Background

The Government of India (GOI) has acknowledged the significance of hydrogen as a fuel and has implemented targeted policies and missions to encourage its production and utilization within the country. As a part of these endeavors, the GOI has launched the National Hydrogen Energy Mission with the primary goal of creating a comprehensive roadmap for hydrogen production, storage, and utilization. This mission encompasses the establishment of hydrogen hubs and pilot projects to showcase hydrogen-based technologies and their integration with renewable energy sources.

In addition to the National Hydrogen Energy Mission, the GOI has also introduced the Green Hydrogen Policy. This policy serves as a catalyst for the production and utilization of green hydrogen through various means, including financial support and research & development activities. These initiatives exemplify India's commitment to harnessing hydrogen as a clean energy source while reducing dependence on fossil fuels. By actively pursuing these initiatives, India aims to develop a comprehensive hydrogen ecosystem that facilitates the efficient production, storage, and utilization of hydrogen.

In this context, a study was conducted by ICF on behalf of FIPI to understand & analyze the potential of hydrogen development in India including possible sectoral demand, future cost economics, infrastructure requirement and current gaps in policy and regulation. This study focuses on the following key study areas:

- Hydrogen demand in India
- Green hydrogen production technology trends across globe
- Future cost economics
- Hydrogen storage and transportation
- Identifying imperatives for hydrogen policy and regulatory environment.

Key Findings

Key findings / highlights of the study are:

- India is the third largest consumer & producer of hydrogen today in the World after China & USA.
- Hydrogen demand In India is expected to increase significantly (by 2.5 - 3.5 times) by 2040
- However, given the large growth in energy requirements, hydrogen may still only form less than 5% of total primary energy consumption of India by 2040
- Since, the cost of Hydrogen transportation is high therefore supply needs to come near demand centers & hydrogen hubs/valleys needs to be created.
- This presents a great opportunity for clean hydrogen suppliers to build a business with a market size of ~$27 B/yr (2030) & ~$40 B/Yr (2040)
- However, there are challenges:
    - As per MNRE, 125 GW of additional renewable energy capacity addition would be required to meet the GOI’s 2030 target of green hydrogen production capacity - 5 Million tonnes per annum. Further, India has committed at COP26 that it would have 500 MW Non-fossil fuel capacity by 2030; majority of which is expected to replace existing conventional power.
    - Difficult to drive Green Hydrogen demand purely on economics, might need fiscal incentives to support consumption. Assuming $9 per MMBTU flat delivered gas prices, green hydrogen is likely to achieve parity by 2035 (~$2/kg by 2035)

- Key benefit: (1) CO_2 reduction (2) Import Bill Savings of $14 - 22 Billion per annum can be achieved by replacement of current fuels with locally produced Hydrogen in end use sectors
- US, EU, Korea and Japan leading initiatives to drive Hydrogen consumption e.g. US IRA provides up to $3 per kg production subsidy to green H2 projects

Recommendations -

Key recommendations of the study are:

HYDROGEN MARKET CREATION

A. **Demand Side:** Green hydrogen purchase obligation on industries to create demand, similar to RPO in Renewable power sector. This obligation can be mandated to key demand sectors in a phased manner over time & in the order of preference to replace their current consumption of grey hydrogen:
    i. Refineries
    ii. Fertilisers other than Urea
    iii. Glass Industry
    iv. Steel Industry
    v. Chemical industry other than Pharma
    vi. CGD (blending %)
    vii. Urea

    Create vision for other demand sectors:
    i. Consider mandatory blending of limited % of green hydrogen with natural gas in pipelines (subject to existing technical tolerance limits).
    ii. Target to reduce methanol imports in India by incentivizing chemical industries to produce methanol locally.
    iii. Heavy Duty Vehicles: consider incentives to support migration of HDVs to hydrogen FCEVs or Hydrogen based ICEs
    iv. Incentives for using HCNG (H2 blended in CNG) in vehicles can be considered.
    v. Support development of green hydrogen production hubs in key Ports to cater to the demand of EU's green fuel for shipping (EU 2% mandate for green shipping fuels by 2025)

