सत्यमेव जयते

पेट्रोलियम एवं प्राकृतिक गैस मंत्रालय

Ministry of Petroleum & Natural Gas

Government of India

HydrogenTimes

"I believe that water will one day be employed as fuel, that hydrogen and oxygen which constitute it, used singly or together, will furnish an inexhaustible source of heat and light, of an intensity of which coal is not capable."

~Jules Verne, The Mysterious Island (1874)

हरित ऊर्जा से आत्मनिर्भर भारत की ओर

A Quarterly Newsletter of Ministry of Petroleum & Natural Gas (MoP&NG) on Green Hydrogen Initiatives

April, 2023, Vol.-I

Hardeep S Puri
Minister of Petroleum and Natural Gas
& Minister of Housing and Urban Affairs

सत्यमेव जयते

Message

Addressing the nation on the 75th Independence Day, Hon'ble Prime Minister Narendra Modi announced the National Hydrogen Mission with an aim to make India energy independent by 2047 and a hub for the production and export of green hydrogen.

On 4th of January 2023, the Union Cabinet, has approved National Green Hydrogen Mission (NHM). The initial outlay for the Mission will be Rs. 19,744 crore, including an outlay of 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 crore towards other Mission components.

India is on the cusp of energy transition. These initiatives of GoI offer a great opportunity to the energy entrepreneurs of the country. MoP&NG has taken significant strides towards creating hydrogen ecosystem in the country. Oil refineries are already a major producer and consumer of hydrogen and therefore, can and have been taking lead in transition to green hydrogen by drawing plans to produce Green Hydrogen. Other initiatives include hydrogen blending in the CGD network, developing and operating Hydrogen fuel cell Buses. Parallely, research work has been taken to develop indigenous electrolyser, fuel cells and hydrogen storage including safety standards on Production, Storage and Transportation of Hydrogen. A Hydrogen test loop is being set up for studying metallurgical aspects of hydrogen transportation through existing pipelines.

MoP&NG is committed to usher in greener and cleaner future through the efficient use of green resources in every sphere of energy use. Next decade belongs to India and Green Energy Initiatives taken by us are going to shape the global initiative towards decarbonization.

I am very happy to learn that CHT under Ministry of Petroleum and Natural Gas is bringing out a Quarterly Newsletter **"Hydrogen Times"** to disseminate latest information and developments both in India and globally

Jai Hind

1st April, 2023

Initiatives by PSUs under MoP&NG

Production plans for Green Hydrogen

Organization	Project Site	Green Hydrogen Capacity by 2030 (KTA)
IOCL	Panipat Refinery	70
HPCL	Visakh Refinery & Barmer Refinery	29
BPCL	Bina/Kochi/Mumbai	28
GAIL	H2 blending in City Gas Distribution Network	45
MRPL	MRPL, Mangalore	5
NRL	Numaligarh Assam	9
ONGC	-	180
TOTAL		366

GAIL has started injecting 2% hydrogen in the CGD network in Indore, soon the blend shall be raised to 5% hydrogen. GAIL has also signed an MoU with Pipeline Infrastructure Limited (PIL) with the objective to explore options in Hydrogen transportation and blending of hydrogen with natural gas.

IOCL has been running a 30 Nm3/hr capacity PEM Electrolyser and also country's first high pressure (550 bar) hydrogen storage facility at its R&D centre at Faridabad. IOCL has created one of country's biggest fuel cell research infrastructures, with the capabilities for development and evaluation of PEM Fuel cell up to 10 kW capacity.

BPCL is collaborating with BARC, Mumbai and NFTDC, Hyderabad to develop an Alkaline Electrolyser for production of Green Hydrogen. A plant with 5 Nm3/hr capacity is under construction.

Oil India Limited (OIL) under its start-up program "SNEH" has initiated development of Liquid Organic Hydrogen Carrier (LOHC) for Hydrogen storage and transportation.

