International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 08 Issue: 05 | May - 2024 SJIF Rating: 8.448 ISSN: 2582-3930

Review on Challenges in India's National Hydrogen Mission

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Abstract:

India's deep commitment to aspirational Climate Goals has been widely acknowledged in the comity of nations. Our achievements have matched our ambition. India has the fastest growing Renewable Energy capacity in the world. India has also emerged as one of the most attractive destinations for investments in Renewables. As India has set its sight on becoming energy independent by 2047 and achieving Net Zero by 2070, we recognise the critical role of Green Hydrogen. India, with its vast renewable energy resources, also has the opportunity to produce Green Hydrogen for the world. The National Green Hydrogen Mission aims to provide a comprehensive action plan for establishing a Green Hydrogen ecosystem and catalysing a systemic response to the opportunities and challenges of this sunrise sector.

Key Words: National Green Hydrogen Mission, Grey Hydrogen, Blue Hydrogen and Green Hydrogen

Introduction:

Addressing the nation on the 75th Independence Day, Prime Minister Narendra Modi announced the National Hydrogen Mission with an aim of making India a hub for the production and export of green hydrogen. India is at a crucial juncture in terms of its energy landscape and green hydrogen has a critical role to play to make the nation self-reliant and energy-independent. On January 4, 2022, the National Green Hydrogen Mission was approved by the Union Cabinet, chaired by the Hon'ble Prime Minister Shri Narendra Modi. Currently, India spends over $160 billion of foreign exchange every year for energy imports [1]. These imports are likely to double in the next 15 years without remedial action. With this approval, the stage is set for India to become a global champion in green hydrogen [2]. The initial outlay for the Mission will be Rs. 19,744 crore, including an outlay of Rs. 17,490 crore for the Strategic Interventions for Green Hydrogen Transition (SIGHT) programme, Rs. 1,466 crore for Pilot Projects, Rs.400 crore for Research & Development, and Rs. 388 crore towards other Mission components. Ministry of New and Renewable Energy (MNRE) will formulate the scheme guidelines for implementation of the respective components.

Sub component of National Hydrogen Mission:

Under the Strategic Interventions for Green Hydrogen Transition Programme (SIGHT), two distinct financial incentive mechanisms – targeting domestic manufacturing of electrolysers and production of Green Hydrogen – will be provided under the Mission [3]. The Mission will also support pilot projects in emerging end-use sectors and production pathways. Regions capable of supporting large scale production and/or utilization of Hydrogen will be identified and developed as Green Hydrogen Hubs [3]. Public-Private Partnership framework for R&D (Strategic Hydrogen Innovation Partnership – SHIP) will be facilitated under the Mission. R&D projects will be goal-oriented, time bound, and suitably scaled up to develop globally competitive technologies [3]. A coordinated skill development programme will also be undertaken under the Mission.

Outcomes of National Hydrogen Mission:

The Mission will result in the following likely outcomes by 2030:

Development of green hydrogen production capacity of at least 5 MMT (Million Metric Tonne) per annum with an associated renewable energy capacity addition of about 125 GW in the country, Over Rs. Eight lakh crore in total investments, Creation of over Six lakh jobs, Cumulative reduction in fossil fuel imports over Rs. One lakh crore, Abatement of nearly 50 MMT of annual greenhouse gas emissions [4].

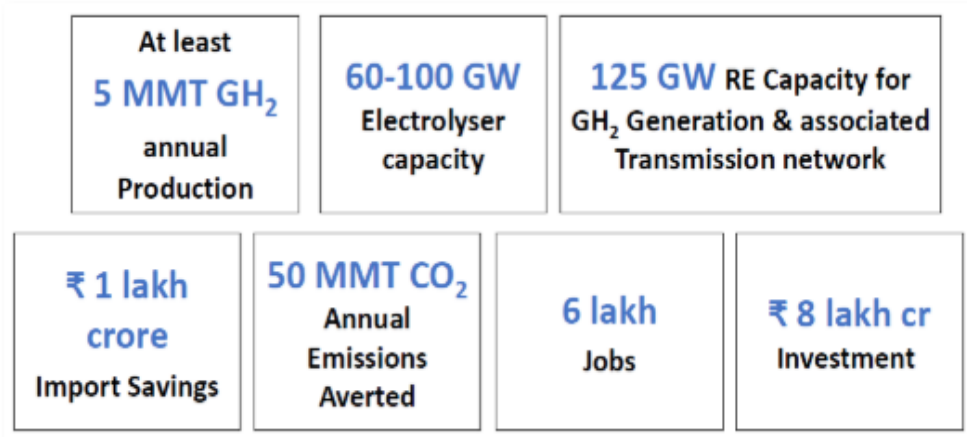

Fig. 1 Mission Outcomes

Benefits of National Hydrogen Mission:

Making India a leading producer and supplier of Green Hydrogen in the world. Creation of export opportunities for Green Hydrogen and its derivatives. National Hydrogen Mission helps to reduction in dependence on imported fossil fuels and feedstock. Development of indigenous manufacturing capabilities possible because the National Hydrogen Mission. Attracting investment and business opportunities for the industry. Creating opportunities for employment and economic development. Supporting R&D projects [5]. The Mission will support pilot projects in other hard-to-abate sectors like steel, long-range heavy-duty mobility, shipping, energy storage etc. for replacing fossil fuels and fossil fuel based feed stocks with Green Hydrogen and its derivatives.

Fig. 2 Green hydrogen can replace the fossile fuel in all the above

Grey, Blue and Green Hydrogen:

Hydrogen is the lightest and most abundant element in the universe. It is rarely found in nature in its elemental form and must always be extracted from other hydrogen-containing compounds. Depending on the nature of the method of its extraction, hydrogen is categorised into three categories, namely, Grey, Blue and Green [5].

1. Grey Hydrogen: It is produced via coal or lignite gasification (black or brown), or via a process called steam methane reformation (SMR) of natural gas or methane (grey). These tend to be mostly carbon-intensive processes.

2. Blue Hydrogen: It is produced via natural gas or coal gasification combined with carbon capture storage (CCS) or carbon capture use (CCU) technologies to reduce carbon emissions.

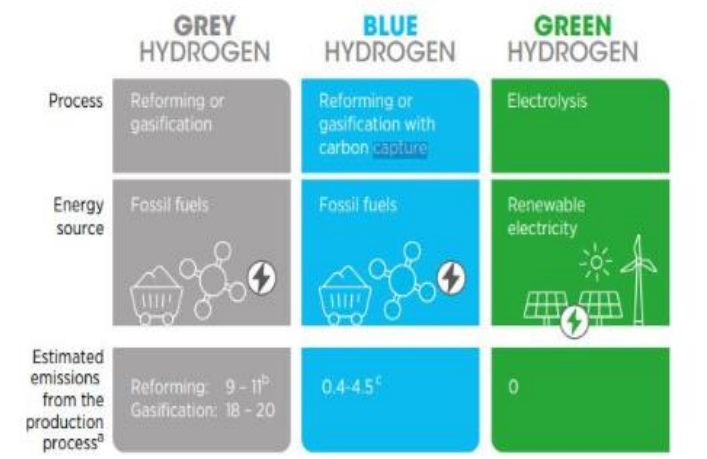

Fig. 3 Types of hydrogen [6]

3. Green Hydrogen: It is produced using electrolysis of water with electricity generated by renewable energy. The carbon intensity ultimately depends on the carbon neutrality of the source of electricity (i.e., the more renewable energy there is in the electricity fuel mix, the "Greener" The Hydrogen Produced).

Green Hydrogen – The Fuel of the Future:

Hydrogen and Ammonia are envisaged to be the future fuels to replace fossil fuels [7]. Production of these fuels by using power from renewable energy, termed as green hydrogen and green ammonia, is one of the major requirements towards environmentally sustainable energy security of the nation. Government of India is taking various measures to facilitate the transition from fossil fuel / fossil fuel-based feed stocks to green hydrogen / green ammonia [9].

Hydrogen- The Indian Context:

Increasing renewable energy use across all economic spheres is central to India's Energy Transition. Green Hydrogen is considered a promising alternative for enabling this transition. Hydrogen can be utilized for long-duration storage of renewable energy, replacement of fossil fuels in industry, clean transportation, and potentially also for decentralized power generation, aviation, and marine transport [8].

Hydrogen for Integrating Renewable Energy

Hydrogen provides a means for storage of variable renewable energy for stabilizing its output. For long duration storage, running into several hours, converting excess available energy into hydrogen and utilizing it for grid support and other applications is seen to be a suitable alternative.

