Green Hydrogen (GH) and GoI Policy on GH

A. What is Hydrogen?

Hydrogen is the lightest element and the first element in the periodic table. It is more commonly called Hydrogen gas, molecular Hydrogen or simply Hydrogen. It is highly combustible, colorless, odorless, tasteless, and non-toxic. Hydrogen gas forms explosive mixtures with air in concentrations from 4–74% and with chlorine at 5–95% (Eg: it may become Hydrogen bomb if used in uncontrolled state. Eg: Enriched fuel for other uses if used in safe manner like Uranium in Nuclear Energy reactors).

B. Methods of Hydrogen Production

Some of the ways Hydrogen can be produced are as below –

- by steam reforming of natural gas and other light hydrocarbons,
- partial oxidation of heavier hydrocarbons,
- coal gasification,
- biomass gasification,
- zero-CO2-emission methane pyrolysis,
- electrolysis,
- from Earth extraction etc.

As of now, there are four main sources for the commercial production of Hydrogen globally[1]:

i. Natural gas - 48%
ii. Oil - 30%
iii. Coal - 18%
iv. Electrolysis - 4%

C. Types of Hydrogen

There are different types of Hydrogen produced according to their production processes as below –

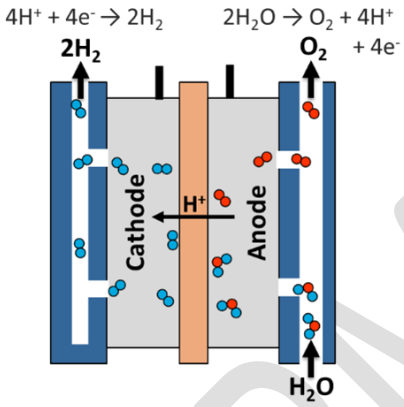
- **Grey Hydrogen** - Hydrogen produced from fossil fuels, resulting in carbon dioxide emissions released to the atmosphere.
- **Blue Hydrogen** – Hydrogen produced in a controlled manner where emissions are captured through carbon capture and storage (CCS) system.
- **Green Hydrogen** - Hydrogen produced by Green Electricity (Renewable Energy) through electrolysis process.
- **Pink Hydrogen** - Hydrogen produced from nuclear energy via electrolysis. Often referred to as subset of green Hydrogen but can also be referred to as pink Hydrogen.
- **Gold Hydrogen** - Hydrogen that is formed by natural processes. Natural Hydrogen has been identified in many source rocks in areas beyond the sedimentary basins where oil

[1] https://assets.kpmg.com/content/dam/kpmg/in/pdf/2022/03/Indias-green-hydrogen-ambition.pdf

companies typically operate. It is non-polluting and may offer lower costs than industrial Hydrogen. It is also known as white Hydrogen, geologic Hydrogen, or natural Hydrogen.

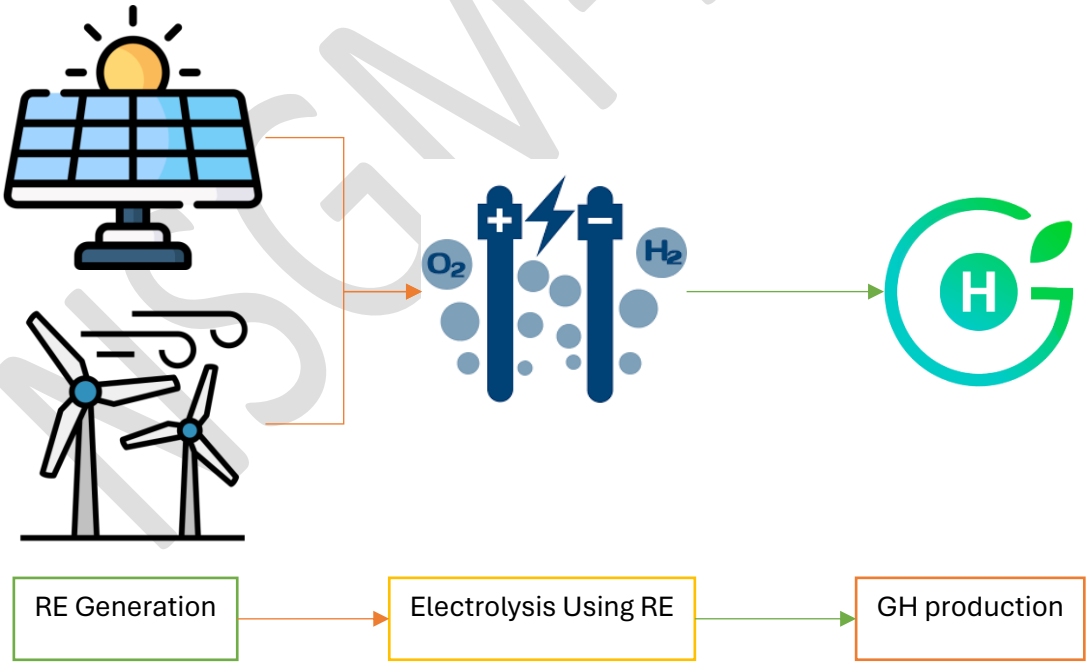
D. Green Hydrogen (GH)[2]