EIL is involved in various conceptual/ consultancy services for green hydrogen projects including Study for setting up Green Hydrogen Facility in Dhorela smart city, Gujarat; Consultancy Service for LEPC selection for water electrolyser at Bina refinery; PMC Services for electrolyser based Green Hydrogen plant at Vijaipur for GAIL along with EPCM services for the Balance of Plant; Hydrogen blending in NG pipeline/ CGD Network & impact on end user for GAIL; studying the suitability of NG pipelines and CGD network for H2/NG mix services and its impact on end user; DFR of setting up of 4000 TPD Green Ammonia plant at Gopalpur, Odisha.

R&D Initiatives

- IOCL is working with IIT-Kharagpur for development of Indigenous Type III Hydrogen storage cylinders (350 bar)
- HPCL has developed a CO_2 & water-free process and set up a pilot plant for production of H-CNG using indigenous catalyst. The process also produces Carbon Nano Tubes (CNT) as a valuable by-product.
- ONGC is working on production of hydrogen using various Thermochemical cycle processes.
- MoP&NG has set up a Hydrogen Corpus Fund (HCF) to promote technologies related to production, storage and transportation of hydrogen. Centre for High Technology (CHT) is the Nodal Agency for executing HCF projects. Some of the major projects taken under HCF are:

1. Development & demonstration of 15 fuel cell buses based on hydrogen Produced from multiple pathways at a total cost of Rs 296 crore.
2. Single step compact reformer unit to produce hydrogen blended CNG (H-CNG) and associated facilities in Delhi bus depot for demonstration in commercial CNG vehicles.
3. Effective hydrogen Production through membrane less electrolysers and storage.
4. Development and scale-up of indigenous next generation Solid Oxide Fuel Cell Technology and demonstration of process line (10 kW) for prototype production.
5. Development and Demonstration of BS-VI compliant Hydrogen Fuelled Internal Combustion Engine in Commercial Vehicle.
6. Development of test Loop to establish feasibility for transportation of H_2-NG blend through CGD and High-pressure pipeline network.

Interesting Facts about Hydrogen

Hydrogen although abundant on earth as part of the compounds, such as water (H_2O) or methane (CH4), it is not a primary fuel as it is not available naturally in pure form and need to be produced using some primary energy resource.

English scientists William Nicholson and Sir Anthony Carlisle in the year 1800 discovered that applying electric current to water produced hydrogen and oxygen gases. This process was later termed "electrolysis." Typically, electrolysers consume 50-55 kilowatt-hours or units of electricity to produce one kilogram of hydrogen.

German engineer Rudolf Erren in 1920s converted the internal combustion engines of trucks, buses and submarines to use hydrogen or hydrogen mixtures. British scientist and Marxist writer J.B.S. Haldane introduced the concept of renewable hydrogen in his paper, Science and the Future, by proposing that "there will be great power stations where during windy weather the surplus power will be used for the electrolytic decomposition of water into oxygen and hydrogen."1998 – Iceland unveiled a plan to create the first hydrogen economy by 2030.

History of synthesizing Ammonia

Haber-Bosch process, method of directly synthesizing ammonia from hydrogen and nitrogen, developed by the German physical chemist Fritz Haber in 1913, which used coal-based technology for gas production and made the manufacture of ammonia economically feasible. Because electrolysis-based ammonia synthesis was substantially more energy efficient and had a lower capital investment, it became favoured process where cheap hydropower was available. By 1930, about 30% of the total ammonia production capacity was based on electrolysis-based ammonia synthesis. For economic reasons again, renewable ammonia production declined from the 1960s onward in favour of fossil-based ammonia production. Especially, the emergence of abundant and low-cost natural gas was responsible for the decline in renewable ammonia production. Currently, essentially all ammonia production outside China is based on natural gas.

In 1958, a renewable ammonia plant became operational in Nangal, located in the northern part of India. The electricity was derived from the Bhakra Dam. The electrolysers were operated at a reduced load from 1978 onwards, when the ammonia plant was changed to fuel oil as feedstock. The plant was converted to natural gas in 2013.

Renewable ammonia has recently gained traction again and will probably play a significant role in maintaining national and global energy and food security during the 21st century.

The colours of Hydrogen

Hydrogen itself is a colourless gas but there are different colour codes such as green, blue, grey, brown or black, turquoise, purple, pink, red and white, which refer to the source or the process used to make hydrogen.