B. **Supply Side:** Support producers of green hydrogen via subsidy schemes like production linked incentives, tax benefits, soft loans, & green hydrogen certificates on production green hydrogen.
    - Financial incentives:
        - Viability Gap Funding (VGF) for procurement of electrolysers/ Link production with PLI scheme of electrolysers to ensure procurement at competitive rates.
        - Declaring hydrogen as priority lending sector for Banks/ Financial institutes
    - Fiscal incentives:
        - Custom duty waiver on purchase of essential imported equipment to set up the plant
        - Income Tax/ Minimum Alternate Tax benefit to both producers and consumers
    - Non-fiscal/financial incentives:
        - Identification and allocation of suitable government land for setting up of large green hydrogen plants.

- Easy access to cheap renewable power (which can be procured through SECI or other agencies).
- Ease the process of approval for grid connectivity for RE power either through open access or DISCOMS.
- Specific allocation of water resource for production of hydrogen.
- Consider incentives / subsidy for setting up H2 dispensing infrastructure.
- Specific grants could be provided for dedicated R&D efforts for alleviating challenges (like lack of adequate supply chain of electrolyser components, limited access to critical minerals) in establishing indigenous hydrogen value chain

C. **Create appropriate market mechanisms**:
  - Support creation of Hydrogen pricing index or 'hydrogen price walls' to regularize the sale purchase of hydrogen for both domestic and international markets.
  - Create a hydrogen certificate market like REC. GPO of buyers could then be met either through direct consumption or through purchase of "Green Hydrogen Certificates".
  - India is developing its own carbon market, consider bringing green hydrogen producers and consumers under this scheme to benefit from carbon pricing.

BLENDING HYDROGEN WITH NATURAL GAS / DEDICATED HYDROGEN PIPELINES

- Hydrogen is not covered in the PNGRB act. Amendment needed to bring hydrogen into the ambit of PNGRB so that regulations can be drafted on transport of hydrogen.
- Consider providing incentives to industries to retrofit equipment and make them hydrogen ready.
- Develop regulations and specifications for blending hydrogen at different points of the natural gas networks.
- Specification for retrofitting of existing natural gas lines.
- Amendment to tariff guidelines and regulations to include hydrogen.

POLICY, REGULATORY AND INSTITUTIONAL STRUCTURE

- A well-defined institutional structure would be required to monitor and regulate the hydrogen ecosystem. This institutional set up may require a separate legislation to be passed in the parliament (for instance a hydrogen act) or could be integrated in existing legislation via amendments (like PNGRB Act). However, hydrogen development in the country may be regulated by a single Ministry to make the process smooth.
- This central nodal ministry/ agency would need requisite powers to:
  - Develop fiscal & non-fiscal incentives for hydrogen in discussion with Finance Ministry.
  - Monitor the market development of hydrogen & prevent abuse of market power in time.
  - Create suitable policies & regulations needed to support production, transport & use of hydrogen.
  - Review the technical and safety aspects of hydrogen via a suitable technical organisation (e.g. PESO).
- Review and update existing PESO regulations on safety for hydrogen production, transport, storage and usage.
- Clear categorization of green hydrogen produced from by-products (chlor-alkali) & renewable energy.
- Hydrogen is currently under GST regime and natural gas under VAT so to avoid double taxation in blended fuel notification to be issued clearing the taxation policy for hydrogen

Background

MNRE has published guidelines for the two incentive schemes under the SIGHT programme of the National Green Hydrogen Mission. The two incentive schemes are: - i) Component I: Incentive scheme for electrolyser manufacturing ii) Component II: Incentive scheme for green hydrogen production (under Mode 1)

The key features of the hydrogen production incentive scheme (Component II) are: -

Component II: Incentive scheme for green hydrogen production (under Mode 1)