Hydrogen is produced by splitting water into Hydrogen and oxygen through Electrolysis process in presence of electricity. GH is produced by us Green Electricity (Renewable Energy) during electrolysis process.



Extraction of H2 through Electrolysis Process

Source: https://www.energy.gov/eere/fuelcells/hydrogen-production-electrolysis



Production of Green Hydrogen

GH is a source of clean energy as its only biproduct from water and there are no greenhouse gas emissions. India aims to become energy independent by 2047 and achieve net zero emissions by

[2] https://ncert.nic.in/ncerts/l/lech103.pdf

2070. India has an ambitious target to install 500 gigawatts (GW) of non-fossil energy capacity and meet 50% of electricity generation from renewables by 2030.

Around 8 GW of electrolysis capacity is installed worldwide in 2020, accounting for around 4% of global Hydrogen production. India has also put target for GH production of 5 MTPA by 2030, which requires 26-36 GW of Eletrolyser capacity addition. By 2030, GH demand will be 20-30% of the overall Hydrogen demand[3]. Further, the production cost of GH is also expected to decline up to 50% such as carbon pricing, scale-led decline in Electrolyser price, innovation etc. by 2030.

E. Potential Use Cases

Decarbonizing industrial sector, long-distance road transport, aviation, and shipping would be impossible unless green hydrogen is available. Some of the potential use cases of GH including export-oriented Industries identified are as below –

Refinery Sector	•Existing use of Hydrogen in hydro treating and hydrocracking for desulfurization and catalytic conversion can be replaced with GH.
Fertilizer (Ammonia)	•GH as Feedstock to produce ammonia, which is used in making Urea, DAP etc.
Methanol	•GH can be blended with Natural Gas to make methanol. This blending can reduce emission of methane gas in environment.
Mobility	•GH as fuel in FCEV (fuel cell EV). •GH can be blended with CNG to make HCNG for Vehicles.
Steel	•GH as primary fuel within H2 based (H2-DRI) iron production.
Power	•GH in generator cooling, co-firing ammonia in coal-based boilers. •GH as fuel in fuel cell to replace diesel based backup.

F. Challenges in GH production

Green hydrogen is difficult to produce because of several factors[4].

- each kilogram of green hydrogen would require about nine liters of water, which could be an issue in water-deficit areas.
- producing each kilogram needs 50 units of power, with a 70% efficiency of electrolysers (as per an estimate by TERI).

[3] https://newclimate.org/sites/default/files/2023-11/The landscape of green hydrogen in India_nov2023.pdf
[4] https://www.msn.com/en-in/news/opinion/green-hydrogen-push-needs-to-be-substantive/ar-BB1lleB9

- need renewable power delivered to the electrolyser through a dedicated transmission line.
- transport is a problem as hydrogen is inflammable and can escape easily.
- hydrogen has very low density, hence it requires a large storage capacity unless the gas is converted to liquid form.
- to achieve the Paris targets, 30% of the world's electricity use will have to be dedicated to green hydrogen by 2050. (The International Renewable Energy Agency (IRENA) estimates)
    - India would require 125 GW of renewable power (as India targeting to produce 5MT of green hydrogen by 2030)
- Converting to liquid form would need temperatures of around 253 C below zero. This again requires a lot of energy that must be drawn from renewable sources.