THE COLOURS OF HYDROGEN

GREEN
Hydrogen produced by electrolysis of water using electricity from renewable sources like wind or solar. Zero CO_2 emissions are produced.

BLUE
Hydrogen produced from fossil fuels (ie, grey, black, or brown hydrogen) where CO_2 is captured and either stored or repurposed.

GREY
Hydrogen extracted from Natural Gas using steam-methane reforming. This is the most common form of hydrogen production in the world today.

PURPLE/PINK
Hydrogen produced by electrolysis using nuclear power.

TURQUOISE
Hydrogen produced by thermal splitting of methane (methane Pyrolysis). Instead of CO_2, solid carbon is produced

BROWN/BLACK
Hydrogen extracted from coal using gasification.

YELLOW
Hydrogen produced by electrolysis using grid electricity from various sources (i.e., renewables and fossil fuels).

WHITE
Hydrogen produced as a byproduct of industrial processes. Also refers to hydrogen occurring in its (rare) natural form.

The global energy crisis underscores the need for policy to align energy security needs with climate goals. India is in a unique position to pioneer a new model for low-carbon, inclusive growth as its energy future depends on buildings and factories yet to be built, and vehicles and appliances yet to be bought.

INDIA

About 5 MMT Grey Hydrogen is consumed annually in India, and about 99 percent of this is utilized in petroleum refining and manufacture of Ammonia for fertilizers.

India's National Hydrogen Mission, is to provide Rupees 197.44 billion ($2.4 billion) in funding support for renewable hydrogen production and electrolyser manufacturing, with a goal of delivering 5 million mt/year of green hydrogen by 2030.

BPCL is working for the development of eco-system for electrolyser stack manufacturing including setting up an experimental prototype of indigenous alkaline electrolyser (BARC technology).

IOC, L&T, ReNew have joined hands for green hydrogen business. IOC and L&T have additionally signed a pact to form a joint venture with equity participation to manufacture and sell electrolysers.

HPCL is collaborating with RMIT, Australia for production of Hydrogen via direct electrolysis of sea water and also with University of Birmingham on hydrogen storage and transportation.

Reliance Industries Limited (RIL) and Ashok Leyland unveiled India's first Hydrogen Internal Combustion Engine (H2-ICE) powered heavy-duty truck on February 13, 2023, India's first Hydrogen powered truck was flagged off by Hon'ble PM Shri Narendra Modi during India Energy Week at Bengaluru.

At Mumbai, BEST has proposed to convert 220 diesel buses of Mumbai running on "green hydrogen" with a pilot project planned with Union Transport Ministry.

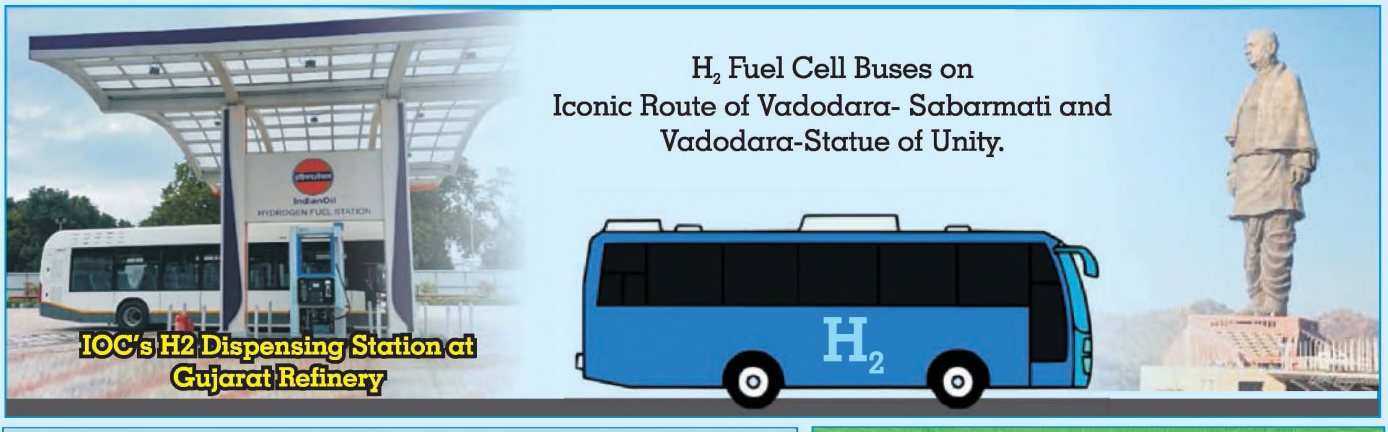
EIB (European Investment Bank) to extend 1 billion Euro funding for Green Hydrogen projects in India

