India Alternative Energy Market Research (mainly focusing on Green Ammonia)

Executive Summary

New Energy and Industrial Technology Development Organization (NEDO)

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Grant Thornton

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SHAPING A VIBRANT INDIA

Executive Summary

India is one of the key market for production and consumption of green hydrogen and ammonia. Australia, Middle East, US, Canada and Europe are the other key markets which focus on green hydrogen and its derivatives.

Green Hydrogen and Ammonia Progress in India India has already announced ~ 21 MMTPA of green ammonia capacity which will drive about 4 MMTPA GH_2 Capacity in next 2-4 years. This is almost closer to the India's target of producing 5 MMTPA GH_2 by 2030.

Cost Economics Green hydrogen production cost in India is expected to be between 3.52 and 3.86 USD/kg in 2024, which is anticipated to reach ~ 2.85 to 2.91 USD/kg by 2030. Renewable energy cost optimization, Off-take arrangements and Technical advancement in electrolyzer to play a significant role in bringing down the cost of Green Hydrogen and Ammonia in India.

Green ammonia production cost in India is expected to be between 0.71 and 0.77 USD/kg in 2024, which is estimated to reach ~ 0.58 to 0.60 USD/kg by 2030.

Globally green ammonia off-take outlook is promising as compared to grey and blue Ammonia. Hence, most of the green ammonia investment announcements in India are planned to cater the export market demand.

Efficient carbon standard for production of green hydrogen and its derivatives in India is likely to make the commodity premium in the global market.

Opportunity for Private Investment Further, the high Return on Equity (ROE) from fertilizer industry and use of expensive Natural Gas (subsidized by GoI) offers an opportunity for non-traditional players (domestic and FDI) including renewable energy companies to enter green ammonia market in India.

The private sector dominates the grey ammonia market in India, and the trend will continue with dominance of private investments in green ammonia as well

Immediate drivers for Green Ammonia in India Government of India push for reducing dependency on imported natural gas and prevailing fertilizer subsidy drives domestic NH_3 manufacturers to shift towards GNH_3 production, thus opening-up market for domestic RE and global players.

However, the green ammonia cost is almost 2x the grey ammonia production cost in India and the price parity is expected to reach around 2030 or early next decade.

India currently have ammonia deficit of 8 to 9 MMTPA, which is expected to be fulfilled by green ammonia investments by 2030 onwards (post achieving price parity).

A 10 MMTPA shortfall in grey ammonia supply is likely to propel the demand for green ammonia in India with right fiscal measures from Government of India (i.e., reducing the natural gas subsidy and allowing retail price of grey ammonia to increase or provide subsidy for green ammonia).

Import Outlook India majorly rely on China and Middle East markets for importing the grey ammonia. However, the domestic production of green hydrogen & ammonia in India will be cost competitive as compared with import of green ammonia from Middle East region.

Hence, opportunity to import green hydrogen and ammonia may not be cost effective route to cater the domestic demand in India.

Midstream Market in India Beyond green hydrogen and its derivatives production, India also offers significant opportunity in developing midstream infrastructure market in the value chain i.e., storage, transportation and distribution.

Given that, grey ammonia is established market in India, supply chain ecosystem is well recognized in India, however, mid-stream eco-system for hydrogen to be developed in the country.

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Fiscal Challenge for Subsidization Given that green ammonia production cost is nearly 2x the conventional ammonia production cost ranging between ~ 780 and 800 USD per MT, it is a fiscal heavy case for Government of India to narrow down the cost gap with subsidy support.

Green Hydrogen and Ammonia based Power The fiscal support for green hydrogen or green ammonia-based power generation is yet to take-off in India, however, governments has taken steps to have landed electricity cost effective from G-NH_3 or H_2 through concessional grid charges under open access regulations.

Need for High Carbon Price Regime In order for green ammonia/hydrogen-based power to become price parity with conventional power from thermal power plant or gas-based power plant, a high carbon price in the range of 0.4 to 0.7 USD per kg CO_2 is needed to compensate the high cost of power generated using GH_2 and GNH_3.

On policy front, Government of India has launched the National Green Hydrogen Mission (NGHM) with aims to position India as a global leader in the production, utilization, and export of Green Hydrogen and its derivatives.

India's Green Hydrogen Mission

Initial expenditures for the mission are set at INR 19,744 crore, with allocations primarily directed towards the Scheme Guidelines for Implementation of Strategic Interventions for Green Hydrogen Transition (SIGHT) program, pilot initiatives, research and development, and other essential mission elements.

In tandem with the NGHM, the Ministry of New and Renewable Energy has introduced various scheme guidelines such as facilitating the establishment of Green Hydrogen Hubs and implementing pilot projects in critical sectors such as Iron & Steel and shipping

To further incentivize and expedite Green Hydrogen production, the GoI has implemented policy measures such as 100% waiver on Inter-State Transmission System charges for projects commissioned up to December 31, 2030, and inclusion of Green Hydrogen and Green Ammonia towards Renewable Purchase Obligation compliance.

