

Today's Important Topic for UPSC CSE Aspirants (White Hydrogen)

Comprehensive Explanation for Questions :

Inside Story of the News (White Hydrogen) :

- In northeastern France, scientists searching for fossil fuels beneath the Earth's surface stumbled upon a vast reservoir of hydrogen, specifically "white hydrogen." This remarkable discovery, estimated to range from 6 to 250 million metric tons, stands as one of the largest deposits of white hydrogen ever found.
- Two scientists- Jacques Pironon and Phillipe De Donato, both directors of research at France's National Centre of Scientific Research were assessing the amount of methane in the subsoils of the Lorraine mining basin.
- When they reached a couple of hundred meters down, they found low concentrations of hydrogen. But, as they went deeper, the concentration surged reaching 14% at 1,100 meters and 20% at 1,250 meters.
- The study indicated the presence of a large reservoir of hydrogen beneath which ran into millions of metric tons of hydrogen, making it one of the largest deposits of "white hydrogen" ever discovered.

Kahani Ander Ki : After the above-mentioned incidents, it becomes necessary for us to get detailed information about White Hydrogen . Since this matter is also related to Hydrogen, then it becomes necessary for us to know about Understanding Hydrogen also. We know that at this program related to National Hydrogen Mission , so then it becomes necessary to know about National Hydrogen Mission .

Understanding Hydrogen :

- **Hydrogen is the lightest and most abundant element in the universe. It is commonly found in combination with other elements, such as oxygen in water (H₂O).**
- **Hydrogen can be extracted from various sources, including natural gas, coal, and even water, through a process called electrolysis.**
- **Once produced, hydrogen can be used as a clean and efficient energy carrier, emitting only water vapor when used in fuel cells or combustion engines.**
- **Hydrogen produces only water when burned, making it very attractive as a potential clean energy source for industries like aviation, shipping and steel-making that need so much energy it's almost impossible to meet through renewables such as solar and wind.**

About White Hydrogen :




- **White hydrogen, also referred to as "natural," "gold" or "geologic" hydrogen, is naturally produced in the Earth's crust and is considered a potential clean energy.**
- **It is the naturally produced gas present in the Earth's crust. Though, it is the most abundant element in the universe, it generally exists combined with other molecules.**
- **It is relatively new to scientific exploration, first gaining attention in 2018 when a well in Mali produced 98% hydrogen gas.**

- These deposits have since been discovered worldwide, including in the US, Eastern Europe, Russia, Australia, and France. It's estimated that there could be tens of billions of tons of white hydrogen globally.
- Hydrogen, especially in its white form, is seen as a promising clean energy source, particularly in industries like aviation, shipping, and steel production.
- When burned, hydrogen only produces water, making it a more environmentally friendly energy source compared to solar or wind energy.
- **Advantages of White Hydrogen :**
 - It causes no CO₂ emissions when used as a fuel.
 - It is compatible with existing infrastructure and technologies for hydrogen production and utilization.
 - It is cheaper and more efficient than steam reforming or electrolysis. it's cost-effective, with white hydrogen estimated to be around \$1 per kilogram, significantly cheaper than green hydrogen at approximately \$6 per kilogram.



- It is potentially abundant and untapped, offering a source of clean-burning energy.
- **Types of Hydrogen based on Extraction Methods :**
 - Depending on the nature of the method of its extraction, hydrogen is categorized into three categories, namely, Grey, Blue and Green.
 - ✚ **Grey Hydrogen:**
 - It is produced via coal or lignite gasification (black or brown), or via a process called steam methane reformation (SMR) of natural gas or methane (grey).
 - These tend to be mostly carbon-intensive processes.
 - ✚ **Blue Hydrogen:**
 - Blue hydrogen is produced mainly from natural gas, using a process called steam reforming, which brings together natural gas and heated water in the form of steam. The output is hydrogen, but carbon dioxide is also produced as a by-product. So, the definition of blue hydrogen includes the use of carbon capture and storage (CCS) or carbon capture use (CCU) technologies to trap and store this carbon.

- Blue hydrogen is sometimes described as ‘low-carbon hydrogen’, as the steam reforming process doesn’t actually avoid the creation of greenhouse gases.