G. National Green Hydrogen (NGH) Mission[5]

Government of India has identified the importance of Green Hydrogen for its numerous advantages and applications as well as promoting cleaner energy. A mission was approved by the Union Cabinet on 4th January 2023 under MNRE with initial outlay of Rs.19,744 crore, including –

- Rs.17,490 Crore for the SIGHT (Strategic Interventions for Green Hydrogen Transition) program,
- Rs.1,466 Crore for pilot projects,
- Rs.400 crore for R&D, and
- Rs.388 crores towards mission components.

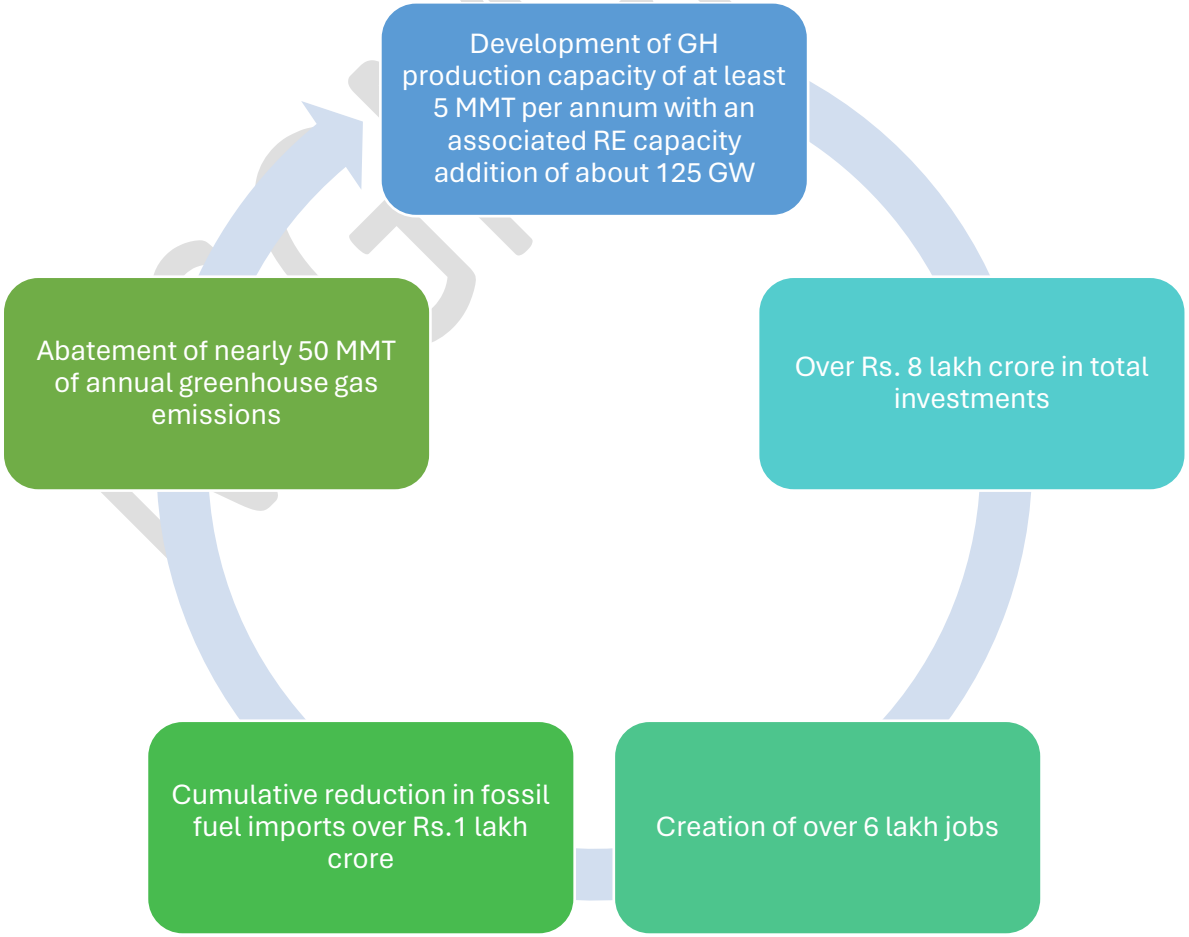
The policy aims at facilitating Green Hydrogen production in India –

- By waiver of inter-state transmission charges for a period of 25 years to the producer of Green Hydrogen and Green Ammonia for the project commissioned before 30th June 2025.
- By easing the process through time bound single-window clearances, manufacture, transportation, storage, and distribution of GH/GA. Concerned agencies will be requested to provide the clearance in the time bound manner, preferably within the period of 30 days from the date of application.
- By allowing power banking of surplus unconsumed renewable power for 30 days.
- By empowering state commission to regulate charges of banking which shall not be more than the cost differential between the average tariff of renewable energy bought by the distribution licensee during the previous year and the average market clearing price (MCP) in the day ahead market (DAM) during the month in which the RE has been banked.

