INDIA'S GREEN HYDROGEN INDUSTRY – DEVELOPMENTS

INTRODUCTION

As the world transitions towards cleaner and more sustainable energy sources, green hydrogen has emerged as a promising solution to decarbonize various sectors of the economy. India is strategically positioning itself as a significant contender in the global green hydrogen market, leveraging its ambitious renewable energy goals and increasing emphasis on sustainability. With increasing environmental concerns and the need to reduce carbon emissions, there is a growing demand for clean energy alternatives.

Government-led initiatives, coupled with private sector investments and research collaborations, are driving innovation and facilitating the scaling up of green hydrogen production.

Government Initiatives and Policies

The Indian government has recognized the potential of green hydrogen and has introduced several initiatives to promote its production and adoption.

National Hydrogen Mission

The National Green Hydrogen Mission was approved by the Union Cabinet on January 4, 2023, under the direction of the Honorable Prime Minister, Narendra Modi, with the following objectives:

- Establishing India as a global leader in the production and supply of green hydrogen
- Opening up markets for green hydrogen and its derivatives for export
- Less dependence on imported feedstock and fossil fuels
- Building up domestic manufacturing capacity
- Attracting capital and business ventures for the industry
- Generating employment opportunities and economic development opportunities
- Assisting with research and development projects

(Source: National Green Hydrogen Mission| National Portal of India)

The Mission, launched as part of India's commitment to the Paris Agreement, aims to scale up green hydrogen production and reduce its cost to make it competitive with conventional fuels.

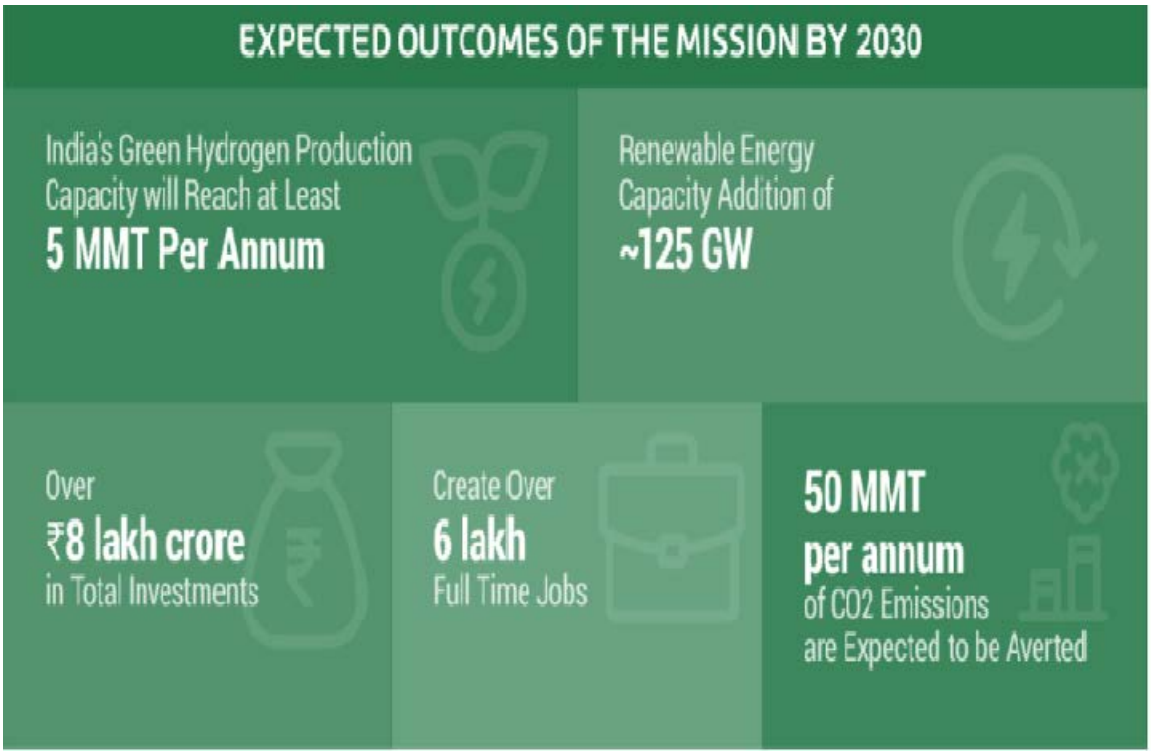
- The Strategic Interventions for Green Hydrogen Transition (SIGHT) programme will have an initial outlay of Rs. 17,490 crore (USD 2.1 billion)
- Pilot projects will receive Rs. 1,466 crore (USD 175.9 million)
- R&D will receive Rs. 400 crore (USD 48 million)
- Additional mission components will receive Rs. 388 crore (USD 46.5 million)