	GREY HYDROGEN	BLUE HYDROGEN	GREEN HYDROGEN
Process	Reforming or gasification	Reforming or gasification with carbon capture	Electrolysis
Energy source	Fossil fuels 	Fossil fuels 	Renewable electricity 
Estimated emissions from the production process ^a	Reforming: 9 – 11 ^b Gasification: 18 – 20	0.4-4.5 ^c	0

Source: [World Economic Forum](#)

✚ Green Hydrogen:

- It is produced using electrolysis of water with electricity generated by renewable energy.
- The carbon intensity ultimately depends on the carbon neutrality of the source of electricity (i.e., the more renewable energy there is in the electricity fuel mix, the "greener" the hydrogen produced).
- The most eco-friendly hydrogen is “green” hydrogen, which is produced using renewable energy to split water.

- Other Types of Hydrogen :

- ✚ Black and Brown Hydrogen :

- Using black coal or lignite (brown coal) in the hydrogen-making process, these **black and brown hydrogen are the absolute opposite of green hydrogen in the hydrogen spectrum and the most environmentally damaging.**
- Just to confuse things, any hydrogen made from fossil fuels through the process of ‘gasification’ is sometimes called black or brown hydrogen interchangeably.
- Japan and Australia announced a new brown coal-to-hydrogen project recently.
- This project will use brown coal in Australia to produce liquefied hydrogen, which will then be shipped to Japan for low-emission use.

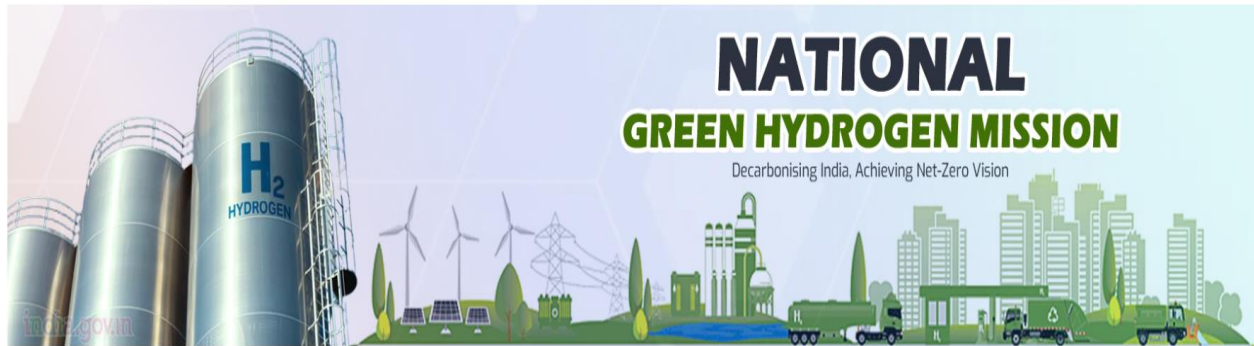
- ✚ Pink Hydrogen :

- **Pink hydrogen is generated through electrolysis powered by nuclear energy.**
- Nuclear-produced hydrogen can also be referred to as purple hydrogen or red hydrogen.
- In addition, the very high temperatures from nuclear reactors could be used in other hydrogen productions by producing steam for more efficient electrolysis or fossil gas-based steam methane reforming.

- ✚ Turquoise Hydrogen :

- This is a new entry in the hydrogen colour charts and production has yet to be proven at scale.

- It is made using a process called methane pyrolysis to produce hydrogen and solid carbon.
- **In the future, turquoise hydrogen may be valued as a low-emission hydrogen, dependent on the thermal process being powered with renewable energy and the carbon being permanently stored or used.**



