

Opportunities in India's Hydrogen Market

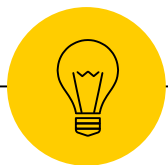
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India

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India - Czech Hydrogen Collaboration
Seminar

Organised by

Czech Trade Promotion Agency



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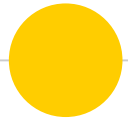
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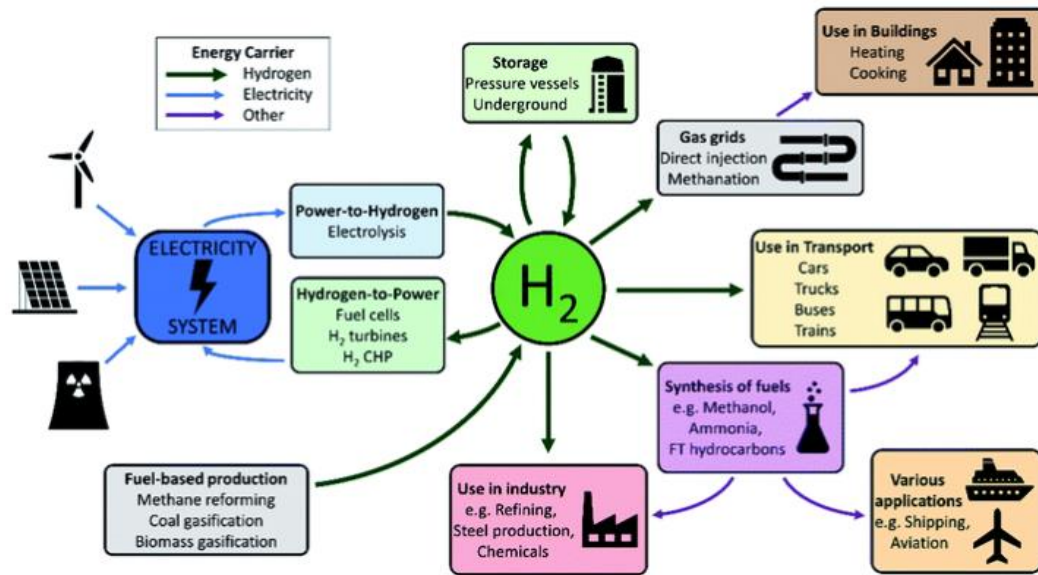
HEALTH
& NUTRITION