The total outlay for the Mission will be Rs. 19,744 crore (USD 2.4 billion). The guidelines for the scheme's implementation of each component will be formulated by the Ministry of New and Renewable Energy (MNRE).

India is expected to produce at least 5 MMT of green hydrogen annually, adding over 125 GW of new renewable energy capacity in the process. By 2030, the goals should generate over Rs. 8 lakh crore (USD 96 billion) in investments and over 600,000 new jobs. By 2030, it is anticipated that CO2 emissions will be reduced by around 50 MMT annually.

A crucial aspect of the mission is to substitute fossil fuels with green hydrogen and its derivatives, aiming to curtail fossil fuel imports by approximately Rs. 1 lakh crore (USD 12 billion) by 2030, consequently bolstering India's energy security.

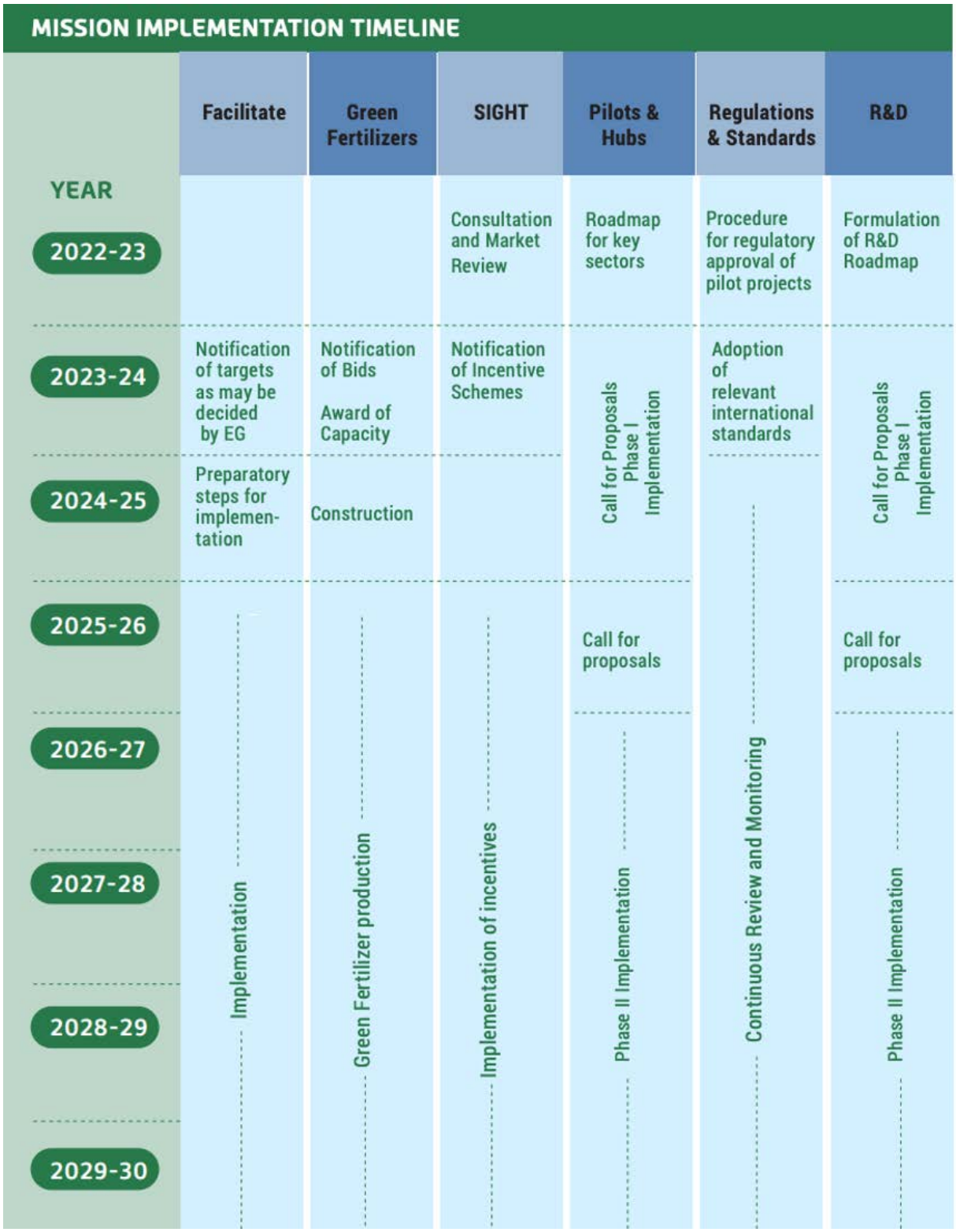
(Source: National Green Hydrogen Mission | NSWS)