- Under the scheme, a direct incentive in ₹/kg of Green Hydrogen production will be provided for a period of 3 years
- The incentives will be capped at ₹ 50/kg in the first year of production, ₹ 40/kg during the second year of production and ₹ 30/kg during the third year of production
- Beneficiaries under the scheme will be selected through a competitive bidding process.
- Selection will be done through SECI tenders on basis of least averaged incentives
- Total available bidding capacity in Tranche 1 is restricted to 4,10,000 tonnes per annum (Bucket 1 - technology agnostic pathway) and 40,000 tonnes per annum (Bucket 2 - biomass based pathway), with a max / min bid size of 90,000/10,000 tonnes per annum in bucket 1 and 4000/500 tonnes per annum in bucket 2
- Eligibility criteria – Net worth should be greater than ₹ 15 Cr (Technology agnostic pathway) & ₹ 1.5 Cr – (biomass based pathway) for each thousand tonnes per annum of green hydrogen production capacity quoted
- SECI will be eligible for 0.5% of the incentive amount disbursed as administrative charges on an annual basis

Impact of the scheme (Component II)

The impact of this scheme can be understood by assessing the cost of production for grey vs. green hydrogen. Today, the cost of producing grey hydrogen (through SMR) in India is between $1.92/kg - $2.43/kg assuming delivered natural gas prices of $9/MMBtu and $12/MMBtu, respectively. In contrast, the cost of green hydrogen production for a large-scale (~1 GW) PEM plant is around $3.93/kg (refer to Annexure 1 for detailed assumptions considered to arrive at this cost). Thus, the cost differential between green and grey hydrogen (for a 1 GW PEM plant) today is anywhere between $1.5/kg to $2/kg, depending on the natural gas prices considered.

For consumers to buy green hydrogen, this cost differential needs to be minimized and removed through different measures such as production subsidy, fiscal benefits or providing carbon benefits to green hydrogen production.

The SIGHT scheme is proposing to provide direct incentives on production of green hydrogen at $0.63/kg, $0.50/kg, and $0.38/kg for the first, second, and third years respectively. This incentive, while significant, is not sufficient to remove the entire cost differential between grey and green hydrogen today unless natural gas prices fall significantly. Thus, the Government may need to consider providing further support to green hydrogen production so that its cost can be at parity with grey hydrogen.

Source : https://mnre.gov.in/img/documents/uploads/file_f-1687964057675.pdf
https://mnre.gov.in/img/documents/uploads/file_f-1687963916599.pdf
*Considering an exchange rate of 80 INR/USD
^Carbon market price in European Union in June, 2023

Another driver of competitiveness in future for green hydrogen production will be the developing of carbon markets in India. To illustrate, if we consider Europe's carbon price for India (which is at ~100 Euros per tonne of CO_2) the additional benefit available to green hydrogen producers (by selling carbon credits in the market) can help them bring down the cost of green hydrogen for consumers by ~$ 1/kg. However until this market develops, green hydrogen producers do not have visibility of this potential benefit.

A key difference in the cost of grey and green hydrogen is that grey hydrogen cost has a variable cost element associated with it (natural gas prices) while green hydrogen costs are largely fixed in nature (capex) and will not change much as the project life progresses. However, newer green hydrogen projects that come up in the next 5 years would likely benefit from the capital cost reduction in electrolysers (widely expected in industry to happen over next 5 years). Therefore, the green hydrogen projects that are set up today will not only have to compete with existing and new grey hydrogen projects, but also with newer green hydrogen projects that come up at reduced capex.

Given these uncertainties (natural gas prices for grey hydrogen cost, capex reduction for 2nd generation and 3rd generation green hydrogen plants), the green hydrogen projects that are set up today will only attract financing if lenders and equity providers feel that these projects would remain viable throughout their entire project life. In this context, the SIGHT programme's shortcoming is that it provides the subsidy only for the first three years.