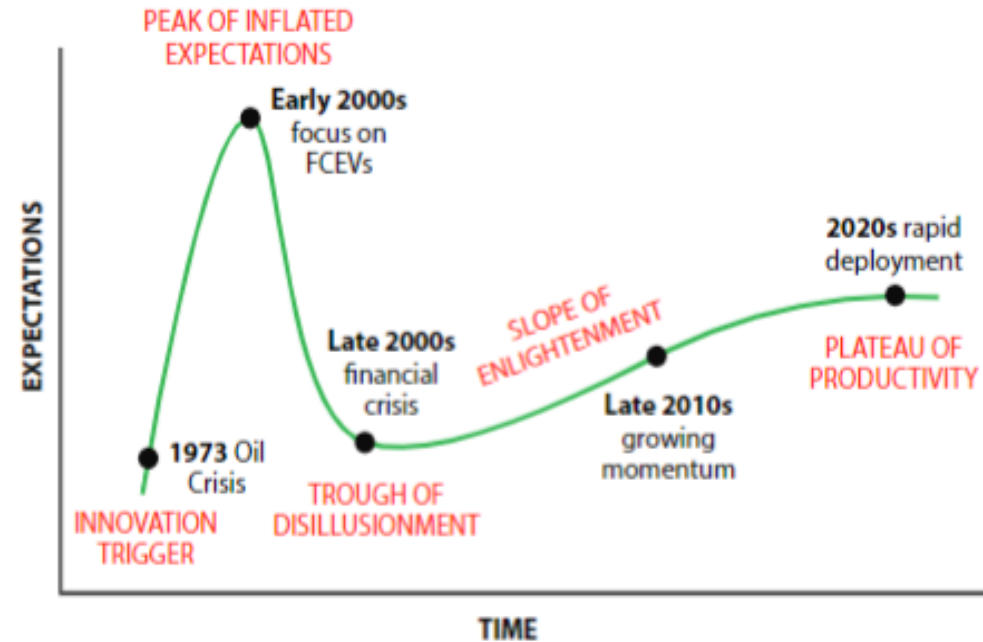
Flow of the presentation

- Overview
- TERI analysis
- Initiatives by Indian industries
- Collaboration areas

The recent global “hydrogen hype”- what it mean for India?



Source: adopted from public sources



- Due to hydrogen’s storage, energy and chemical attributes- considered as a potential solution to fight climate change and air pollution issues
- Falling costs of green hydrogen, increasing demand and strengthening policies across globe to leverage benefits of hydrogen
- Together with, the cheap and vast untapped potential of renewable resources in the country makes it a sweet spot for green hydrogen production.



Overview

2006

MNRE High-level committee published:
National Hydrogen Energy Road Map: Vision 2020

2016

Dr. K. Kasturirangan committee constituted by MNRE on hydrogen.
Hydrogen Energy and Fuel Cells in India: The way forward released.

August 2020

Hon'ble P.M declares that **Ladakh, Leh and Kargil** will be developed as carbon-neutral regions.

August 2021

Hon'ble P.M announces the proposed launch of the National Hydrogen Energy Mission (NHEM)

September 2021

Addressing the UNGA, Hon'ble P.M announces plans to scale up annual green H₂ production to **1 MT by 2030**.

Going forward

Expected release of NHEM and announcement of **Green H₂ Purchase Obligations for some sectors**



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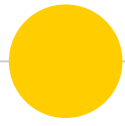
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Actions by Government bodies and Academic Institutions

Ministry of New and Renewable Energy (MNRE)

- During the past 10 years - spent approximately USD 3.32mn on fuel cell research.
- Supporting projects to address challenges in production of green hydrogen, safe and efficient storage, and utilization for energy and transport applications.
- Demonstration projects
- Proof of concept project

Department of Science and Technology (DST)

- Launched Hydrogen and Fuel Cell Programs.
- In 2020-21, provided funding of approximately USD 0.11 mn.
- Supporting the development of technologies in hydrogen production, distribution and storage etc.
- AHFC program to support indigenous development and commercialization

Various academic and research Institutions

- Leading academic Institutions, such as, IIT Madras, IIT Bombay, IISc Bangalore and others are working to develop technologies across the hydrogen value chain in hydrogen production, hydrogen storage and fuel cells.