(Source: national-green-hydrogen-mission.pdf (icgh.in))

The Mission's strategies will be implemented in a coordinated manner, following a phased approach. Initially, foundational activities such as establishing regulatory frameworks and pilot projects will be prioritized, alongside efforts to create demand and facilitate early deployment. Subsequent phases will expand on these activities, introducing green initiatives in additional sectors of the economy. Close collaboration with stakeholders will be maintained throughout to ensure the achievement of Mission objectives.

The key actions and implementation timelines are outlined in the table below.



(Source: [national-green-hydrogen-mission.pdf (icgh.in)])

Hydrogen initiatives of the Ministry of Petroleum and Natural Gas

Few attempts are being carried out by the Ministry of Petroleum & Natural Gas (MoPNG) to increase the amount of hydrogen in the energy mix.

In order to investigate the potential for using solar power to manufacture hydrogen, Secretary P&NG called a meeting of leading solar power producers and oil and gas marketing businesses in the petroleum sector. Five pilot projects based on Green Hydrogen are scheduled as a result of these discussions, with the hydrogen produced serving as both an industrial input for refineries and a fuel for transportation. These include:

- In order to demonstrate fuel cell vehicles at tourist destinations like Delhi-Agra, Gujarat (Statue of Unity), etc., two pilot programs are being set up for the installation of solar hydrogen refueling stations at two different locations.

- One pilot project would establish a green hydrogen plant and investigate the possibility of using green hydrogen instead of conventional hydrogen in refineries.

- One pilot project would produce green hydrogen and mix it with compressed natural gas (CNG), at a suitable location in Rajasthan, before it is dispensed at retail establishments.

- One pilot project would establish pipeline injection of green hydrogen and green hydrogen infrastructure in the City Gas Distribution (CGD) network.

(Source: Articles - Ministry of Petroleum And Natural Gas (mopng.gov.in))

Transport Sector: Prime hub for the Green Hydrogen revolution

MNRE has recently issued guidelines for a program aimed at supporting pilot projects focused on utilizing green hydrogen as a fuel for various types of vehicles including four-wheelers, buses, long-haul trucks, and heavy-duty vehicles. This technology involves both fuel cell-based and internal combustion engine-based propulsion methods.

The Green Hydrogen Mission will provide support to the iron and steel sector and the shipping sector to carry out these pilot projects. Key aspects of the project include:

- Pilot Projects through the Ministry of Ports, Shipping and Waterways (MoPSW) with a budget of Rs. 115 crore (USD 13.8 million) by 2025-26 to drive innovation in green hydrogen.
- The introduction of green hydrogen in maritime operations for piloting maritime propulsion, including passenger ferries, civilian boats, pleasure cruising, and ship refueling, involves assessing technical feasibility, economic viability, and operational effectiveness.
- Oversight by the Ministry of Steel and designated Implementing Agencies for pilot projects in the Steel and Iron Sector, with the aim of substituting fossil fuels and feedstock with green hydrogen and its derivatives.
- Funding for projects exploring innovative hydrogen applications to reduce carbon emissions in the iron and steel manufacturing process.

According to MNRE, the initiative will be implemented with a total budget of Rs. 496 crore (USD 59.5 million) until the fiscal year 2025-26. Such a significant budget allocation indicates a primary focus on pilot projects in the transport sector and the establishment of advanced infrastructure for green hydrogen production and installation of hydrogen refueling stations as needed.