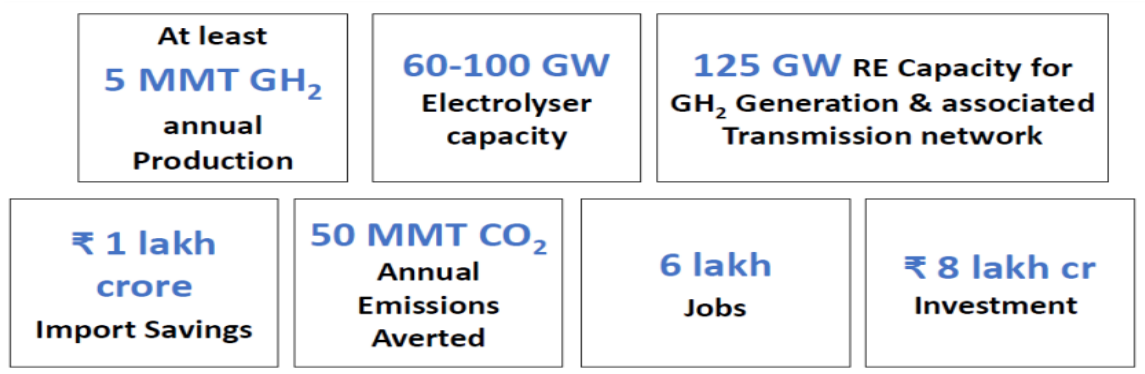
✚ Yellow Hydrogen :

- **Yellow hydrogen is a relatively new phrase for hydrogen made through electrolysis using solar power.**

About National Green Hydrogen Mission :

- **On January 4, 2022, the National Green Hydrogen Mission was approved by the Union Cabinet, chaired by the Hon'ble Prime Minister Shri Narendra Modi.**
- Currently, India spends over \$160 billion of foreign exchange every year for energy imports.
- These imports are likely to double in the next 15 years without remedial action. With this approval, the stage is set for India to become a global champion in green hydrogen.
- **The initial outlay for the Mission will be Rs. 19,744 crores, including an outlay of Rs. 17,490 crores for the Strategic Interventions for Green Hydrogen Transition (SIGHT) programme, Rs. 1,466 crores for Pilot Projects, Rs.400 crore for Research & Development, and Rs. 388 crores towards other Mission components.**
- **Ministry of New and Renewable Energy (MNRE) will formulate the scheme guidelines for implementation of the respective components.**
- **Mission Subcomponents :**
 - ✚ **SIGHT Programme:**
 - Under the Strategic Interventions for Green Hydrogen Transition Programme (SIGHT), two distinct financial incentive mechanisms – targeting domestic manufacturing of electrolyzers and production of Green Hydrogen – will be provided under the Mission.
 - ✚ **Pilot Projects:**
 - The Mission will also support pilot projects in emerging end-use sectors and production pathways.
 - Regions capable of supporting large scale production and/or utilization of Hydrogen will be identified and developed as Green Hydrogen Hubs.
 - ✚ **R&D Projects:**
 - Public-Private Partnership framework for R&D (Strategic Hydrogen Innovation Partnership – SHIP) will be facilitated under the Mission.