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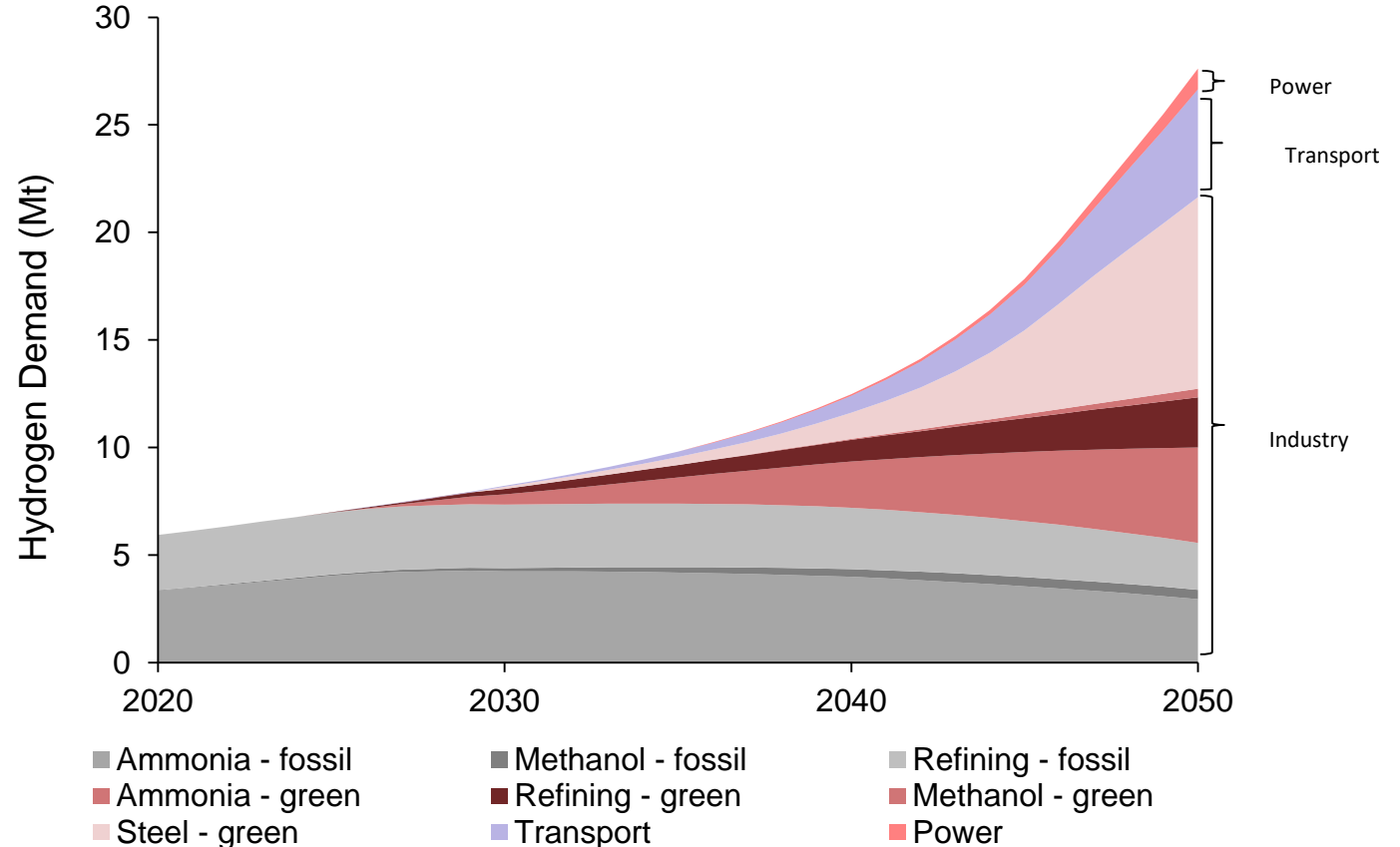
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TERI analysis - Hydrogen demand

Hydrogen demand projection in the Low-Carbon scenario, 2020-2050

- India's H₂ demand today is around 6 Mt. Primarily used in the fertilizer and refinery industry.
- Demand could increase to 28 Mt by 2050, driven by industrial sectors.
- Expanding in existing sectors - fertilizer and refineries, or growing into new sectors, such as steel.
- Transport will see some growth, mainly in the heavy-duty and long-distance trucking and inter-city bus segments.
- H₂ could also play a role in the power sector as a long-term storage vector.



Source: TERI analysis



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National Hydrogen Mission

- Speaking on India's 75th Independence Day, the Hon'ble Prime Minister announced the launch of the **National Hydrogen Mission (NHM)**. The PM also announced the target of making India energy self-reliant by 2047.
- The NHM aims to make India a **global hub for the production and export of green hydrogen**.
- The Draft Mission Document was circulated amongst stakeholders by Ministry of New and Renewable Energy (MNRE) in May 2021. The NHM document is expected to be released in 2021.
- The draft proposes a **financial outlay of approximately Rs. 800 crores** for the next three years (2021-2024).
- In July 2021, The Minister for Power, announced the plan for introduction of Green Hydrogen Consumption Obligation (similar to Renewable Purchase Obligations) in fertilizer production and petroleum refining. A green hydrogen bid in the next four-five months is also expected.
- It aims to leverage the country's landmass and low solar and wind tariffs to produce low-cost green hydrogen and ammonia for export.
- India also plans to call **bids for 4 GW electrolyzer capacity**. The government could also extend the production-linked incentive (PLI) scheme for manufacturing electrolyzers to produce green hydrogen