(Source: Indian Government Announces Massive New Green Hydrogen Project • Carbon Credits)

India Green Hydrogen Market Overview

India's Green Hydrogen market size reached USD 4.53 billion in 2022 and is projected to grow significantly to USD 12.33 billion by 2032, demonstrating a compound annual growth rate (CAGR) of 11.1% during the forecast period from 2023 to 2032. The growth of the green hydrogen market in India is driven primarily by the availability of renewable energy resources and advancements in electrolysis technology. These factors are expected to fuel the adoption and expansion of green hydrogen initiatives across various sectors, contributing to the country's sustainable energy transition.

Key companies in the Indian Green Hydrogen market include:

- Cummins India
- Hydrogen Pro AS
- MHI
- Stiesdal A/S
- Siemens
- Thyssenkrupp
- Acme Group
- Azure Power
- Adani Group
- Reliance Industries Ltd.
- NTPC Limited
- GAIL Limited
- L&T
- Air Products
- Bharat Petroleum Corporation Limited (BPCL)
- JSW Energy Neo Ltd

Source: https://www.marketresearchfuture.com/reports/india-green-hydrogen-market-16080

Indian Companies leading the Green Hydrogen Revolution

1. Reliance Industries

   Reliance Industries Ltd (RIL), India's largest private oil and gas company, is accelerating its sustainability efforts intending to achieve net carbon-zero status by 2035. To drive this transition, RIL has committed Rs. 75000 crore (USD 9 billion) over three years to renewable energy initiatives, primarily investing Rs. 60000 crore (USD 7.2 billion) in the Dhirubhai Ambani Green Energy Giga Complex in Jamnagar, Gujarat. This expansive 5,000-acre complex will house advanced facilities for solar cell, module, energy storage battery, fuel cell, and electrolyzer plant production, crucial for green hydrogen generation.

Additionally, RIL is partnering with Danish company Stiesdal A/S through its subsidiary Reliance New Energy Solar (RNESL) to establish a 2.5-gigawatt electrolyzer manufacturing unit, aiming to address both domestic and international green hydrogen demand.

2. GAIL

GAIL (India), a state-owned enterprise, is making significant strides in the realm of green hydrogen to complement its natural gas operations with environmentally friendly fuel alternatives. With ambitions to construct India's largest green hydrogen plant, the company aims to reduce carbon emissions and bolster its energy portfolio. During a recent announcement, GAIL's chairman and managing director, Manoj Jain, revealed that the company has initiated a global tender to procure an electrolyser for this endeavor. Additionally, GAIL has identified 2-3 potential sites for the plant, including one in Vijaipur, Madhya Pradesh, with plans to commence operations within 12-14 months. The proposed plant is slated to have a capacity of 10 MW, making it the largest of its kind announced in the country thus far.

3. NTPC

NTPC is making significant progress in sustainable energy with its forthcoming 4,750 MW renewable energy park in the Rann of Kutch, alongside a pilot project at its Vindhyanchal unit aimed at reducing hydrogen production costs to USD 2.8-3/kg. The company's expansion into green hydrogen infrastructure includes plans for a pioneering hydrogen fueling station in Leh, Ladakh, and the introduction of five hydrogen buses, marking a move towards sustainable mobility solutions. NTPC's advocacy for green hydrogen spans multiple sectors, supporting its revised goal of achieving 60 GW renewables capacity by 2032, indicating a robust commitment to sustainable energy initiatives.

4. Indian Oil Corp

The largest fossil fuel supplier in the country, Indian Oil Corp announced plans to build a green hydrogen plant at its Mathura refinery in Uttar Pradesh, with a capacity to process around 160,000 barrels per day. The plant will utilize electrolysis, powered by its wind project in Rajasthan, to produce entirely green hydrogen. Moreover, Indian Oil plans to

establish a standalone green hydrogen production facility in Kochi, leveraging the solar power system at the airport for energy. With a commitment to sustainability, Indian Oil aims to swiftly transition at least 10% of its refinery hydrogen consumption to green hydrogen.