[5] https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/01/2023012338.pdf

- By providing connectivity, at the generation end and the GH/GA manufacturing end, to the ISTS for the RE capacity setup for the purpose of manufacturing GH/GA under the Electricity Rules 2021.
- By enabling land in RE parks allotment for the manufacture of GH/GA.
- By setting up manufacturing zones for production of GH/GA.
- By encouraging manufacturers of GH/GA to set up bunkers near ports for storage of GH/GA for export/use by shipping. The land for storage purposes shall be provided by the respective port authorities at applicable charges.
- RE consumes for production of GH/GA shall count towards RPO compliance of the consuming entity. RE consumed beyond RPO of the producer shall be count towards RPO compliance of respective discoms.
- Distribution licensee may also procure/supply RE to the manufacturers of GH/GA in their states. In such cases, the Distribution licensee shall only charge the cost of procurement as well as wheeling charges and small margins as defined by state commission.
- To achieve competitive prices, MNRE may aggregate demand from different sectors and have consolidated bids conducted for procurement of GH/GA through any of the designated implementing agencies.

H. Expected Outcomes of NGH Mission



I. Benefits of NGH Mission

- Mission aims to make India a Global Hub for production, utilization and export of Green Hydrogen and its derivatives
- Decarbonization of industrial, mobility and energy sectors
- Reduction in dependence on imported fossil fuels and feedstock
- Development of indigenous manufacturing capabilities
- Creation of employment opportunities
- Development of cutting-edge technologies

J. Estimates[6]

Some of the estimates for GH production is as below –

- Estimated cost of Grey Hydrogen – Rs. 160 - 200 per KG
- KPMG Estimated cost of GH (Pre-policy) – Rs. 320-300 per KG
- KPMG Estimated cost of GH (Post-policy) – Rs. 230-240 per KG
- IOCL comment – New Hydrogen Policy will cut the GH cost by 40-50%.

K. Current Status

[7]At present, less than 1% of the hydrogen being produced is green, and that too in demonstration projects. The status as of December 2023[8] for adoption of Green Hydrogen in the country is as follows:

- GAIL has started India's maiden project of blending Hydrogen in City Gas Distribution grid. 2% volume of Hydrogen is being blended in CNG network and 5% volume of Hydrogen is being blended into PNG network at City Gas Station of Avantika Gas Limited (AGL), Indore.
- NTPC has initiated blending of Green Hydrogen up to 8% (vol/vol) in PNG Network at NTPC Kawas Township, Surat.
- Hydrogen based Fuel-Cell Electric Vehicle (FCEV) Buses in Leh by NTPC
- Hydrogen based Fuel-Cell Electric Vehicle (FCEV) Buses in Greater Noida by NTPC
- OIL has developed a 60-kW capacity Hydrogen fuel cell bus, which is a hybrid of an electric drive and a fuel cell.

[6] https://assets.kpmg.com/content/dam/kpmg/in/pdf/2022/03/Indias-green-hydrogen-ambition.pdf
[7] https://www.msn.com/en-in/news/opinion/green-hydrogen-push-needs-to-be-substantive/ar-BB1lleB9
[8] https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1989809

- Demonstration pilot plants for production of Green Hydrogen through water electrolysis using solar power, biomass oxy steam gasification and CBG reforming for refueling 15 no. of Hydrogen fuel cell buses by IOCL.
- Under the Strategic Interventions for Green Hydrogen Transition (SIGHT) scheme (Mode – I, Tranche – I) of the National Green Hydrogen Mission, Request for Selection (RfS) has been issued for selection of Green Hydrogen producers for setting up production facilities of 450,000 tons for Green Hydrogen in India.

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