Some initiatives by Indian industry

IOCL

- Announced development of India's first green H₂ plant at Mathura.
- MoU with Tata Motors -15 H₂-powered fuel-cell buses developed in collaboration with ISRO.
- Developing Type-3 High Pressure H₂ Cylinder and material-based H₂ storage.
- Green H₂ from biomass

NTPC

- Fuel cell based micro grid in Ladakh.
- Hydrogen storage for renewable power.
- Green methanol plant (H₂ plus carbon capture and utilization).
- Green ammonia production.
- Plans for Green H₂ generation in Gujarat.

BHEL

- Fuel cell technology development and testing infrastructure.
- Business plan across the value chain (supply/ EPC/ Project design etc.).
- Hydrogen buses

Reliance Industries

- Announced investment in four "giga factories" to manufacture photovoltaic modules, batteries, fuel cells and electrolyzers.
- Set out a 1-1-1 target of bringing down the cost of green H₂ to under \$1 per 1 kg in 1 decade.

Adani Enterprises

- Announced plans to invest across the entire green energy value chain.
- MoU with Maire Tecnimont to develop projects in producing ammonia, and hydrogen, and from renewable feedstock.

ACME Group

- Set up the world's first integrated commercial-scale pilot plant for Green Hydrogen and Green Ammonia production in Rajasthan in 2021.

Industry efforts

- **Reliance Industries** announced investments for developing an electrolyser giga-factory. The organisation has also outlined its “**1-1-1 vision**”, where it aims to bring down the costs of green hydrogen to under \$1 per kg in 1 decade.
 - In October, 2021, Reliance New Energy Solar Ltd, and Stiesdal A/S signed an agreement to collaborate on development and manufacturing of HydroGen electrolysers in India.
- In 2021, **Ohmium International** established India’s first green hydrogen PEM electrolyser manufacturing unit in Bangalore. The factory has a capacity of approximately 0.5 GW per year, which can be ramped up to 2 GW per year. The company shipped its first unit of hydrogen electrolyzer from India to the United States.
 - The company announced plans to reduce the costs of green hydrogen to \$1/kg by 2025.
 - In 2022, Ohmium International announced its partnership partnered with IIT Madras Research Park (IITMRP) to accelerate PEM electrolyzer performance enhancements.
- In 2021, **Indian Oil Company Limited (IOCL)** floated a global tender to set up green hydrogen generation units at its Mathura and Panipat refineries with installed capacities of 5000 MTPA and 2000 MTPA respectively, on Build Own Operate (BOO) basis.
- **NTPC Limited** is in talks with Government to set up a green hydrogen production facility in Andhra Pradesh. The project will look at splitting seawater into green hydrogen using solar energy in Tamil Nadu.
- In October 2021, **Gas Authority India Limited (GAIL)**, announced plans to build India’s largest green hydrogen plant. The company aims to build a 10 MW electrolyser with a capacity for generating 4.5 tonnes of green hydrogen daily.
- In November 2021, **Bharat Heavy Electricals Limited (BHEL)**, invited a global EOI seeking to address growing Hydrogen economy business through the manufacturing of: i) Electrolyser System for Hydrogen Production ii) Hydrogen based PEM Fuel Cell System.