5. Larsen and Toubro (L&T)

   L&T, a prominent engineering company, is venturing into the green hydrogen domain with ambitious plans. In alignment with its commitment to sustainability, L&T aims to achieve net-zero emissions by 2040, with 90% of the target attributed to initiatives like renewable energy, green hydrogen, and biodiesel. The remaining 10% will be offset through carbon sink creation. To support these initiatives, L&T plans to allocate between Rs. 1000-5000 crore (USD 120-600 million) over several years towards its green initiatives, underscoring its dedication to environmental stewardship and innovation.

6. Adani Group

   ADANI Group emerges as a leading green hydrogen manufacturing company in India, with significant investments in green and renewable energy. Through its subsidiary, Adani New Industries Ltd (ANIL), the group partners with TotalEnergies SE of France, announcing a USD 50 billion investment over the next decade to establish a green hydrogen ecosystem in India. ANIL sets an ambitious target of producing 1 million tons per annum of green hydrogen by 2030, aligning with the country's renewable energy objectives. To achieve this, ANIL collaborates with Melbourne-based hydrogen technology firm, Cavendish Renewable Technology (CRT), focusing on developing advanced electrolyzer technologies and innovative "C-Cell" technology for mass-scale green hydrogen production.

7. Bharat Petroleum

   In 2021, Bharat Petroleum Corp Ltd (BPCL) partnered with the Bhabha Atomic Research Centre (BARC) to enhance Alkaline Electrolyzer technology for green hydrogen production, aiming to scale up to 1,000 MW by 2027 utilizing renewable sources, including green hydrogen. Additionally, BPCL is establishing a 20-megawatt green hydrogen unit in Madhya Pradesh, slated to be India's largest, by 2040. The company plans to invest USD 18 billion over the next five years to expand its oil business and renewable energy portfolio,

targeting 1 GW of renewable energy capacity by 2025 and 10 GW by 2040. BPCL also intends to invest in ethylene crackers, polypropylene projects, and natural gas infrastructure.

8. JSW Energy

   JSW Green Hydrogen is a subsidiary or division of JSW Energy that focuses on the production and utilization of green hydrogen. It represents JSW Energy's commitment to sustainable energy practices and its efforts to leverage hydrogen as a clean and renewable energy source. Through JSW Green Hydrogen, the company aims to contribute to reducing carbon emissions and advancing the transition towards a greener and more sustainable energy future.

(Source: Mint (livemint.com))

Best Green Hydrogen stocks in India 2024

Name	Sub-Sector	Market Cap (Rs. in cr.)	Close Price (Rs.)	PE Ratio	1Y Return (%)	5Y Return on Investment (%)	Dividend Yield (%)	Fundamental Score
Oil and Natural Gas Corporation Ltd	Oil & Gas – Exploration & Production	2,94,441.43	252.50	8.31	74.26	8.78	4.81	10.00
Reliance Industries Ltd	Oil & Gas – Refining & Marketing	18,30,896.31	2,896.10	27.45	35.19	7.00	0.33	7.71
Bharat Petroleum Corporation Ltd	Oil & Gas – Refining & Marketing	1,02,585.01	492.65	48.14	47.02	10.05	0.83	5.65
Indian Oil Corporation Ltd	Oil & Gas – Refining & Marketing	2,02,922.20	146.70	20.72	79.45	8.17	2.04	5.57
Jindal Stainless Ltd	Iron & Steel	44,329.60	553.00	20.96	117.67	14.99	0.46	5.45
JSW Energy Ltd	Power Generation	80,032.37	496.30	54.16	116.21	8.13	0.41	5.44
NTPC Ltd	Power Generation	3,05,202.57	324.55	18.05	92.21	6.98	2.30	5.11
Adani Green Energy Ltd	Renewable Energy	2,63,709.73	1,715.50	270.75	44.28	6.15	–	4.83
GAIL (India) Ltd	Gas Distribution	1,08,752.15	171.75	19.36	80.88	13.13	3.02	4.25

Note: The stocks are sorted using the Fundamental Score (high to low) on the Tickertape Stock Screener, and the data is from 29th January 2024.

