation:** The fact that the fuel cells make little noise means that they can be used in challenging contexts, such as in hospital buildings.
- **Easier scaling:** Operation times of fuel cells are longer than those of batteries, with fuel cells, only the amount of fuel needs to be doubled to double the operation time, while

batteries require the capacity of the components to be doubled to achieve the same.

▪ **Issues:**

- **High Cost:** Green hydrogen makes up **only 0.03% of global hydrogen production** and it is up to five times more expensive than 'grey' hydrogen produced from natural gas or worse, 'brown' hydrogen produced from coal.
- **Hydrogen Storage:** Storage and transportation of hydrogen is more complex than that required for fossil fuels. This implies additional costs to consider for hydrogen fuel cells as a source of energy.
- **Hydrogen Extraction:** Despite being the most abundant element in the Universe, hydrogen does not exist on its own so needs to be extracted from water via electrolysis or separated from **carbon fossil fuels**.
 - Both of these processes require a significant amount of energy to achieve. This energy can be more than that gained from the hydrogen itself as well as being expensive.
 - In addition, this extraction typically requires the use of fossil fuels, which in the absence of carbon capture and storage (CCS) **undermines the green credentials of hydrogen**.

▪ **Indian Scenario:**

- **Initiatives Taken:** The Union Budget for 2021-22 has announced a [**National Hydrogen Energy Mission \(NHEM\)**](#) that will draw up a road map for using hydrogen as an energy source.
- **Other Initiatives for Renewable Energy:**
 - [**Jawaharlal Nehru National Solar Mission \(JNSM\)**](#).
 - [**International Solar Alliance**](#).
 - [**PM- KUSUM**](#).
 - [**National Wind-Solar Hybrid Policy**](#).
 - [**Rooftop Solar Scheme**](#).
- There is a potential for India **to save more than 24 million tonnes of CO₂ emissions every year** and 2,400 million litres of diesel fuel (and associated costs) if the **trains are switched to hydrogen**.
 - India currently has around 13,500 trains running every day, around 5,000 (37%) of these are diesel locomotives and the rest is fully electrified.

Way Forward

- **Emission Friendly Alternatives:** Another alternative that many hydrogen councils across the world are pushing for is '**blue**' hydrogen, which is **grey hydrogen coupled with additional installations for carbon capture and storage** incorporated into the production facility.
 - This way, up to 90% of the CO₂ emitted during hydrogen production can be captured for reuse or storage and prevented from escaping into the atmosphere.

UPSC Civil Services Examination Previous Year Question (PYQ)

Prelims

Q. Hydrogen fuel cell vehicles produce one of the following as "exhaust" (2010)

- (a) NH₃
- (b) CH₄
- (c) H₂O
- (d) H₂O₂

Ans: (c)

Exp:

- **A fuel cell is a device that converts chemical energy (energy stored in molecular bonds) into electrical energy.**
- It uses Hydrogen gas (H₂) and Oxygen gas (O₂) as fuel and the products of the reaction in the cell

are water (H_2O), electricity, and heat.

- This is a big improvement over internal combustion engines, coal-burning power plants, and nuclear power plants, all of which produce harmful byproducts. **Therefore, option (c) is the correct answer**

Source: DTE

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