Industry efforts - Hydrogen storage and transportation

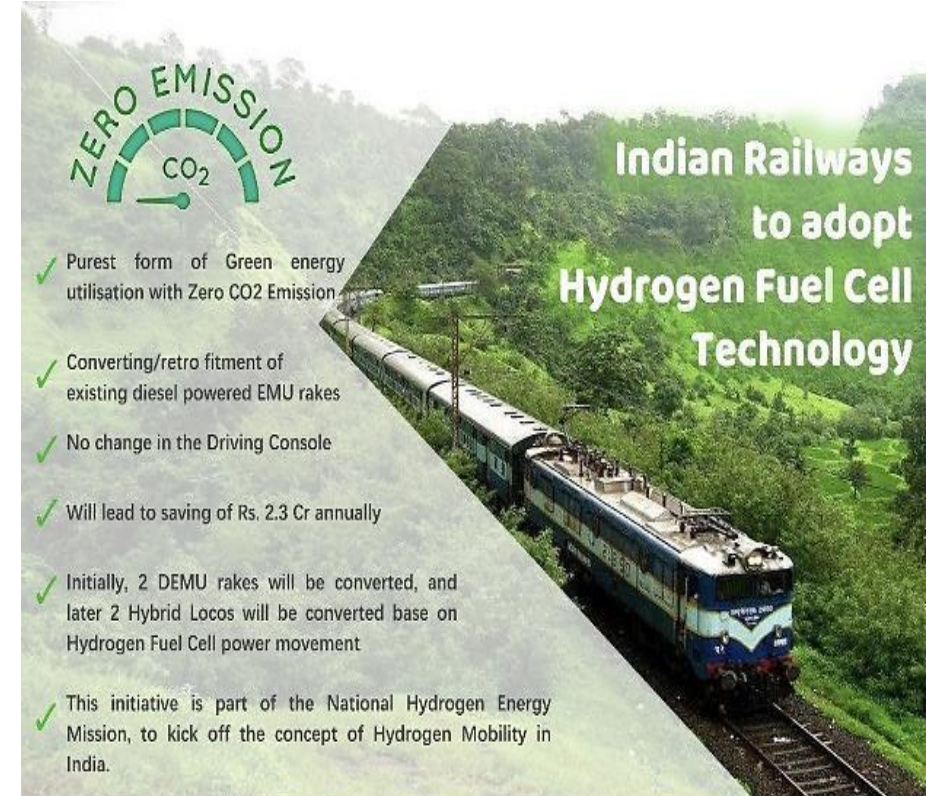
- **IOCL** is working in collaboration with IIT Kharagpur, on the development of the Type-3 High Pressure Hydrogen Cylinder. IOCL owns and operates the 1st high pressure hydrogen storage and dispensing terminal in India; the refuelling station is located in Delhi. This refuelling station uses a PEM electrolyser.
- In August 2021, **NTPC Limited** invited a global EOI to set up a pilot project on hydrogen blending with natural gas in city gas distribution. The pilot will be the first of its kind in India and would explore the viability of decarbonizing India's natural gas grid.



Industry efforts - Mobility

- **Indian Oil R&D** - Developed a single step compact SMR process for H-CNG production.
- **Delhi H-CNG** bus trials - A H-CNG plant and dispensing station has been set up in Delhi for a six-month trial for a fleet of 50 cluster buses.
- **NTPC Limited** - Invited a Global Expression of Interest (Eoi) to provide 10 Hydrogen Fuel Cell (FC) based electric buses and an equal number of Hydrogen Fuel Cell based electric cars in Leh and Delhi. NTPC has also invited an EOI for a green hydrogen fuelling station at Leh.
- **TATA Motors** has received an order of developing 15 hydrogen-based fuel cell buses based on PEM technology from the Indian Oil Corporation Limited (IOCL).
- **IOCL** and **SIAM** conducted joint study on the use of H-CNG in light duty vehicles. Indian Oil R&D collaborated with Tata Motors and Ashok Leyland to validate the use of H-CNG in heavy-duty vehicles

Indian Railways



Indian Railways to adopt Hydrogen Fuel Cell Technology

- ✓ Purest form of Green energy utilisation with Zero CO2 Emission
- ✓ Converting/retro fitment of existing diesel powered EMU rakes
- ✓ No change in the Driving Console
- ✓ Will lead to saving of Rs. 2.3 Cr annually
- ✓ Initially, 2 DEMU rakes will be converted, and later 2 Hybrid Locos will be converted base on Hydrogen Fuel Cell power movement
- ✓ This initiative is part of the National Hydrogen Energy Mission, to kick off the concept of Hydrogen Mobility in India.