Source: Best Green Hydrogen Stocks in India (2024) – Blog by Tickertape

Corporate announcements and partnerships

- In keeping with the government's goal of decarbonizing the economy and reducing reliance on the import of fossil fuels, Reliance Industries (RIL), Tata Motors, and Indian Oil Corporation (IOC) are probably going to be among the leading bidders for the government's pilot project for the use of green/grey hydrogen (H2) in the transportation sector. (RIL, Tata Motors, IOCL to be key bidders for green hydrogen pilot project: Report - BusinessToday)
- As per the sources, Reliance is in collaboration with Ashok Leyland and Daimler India Commercial Vehicles, while Tata Motors is in partnership with IOCL. There are also reports that Ashok Leyland is partnering with NTPC. The goal of the H2 corridor project is to facilitate the gradual rollout of hydrogen-powered automobiles, trucks, and buses. Funds to bridge the viability gap caused by the higher initial cost of hydrogen-powered vehicles will be awarded to the winning bidder. (RIL, Tata Motors, IOCL to be key bidders for green hydrogen pilot project: Report - BusinessToday)
- RIL, Larsen and Toubro (L&T), alongside energy firms Greenko Group and Welspun New Energy, are set to establish green hydrogen and green ammonia units at Gujarat's Deendayal Port Authority (DPA) in Kandla, according to sources. This project, expected to draw investments up to Rs. 1 lakh crore (USD 12 billion), is poised to become one of India's largest investments in both the green energy sector and broader energy infrastructure. Last October, the port authority received expressions of interest for 14 land parcels, each earmarked for the production of 1 million tons per annum (MTPA) of green ammonia. Recently, DPA formally allotted the plots to the four companies, signaling significant progress in India's green energy landscape. (Green Hydrogen Investment: RIL to lead massive INR 1 lakh crore investment in green hydrogen, ammonia units at Kandla, ET Auto (indiatimes.com))
- Indian refiner Bharat Petroleum Corp Ltd (BPCL) announced plans to establish the country's first green hydrogen plant within Cochin International Airport. The 1,000-kilowatt plant will be built and operated by BPCL, leveraging resources contributed by the

airport, including land, water, and green energy. Initially, the plant's output will be used to power vehicles within the airport premises. BPCL intends to invest USD 18.16 billion over the next five years to bolster its oil business and expand its renewable energy portfolio, aligning with its goal of achieving net-zero emissions by 2040. (BPCL to set up first-ever green hydrogen plant in an Indian airport | Reuters)

- JSW Energy is gearing up to establish a green hydrogen plant in Karnataka, with a capacity of 3,800 tonnes. Additionally, the company is finalizing a seven-year contract with JSW Steel, a subsidiary of the same conglomerate, for the supply of green hydrogen and green oxygen to facilitate the production of green steel. (MC Exclusive | JSW Energy to set up 3,800-tonne green hydrogen plant in Karnataka, sign 7-year supply deal with JSW Steel (moneycontrol.com))

International collaborations and future outlook

Research collaborations play a pivotal role in advancing India's green hydrogen industry, fostering innovation, and addressing technological challenges. One notable collaboration involves partnerships between government research institutions, academic institutions, and private sector entities. For instance, the Indian Institutes of Technology (IITs) and the Council of Scientific and Industrial Research (CSIR) are actively engaged in research projects focused on green hydrogen production, storage, and utilization technologies.

Additionally, international collaborations are instrumental in leveraging global expertise and resources to accelerate India's progress in the green hydrogen sector. India's dedication to achieving a sustainable and clean energy future via the Green Hydrogen Economy extends internationally. Partnerships with global allies like Germany, Japan, and Australia highlight India's resolve to tap into international expertise and exchange best practices in the pursuit of eco-friendly energy solutions.

Germany

India and Germany had signed a Joint Declaration of Intent to establish an Indo-German Green Hydrogen Task Force. The goal of creating a national green hydrogen economy is shared by both countries. The long-term objective is to achieve economic viability for green hydrogen. This calls

for a global uptick in the production and consumption of green hydrogen. In order to aid the attainment of the objectives outlined in the Paris Agreement, India and Germany are in favour of the creation of a global green hydrogen economy.

Australia

The Department of Climate Change, Energy, Environment, and Water announced the establishment of the India-Australia Green Hydrogen Taskforce in September 2023. The goal of this taskforce is to facilitate trade, commerce, and research prospects in the production and application of green hydrogen between the two nations. The significance of Australia and India working together to create hydrogen as part of the shift to net zero emissions was underlined, emphasizing the advantages of knowledge sharing and quickening the development of sustainable energy solutions.