In summary the challenges are:

1. The subsidy provided today is not sufficient for green hydrogen projects to effectively compete with grey hydrogen production cost.
2. There is no clarity whether the subsidy will be available after 3 years or not thereby putting a question mark over the lifelong viability of the green hydrogen project set up today.

Recommendations for the Government

1. It is recommended that the Government may consider providing subsidy to green hydrogen projects for their entire project life – this will help attract financing for these projects.
2. The amount of subsidy to be provided may not be static or a fixed number but could depend on the then prevailing market conditions (like natural gas prices, cost reduction for new green hydrogen production, carbon prices in market).
3. Thus, an effective way to provide subsidy would be to develop 'control periods' which could be 3 or 5 year-long periods and then set the subsidy number for the specific control period with a true up at the end and a reset for the next control period. This will ensure that if a carbon market develops and the carbon prices are sufficient to cover the cost differential, then the subsidy could also be entirely withdrawn. At the same time such a scheme would provide the confidence required by lenders to finance the green hydrogen project.
4. GOI must expedite the development of a robust **carbon market in India** which will reduce hydrogen producers' dependence on direct government subsidy under the SIGHT Scheme.

Source :
*https://www.statista.com/statistics/1322214/carbon-prices-european-union-emission-trading-scheme/#:~:text=EU%2DETS%20futures%20pricing%20in%20the%20European%20Union%202022%2D2023&text=The%20price%20of%20emissions%20allowances,of%20CO%E2%82%82%20in%20February%202023. and Lifecycle emission of grey H2 – 9.3 CO2 per kg of H2 - https://energy-cities.eu/50-shades-of-grey-and-blue-and-green-hydrogen

Key points for consumers (like refiners):

- It would be difficult for green hydrogen to currently compete with grey hydrogen & other existing fuels only on price despite availing the proposed incentives.
- The companies (incl. refiners) planning a strategic entry in the green hydrogen market can utilize this incentive scheme to enter the market. However, they might have to bear losses / low returns on the initial projects. There is atleast an expected production cost gap between grey & green hydrogen of around ~ $ 1/kg to ~$ 0.5/kg for natural gas prices of $ 9/mmbtu and $ 12/mmbtu even after availing carbon credits for the project. *(Carbon price upto ~$ 1/kg)*

Annexure 1

1. Assumptions for Green hydrogen cost

Assumptions	Units	Large PEM
Capacity	MW	1000
Capex	$mm	670
Opex	% capex	0.5
Annual Hydrogen Production	KTPA	113.3
Electrolyser efficiency	%	66

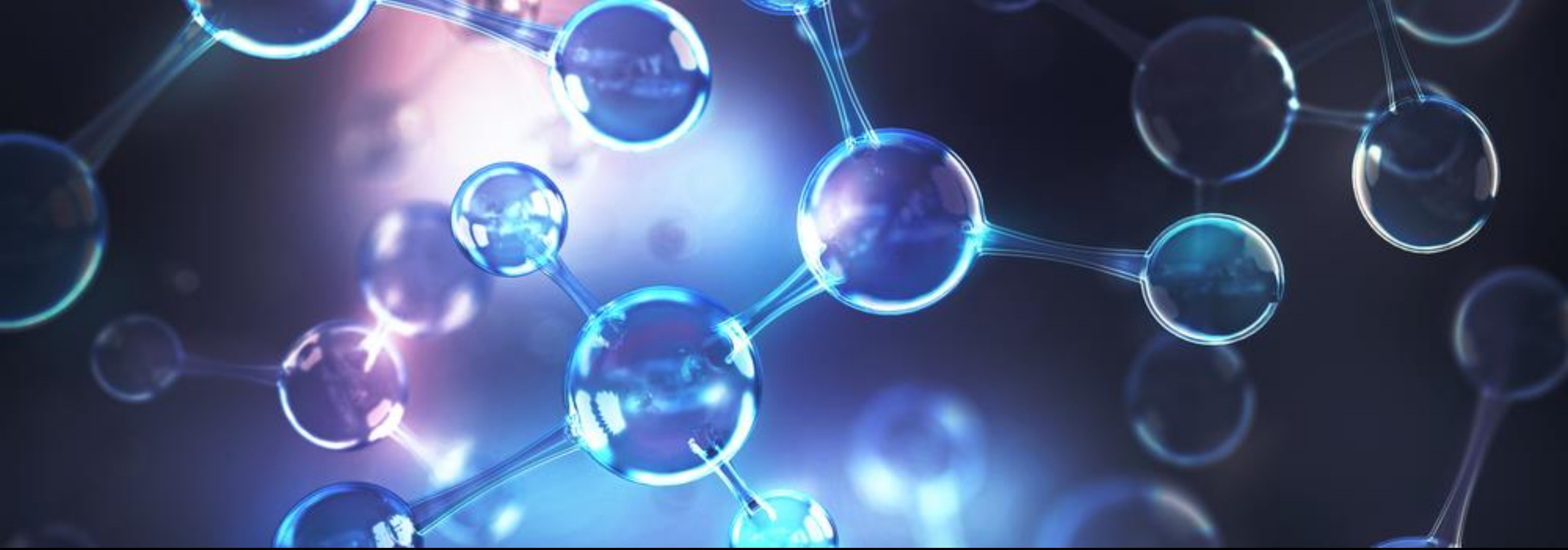
Other assumptions:

- Capacity utilization rate = 98%
- Water use = 15 kg/kg H2
- Water cost = 0.28 $/kg H2
- Purchased electricity use = 50 kWh/kg H2
- Cost of electricity = 0.056 $/kWh

2. Assumptions for Grey hydrogen cost

Assumptions	Units	SMR
Natural Gas Input	**GJ/kg H2**	**0.18**
Water Use	**Kg/ kg H2**	**9**
Purchased Electricity	**kWh/kg H2**	**0.96**
Annual O&M as % of Capex	**%**	**4.7%**
Capex	**$Million**	**397**

Source :
*https://www.statista.com/statistics/1322214/carbon-prices-european-union-emission-trading-scheme/#:~:text=EU%2DETS%20futures%20pricing%20in%20the%20European%20Union%202022%2D2023&text=The%20price%20of%20emissions%20allowances,of%20CO%E2%82%82%20in%20February%202023. and Lifecycle emission of grey H2 – 9.3 CO2 per kg of H2 - https://energy-cities.eu/50-shades-of-grey-and-blue-and-green-hydrogen



Emerging Hydrogen Markets and Opportunities in India

Client: Federation of Indian Petroleum Industry

Power and RE, ICF

15-Aug-23

Global H2 Demand Scenario:

- Demand for hydrogen is on a constant rise. Current global demand is approximately 90 MT/year as opposed to 18 MT/year in 1975.
- 78% of hydrogen produced comes from Natural gas and coal, and over 80% H2 demand comes from the refining and ammonia sector alone.

Indian H2 Demand Scenario:

- Current H2 demand in India is 6.5 MTPA, driven by captive consumption of refineries (3.1 MTPA), fertilizer & ammonia (2.1 MTPA); concentrated in western region.
- Declining prices of hydrogen and growing urgency for decarbonization means that the demand for hydrogen in India could grow by almost 2.4 times by 2040, led by industry and transportation.
- Hydrogen demand as a feedstock is in the following sectors: Refineries, Ammonia, Steel, Glass & Chemicals and as a fuel in: transport, large industries and CGD blending.
- Total unconstrained H2 demand in 2030 is projected at ~11 MTPA and total H2 demand in 2040 at ~24 MTPA.
- Constrained Demand for Hydrogen reaches 16-23 MTPA across the scenarios.
- Grey Hydrogen will continue to take up significant share of Hydrogen Mix in 2040 in cases without govt. intervention / obligation

Executive Summary – Key Takeaways

Source: ICF Research & analysis

Full report is available to the members on request.