L&T has signed a Memorandum of Understanding with the Norway-based H2 Carrier (H2C) to develop floating green hydrogen and green ammonia projects. Under the terms of the MoU, L&T will become a partner for Engineering, Procurement, Construction, Installation and Commissioning (EPCIC) of the topsides for H2C's floating process plants.

L&T has signed an agreement with France's McPhy for electrolyser manufacturing, under this, McPhy will grant an exclusive license of its pressurised alkaline electrolyser technology to L&T for manufacturing, including future product upgrades.

The Green Billions Limited has entered into a collaboration with The Pune Municipal Corporation to set up its first plant in India to extract green hydrogen from biomass and municipal solid waste. The company will utilise the municipal waste of 350 tonne per day in Pune to generate hydrogen for a period of 30 years.

Solar Energy Corporation of India (SECI), a CPSU under MNRE, will soon launch a mega tender for aggregation of demand for green hydrogen, as part of the implementation of the NHM.



Global

The Inflation Reduction Act (IRA) introduced in USA will give $3 tax credit per kilogram of clean hydrogen, at a stroke making it competitive with hydrogen made from natural gas.

Germany Signs Landmark Deal to Buy Denmark's Green Hydrogen that could see the two countries establish a hydrogen pipeline. With Denmark dedicated to large-scale production of green hydrogen from its offshore wind capacity in the North and Baltic Seas, Germany has pledged to provide a ready market.

EU plans subsidies for hydrogen made using renewable energy with launch of a hydrogen funding 'bank', consisting of auctions to award a fixed premium to hydrogen producers up to 10 years. The first auction this year would offer about 800-million-euros.

World's largest electrolyser to be deployed in Norway, HydrogenPro is set to install the world's largest electrolyser in Norway. The electrolyser will have an output of 1,100 Nm3/hour of hydrogen at normal current density. This equals 100 kg of pure hydrogen per hour. The electrolyser has a diameter of 2 meters.

Researchers use sea water to produce green hydrogen at almost 100% efficiency: The Adelaide University team found a way to cleanly make H2 without requiring fresh water. Among the challenges to large-scale production of green hydrogen has to do with the use of fresh water in electrolysers. The reason is that many parts of the world are already facing fresh water supply challenges due to worsening droughts caused by climate change.
Ref: http://www.hydhogenfuelnews.com/

Plug Power and Johnson Matthey Announce Long-Term Strategic Partnership to Accelerate the Hydrogen Economy: Plug Power (Plug) and Johnson Matthey (JM), a global leader in sustainable technologies, announced a long-term strategic partnership to accelerate the green hydrogen economy. This strategic partnership between Plug and JM will support Plug in delivering its targeted revenue of US$5 billion and US$20 billion by 2026 and 2030 respectively. Plug and JM will co-invest in what is expected to be the largest (5GW scaling to 10GW over time) CCM manufacturing facility in the world. The facility will be built in the United States and likely begin production in 2025.
Ref: https://www.azocleantech.com/

Germany bets on global green hydrogen economy : In an effort to boost the continent's ability for research into renewable energy and green hydrogen, Germany is "further extending" its relationship with Africa in the fields of energy and climate.

EU opens door to 'green' nuclear-derived hydrogen: The European Commission could allow some hydrogen produced in nuclear-based energy systems to count towards EU renewable energy goals.

Published by Centre for High Technology on behalf of Ministry of Petroleum & Natural Gas (MoP&NG)