Japan

Japanese engineering conglomerate IHI has agreed to purchase 400,000 tons per year of green ammonia from Indian renewables developer ACME, starting in 2028. IHI will distribute the ammonia to various industries, including power generation, primarily in Japan. ACME plans to supply the ammonia from its project in Odisha, which is expected to produce nearly 1.3 million tons annually once fully operational. Only 30% of the project's output has been pre-sold to IHI. The total project cost is estimated at USD 7.2 billion, with ACME committing USD 3.3 billion, although it's unclear if this covers the first phase or the entire project.

Key events on India's Green Hydrogen Industry

RE-INVEST (Renewable Energy Investors' Meet & Expo)

Global RE-INVEST Renewable Energy Investors Meet & Expo, organized by the Ministry of New and Renewable Energy (MNRE), Government of India, was held from 26 – 28 November, 2020, on a Virtual Platform. RE-INVEST 2020, themed 'Innovations for Sustainable Energy Transition', aimed to accelerate the worldwide effort to scale up development and deployment of renewable energy and connect the global investment community with Indian energy stakeholders. It featured a 3-day conference on renewables and future energy choices, and an exhibition of manufacturers, developers, investors, and innovators.

Renewable Energy India Expo (REI)

The Renewable Energy India Expo (REI), celebrated its 16th anniversary in October 2023, remains Asia's premier B2B expo for renewable energy. With a focus on solar energy, wind energy, bio-energy, energy storage, green hydrogen, and electric vehicles and charging infrastructure, REI provides a comprehensive platform for domestic and international manufacturers, traders, buyers, and professionals. The upcoming 17th edition, scheduled for September 3-5, 2024, anticipates over 800 exhibitors, 40,000 trade visitors, and notable policymakers, decision-makers, influencers, technical experts, and professionals gathering to explore the latest developments and opportunities in the renewable energy sector.

Green Hydrogen (GH2) Summit

The GH2 summit, which was held in Delhi in 2022 and 2023, was supported, among others, by the Green Hydrogen Organization (GHO, Geneva) and the Indo German Energy Forum (IGEF).
It brought together industry experts, thought leaders, and policymakers to discuss and decode various forms of hydrogen production and devise green hydrogen strategies for India. The 3rd edition of Green Hydrogen India, an international exhibition and conference, is scheduled to take place on August 29th and 30th, 2024, at the India International Convention Centre in Dwarka, New Delhi. Over the course of two days, the event will feature specialized sessions focusing on key

aspects of the green hydrogen industry. These sessions will cover topics such as investment strategies for financing green hydrogen projects, technological innovations tailored to specific business needs, and broader discussions encompassing policy frameworks and commercial strategies.

CII The Green Hydrogen Summit Noida

The Confederation of Indian Industry (CII) hosted The Green Hydrogen Summit on December 7, 2023, in Delhi NCR. The summit served as a platform for industry experts and stakeholders to convene and discuss the establishment of a hydrogen-based ecosystem in the country. Key topics addressed during the summit included making the transition towards a green market, emphasizing the importance of infrastructure and its adaptability as the backbone of hydrogen, exploring how industries can embrace the potential of hydrogen, and assessing the navigation of hydrogen energy ecosystems for a sustainable future.

CONCLUSION

India's green hydrogen industry is experiencing significant momentum with various project awards and government initiatives driving growth. The Solar Energy Corporation of India (SECI) awarded tenders for manufacturing 1,500 MW of electrolyzers and 412 ktpa of green hydrogen to major companies like RIL, Greenko-John Cockerill, L&T, and Adani. The government's allocation of Rs. 600 crore (USD 72 million) to the National Green Hydrogen Mission (NGHM) in the 2024 interim budget reflects a doubling of funds from the previous year, signaling strong support for the sector. Large corporations like L&T and Jindal Steel have seen stock gains following green hydrogen project announcements, highlighting investor confidence. However, analysts caution that while the sector holds promise, it is still nascent for significant investment, with many projects in early stages and expected completion not until FY27 or FY30. Challenges such as the cost of hydrogen need to be addressed for widespread adoption, but the sector presents substantial opportunities across various sub-sectors, including manufacturing, renewable energy, and ancillaries.