Hydrogen in Industry

In industry, hydrogen can potentially replace the coal and coke in iron and steel production. Steel manufacturing is one of the largest carbon emitters in the world, decarbonising this sector using hydrogen is expected to have significant impact on our climate goals.

Hydrogen Has Potential to Reduce Fossil Fuel Imports

At present, hydrogen produced from natural gas is widely utilized for production of nitrogenous fertilizers, and petrochemicals. Substituting this with green hydrogen could allow use of renewable energy in these important sectors and reduce import dependence. India's annual Ammonia consumption for fertilizer production is about 15 million tonnes, roughly 15 per cent of this demand (over 2 million tonnes per annum) is currently met from imports. Mandating even 1 per cent green ammonia share is likely to save about 0.4 million standard cubic feet per day of natural gas import. Use of hydrogen in steel industry could substitute imported coking coal. During 2018- 19, the total demand of coking coal for the steel industry was 58.37 million tonne (MT). Out of this, 51.83 MT was met through imports [10].

Hydrogen-Based Transport

Fuel cell electric vehicles (FCEVs) run on hydrogen fuel and have no harmful emissions. Battery Electric Vehicles (BEVs) may be suitable for light passenger vehicle segment for shorter driving range. For heavy duty vehicles with longer trip range, such as buses, trucks and other commercial vehicles, FCEVs are likely to become cost competitive in the coming years. While Battery Electric Vehicles (BEVs) are dependent on imported raw materials like lithium and cobalt for lithium-ion batteries, the hydrogen fuel cell supply chain can be wholly indigenized, making India Aatmanirbhar in the clean transportation segment.

India's Progress Towards Green Hydrogen

Prime Minister Narendra Modi aims to transform India into an energy independent nation by 2047 where green hydrogen will play an active role as an alternate fuel to petroleum/ fossil-based products. In 2020, India's hydrogen demand stood at 6 million tonnes (MT) per year. It is estimated that by 2030, the hydrogen costs will be down by 50 per cent. The demand for hydrogen is expected to see a five-fold jump to 28 MT by 2050 where 80 per cent of the demand is expected to be green in nature [10]. Some of the prominent industrial mammoths such as Reliance Industries Limited (RIL), Gas Authority of India Limited (GAIL), National Thermal Power Corporation (NTPC), Indian Oil Corporation (IOC) and Larsen and Toubro (L&T) plan to foray into the green hydrogen space. RIL plans to become a net-carbon zero firm by 2035 and invest nearly INR 750 billion over the next three years in RE. The government-led public sector undertaking (PSU), Indian Oil, is at the forefront of the green hydrogen revolution. It is planning to setup India's first green hydrogen unit for the Mathura refinery, which will be used to process crude oil. National Thermal Power Corporation (NTPC), has recently set up a tender to establish a first-of-its-kind hydrogen refuelling station to be powered entirely by renewables in Leh through a stand-alone 1.25 MW solar system. Two hydrogen refuelling stations have been established (one each at Indian Oil R&D Centre, Faridabad and National Institute of Solar Energy, Gurugram). India has declared its ambition to become an exporter of hydrogen to Japan, South Korea, and Europe [11]. Various hydrogen powered vehicles have been developed and demonstrated under projects supported by Government of India. These include 6 Cell buses by Tata Motors Ltd., 50 hydrogen enriched CNG (H-CNG) buses in Delhi by Indian Oil Corporation Ltd. in collaboration with Govt. of NCT of Delhi, 2 hydrogen fueled Internal Combustion Engine buses (by IIT Delhi in collaboration with Mahindra & Mahindra) [11].

Fig. 4 Progress Towards Green Hydrogen [11]

Conclusion:

India's distinct advantage in terms of low-cost renewable electricity, complemented by rapidly falling electrolyser prices, can enable green hydrogen to be not just economical compared to fossil-fuel based hydrogen but also compared to the green hydrogen being produced around the globe. With proactive collaboration among innovators, entrepreneurs and government, green hydrogen has the potential to drastically reduce CO2 emissions, fight climate change, and put India on a path towards net-zero energy imports. It will also help India export high-value green products making it one of the first major economies to industrialise without the need to 'carbonise'.

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