State Driven Measures In alignment with the NGHM, several states including Maharashtra, Uttar Pradesh, Rajasthan, and Andhra Pradesh have introduced their own Green Hydrogen Policies offering various incentives for green hydrogen production such as Capex and Production Linked Incentives, incentives on Captive Open Access Charges, as well as subsidies and incentives related to land and water utilization.

The Ministry of Power has taken decisive steps to bolster India's renewable energy sector by issuing the Electricity (Promoting Renewable Energy through Green Energy Open Access) Rules, 2022. These regulations aim to expedite the integration of RE projects into the country's energy mix. Under these rules, consumers with a connected load exceeding 100 kW are empowered to leverage open access for renewable energy.

Furthermore, consumers have the flexibility to utilize banking services, enabling the storage of surplus RE in the grid for future use, albeit with associated banking charges. These charges, subject to annual revisions and variations across states, are indicative of evolving regulatory frameworks aimed at fostering a symbiotic relationship between DISCOMs and consumers.

For instance, Gujarat's recent adjustments to green energy open access regulations highlight a transition from monthly to 15-minute accounting for settlement, indicative of regulatory refinement as the market matures.

However, disparities exist among states regarding grid banking. States like Karnataka, Maharashtra, Gujarat, and Madhya Pradesh embrace grid banking with varying charge structures ranging from 2% to 10%.

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Ministry of Power (MoP) regulations drives RE integration, offering consumers diverse access options while addressing evolving market dynamics. Harmonizing state approaches to grid banking could optimize nationwide RE benefits.

At COP26 in Glasgow, India pledged to elevate its non-fossil energy capacity to 500 GW by 2030. Achieving this target necessitates an additional 320 GW within the decade, equating to an annual increase of over 50 GW. To facilitate this, plans are underway to construct a transmission system capable of evacuating 537 GW of renewable energy also termed as Green Energy Corridor.

GH_2 Demand from Fertilizer Sector On end user side, particularly in fertilizer industry, 65 MMT is consumed in 2022-23, out of which ~35% is through imports.

Ammonia consumption in India is about 26 MMT in 2022-23 of which 17 MMT is domestically produced. Hydrogen demand from 17 MMT of ammonia is ~3 MMT & all of it is grey hydrogen.

About 9 MT of NH_3 is used for non-urea fertilizers where CO_2 is not required. Estimated GH_2 demand from conventional fertilizer units is 0.5 MMT in 2030 and 1.4 MMT in 2035.

About $350 Million of subsidy is avoidable when entire 13.65 MMT (DAP + complex fertilizer) is substituted with GNH_3.

GH_2 Demand from Refinery Sector From petrochemical refinery end, the production capacity of 250 MMT in 2021 is expected to rise by ~450 MMT by 2035.

Among above, 60% of production is operated by PSU, and balance by the private sector & JVs.

India overall hydrogen demand from all sector is ~7 MMTPA in 2021 of which ~3 MMTPA was the demand from refinery and most of it was grey hydrogen.

Estimated GH_2 demand from refinery is 0.1 MMT in 2025 and 0.8 MMT in 2030 and 2.2 MMT in 2035.

The decrease in demand for petroleum & resultant H_2 is majorly expected due to decarbonization of transportation after 2035.

GH_2 Demand from Iron and Steel Sector The sector produced ~126 MT of crude steel in 2022, making it the 2nd largest in the world & is most competitive at ~ USD 650/tcs.

About 90% of the capacity is coal based and remaining is gas-based technology.

Target Crude steel production capacity in India is expected to be 255 MMT by 2030 and 280 MMT by 2035.

Coal-fired technologies will drop to 70% by 2030, and pilot green steel projects are expected to go online by 2027-2028.

H_2 based steel is expected to reach parity with conventional steel by 2030 resulting in uptake of hydrogen demand.

Estimated GH_2 demand is 0.1 MMT in 2030 and 0.5 MMT in 2035

GH_2 Demand from Long Haul Mobility Zero emission trucking (ZET) with a combination of battery and fuel cell shall be competitive on TCO per km by 2035.

Estimated GH_2 demand from mobility market is 0.1 MMT in 2030 and 0.5 MMT in 2035

GH_2 Demand from Mining Iron Ore mining is the larges mining activity in India. Scope 3 emissions account up 95% in mining and requires collaboration with suppliers & customers.

Coal India, Hindustan Zinc, Adani and few other mining players are transitioning to battery electric vehicles / fuel cell electric vehicles for mining operations

Micro grid, EVs and Fuel Cell are the key focus areas for addressing emissions in operations/

Min. $2 Billion is the market size for fleet electrification in mining sector – Battery electricity vehicle & H_2 Fuel Cell

GH_2 Demand from Remote Island Diesel Generators is the primary source of energy with 73% share. Incentive for e-Carriers, e-cars, hybrid/fuel cell and e-buses are provided by local policies, but at insignificant level which may improve post 2024 with GoI's thrust on GH_2 and GNH_3.

GH_2 and GNH_3 based power in demand segment

At present outlook, the cost of power generation from fuel cell using green hydrogen is still costlier (15x the renewable power), and it requires high carbon price regime in the range of 18 USD per kg CO_2 (under CBAM or Indian Carbon Market) to compensate the increased power generation cost

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