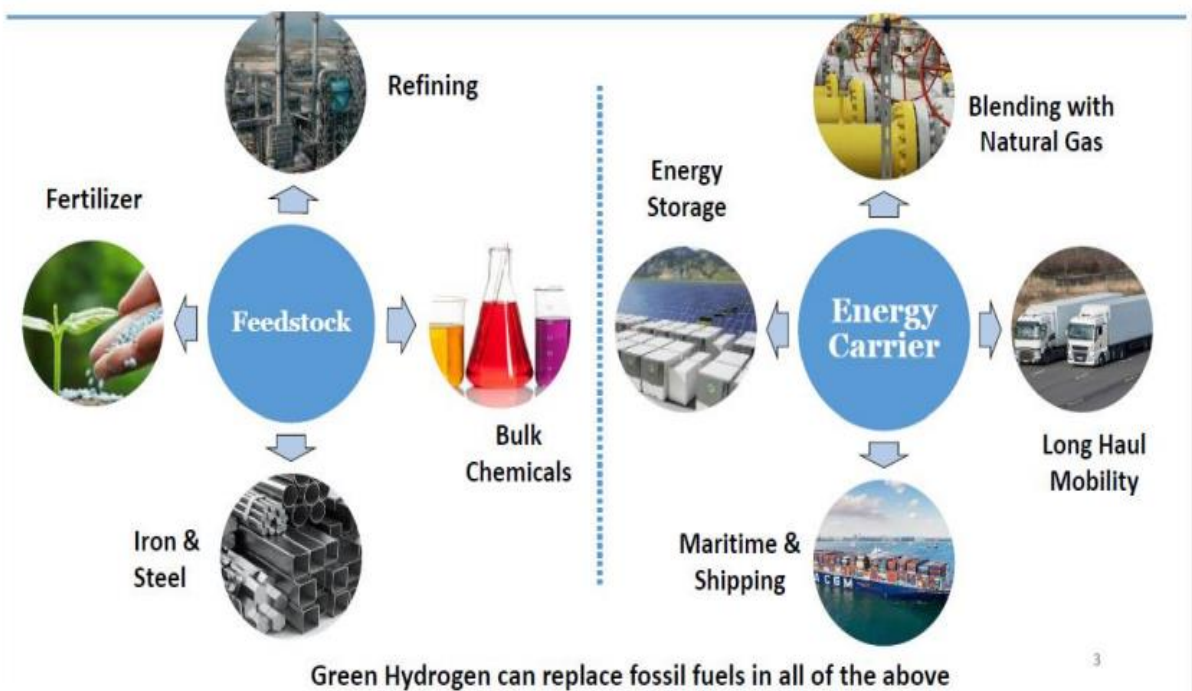
- R&D projects will be goal-oriented, time bound, and suitably scaled up to develop globally competitive technologies.
- ✚ **Skill Development:**
 - A coordinated skill development programme will also be undertaken under the Mission.
- **Mission Outcomes :**
- ✚ The Mission will result in the following likely outcomes by 2030:
 - **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 crores 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**
- **Mission Benefits :**
 - 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
- The Mission will support pilot projects in other hard-to-abate sectors like steel, long-range heavy-duty mobility, shipping, energy storage etc. for replacing fossil fuels and fossil fuel-based feedstocks with Green Hydrogen and its derivatives.
- **India's Progress Towards Green Hydrogen :**
- Prime Minister Narendra Modi aims to transform India into an energy independent nation by 2047 where green hydrogen will play an active role as an alternate fuel to petroleum/ fossil-based products.
- **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.
- **In 2020, India's hydrogen demand stood at 6 million tonnes (MT) per year. It is estimated that by 2030, the hydrogen costs will be down by 50 per cent.**
- **The demand for hydrogen is expected to see a five-fold jump to 28 MT by 2050 where 80 per cent of the demand is expected to be green in nature.**
- Some of the prominent industrial mammoths such as Reliance Industries Limited (RIL), Gas Authority of India Limited (GAIL), National Thermal Power Corporation (NTPC), Indian Oil Corporation (IOC) and Larsen and Toubro (L&T) plan to foray into the green hydrogen space. RIL plans to become a net-carbon zero firm by 2035 and invest nearly INR 750 billion over the next three years in RE.



- The government-led public sector undertaking (PSU), Indian Oil, is at the forefront of the green hydrogen revolution. It is planning to setup India's first green hydrogen unit for the Mathura refinery, which will be used to process crude oil.
- National Thermal Power Corporation (NTPC) has recently set up a tender to establish a first-of-its-kind hydrogen refuelling station to be powered entirely by renewables in Leh through a stand-alone 1.25 MW solar system.
- Two hydrogen refuelling stations have been established (one each at Indian Oil R&D Centre, Faridabad and National Institute of Solar Energy, Gurugram).
- India has declared its ambition to become an exporter of hydrogen to Japan, South Korea, and Europe.
- Various hydrogen powered vehicles have been developed and demonstrated under projects supported by Government of India. These include 6 Cell buses by Tata Motors Ltd., 50 hydrogen enriched CNG (H-CNG) buses in Delhi by Indian Oil Corporation Ltd. in collaboration with Govt. of NCT of Delhi, 2 hydrogen fueled Internal Combustion Engine buses (by IIT Delhi in collaboration with Mahindra & Mahindra).

Source : [file:///C:/Users/aniksingh/Downloads/doc2023110150801%20\(3\).pdf](file:///C:/Users/aniksingh/Downloads/doc2023110150801%20(3).pdf)

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