Potential areas for collaboration



Hydrogen production technologies and fuel cells

Partnerships in electrolyser technologies and fuel cells for knowledge exchange. Research, Development and Demonstration (RD&D) projects with academic institutions to scale-up in H₂ production technologies.

According to one estimate India's plan will need about 4GW capacity electrolyser



Hydrogen in Industry

RD&D and feasibility studies with multiple companies along a supply chain, or in an industrial cluster.

Green hydrogen use is likely to be mandatory for industries in certain % of their hydrogen use

Hydrogen storage and handling technologies



Hydrogen in transport

Collaboration in transport sector particularly in heavy-duty and long-distance segments.

State Governments are also planning for hydrogen busses, inland water ways etc.

H-PNG for improved calorific value and lower emissions from natural gas



Our Work

Research
at the core of what we do, leading to

Technology Products

- Technology development
- Pilots – demonstration and replication
- Large-scale production and commercialization
- Capacity building – manufacturers, operators, users

Policy Advisory & Outreach

- Policy analyses and implementation strategies
- Financing and business model development
- Consultancy & advisory
- Engagement & outreach
- Capacity building - policy makers, academics, youth

Technical Services

- Standard operating procedures
- Consultancy & advisory
- Strategy development for corporates
- Testing and certification
- Capacity building - auditee, service providers



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TERI's role in promoting H₂ & fuel cell

Recommendation for development of “National policy on Hydrogen”

Development of national plan for production of H₂ from renewables (Biomass, Solar, Wind)

Market potential forecast for “Fuel cell applications” for transport, Industry & distributed generation

Come up with report on pilot scale demonstration projects on H₂ from RES

Development of H₂ & fuel cell testing facility (with part funding from Govt. of India and part from other countries)

Currently working on hydrogen production through biotechnology

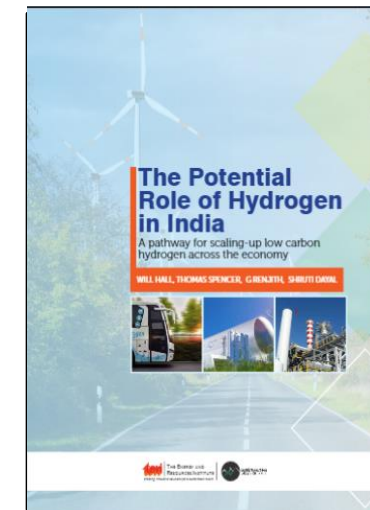
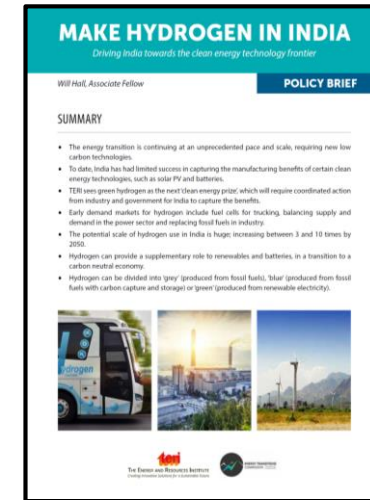
Background

In July 2020, TERI released a policy brief titled 'Make Hydrogen in India', which made the case for greater activity on green hydrogen technologies, to capture manufacturing benefits.

On 16th December 2020, we launched a more detailed technical report, which covers detailed assessment of hydrogen production technologies, and the various potential end-use sectors.

TERI has been organising Indo-Japan workshops on hydrogen and fuel cells since 2019. 4th workshop is planned in March 2022.

TERI is developing the proposal for Centre of Excellence in hydrogen and fuel cells



Thank You!!!

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