Green Hydrogen: Gaining Traction for Energy Transition in India

CareEdge RATINGS

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Synopsis

- The momentum of Green Hydrogen (GH_2) in India will be driven by lower renewable energy costs and India's decarbonisation goals.
- The prevailing levelised cost of Green Hydrogen (LCOH) stands at ~1.75x times and ~1.50x times higher than that of grey and brown hydrogen respectively, posing a significant barrier to its adoption.
- Economic viability of Green Hydrogen requires a 35%-40% drop in electrolyser prices and a 12%-14% improvement in efficiency apart from supportive policies.
- Refineries and ammonia production are expected to be early adopters of Green Hydrogen, with potential for exporting green ammonia.
- However, effective storage and transportation solutions for green hydrogen and its derivatives will be essential for its wide-scale adoption.

Cost dynamics of Green Hydrogen vis-a-vis alternatives

In contrast to other hydrogen alternatives i.e., grey hydrogen (produced from natural gas) and brown hydrogen (produced from coal), green hydrogen is generated through the electrolysis of water, where renewable energy is used to split water into hydrogen and oxygen, thereby eliminating CO_2 emissions.

Green hydrogen has the potential to play a crucial role in achieving India's decarbonisation target as well as reducing India's dependence on fossil fuels. Nevertheless, the estimated levelised cost of GH_2—which includes both capital expenditure (capex) and operational expenditure (opex) per unit of production is currently ~1.75 times that of Grey Hydrogen and ~1.50 times that of Brown Hydrogen. This disparity persists despite the waiver of interstate transmission charges (ISTS) for renewable power, and it remains a key barrier to the viability and widespread adoption of GH_2.

Besides, as per CareEdge Ratings, a significant capex outlay of Rs.2.40 lakh crore is required to produce one million metric tonnes (MMT) of GH_2. Capex for renewable energy generation and capex for electrolyser are the two major cost components with an estimated contribution of 48% and 34% respectively in the overall cost of the project.

Economic viability of Green Hydrogen

LCOH is particularly sensitive to electrolyser cost & efficiency and renewable energy tariff. CareEdge Ratings has outlined various scenarios for LCOH based on the capital expenditure (capex) of electrolysers, their efficiency, and

LCOH (USD/Kg)

	USD 900/Kw	USD 750/KW
Rs.2.19/Kwh	3.12	2.85
Rs.2.43/Kwh	3.28	3.02
Rs.2.67/Kwh	3.45	3.18

Electrolyzers energy consumption – 56 Kwh/Kg

	USD 900/Kw	USD 750/KW
Rs.2.19/Kwh	2.84	2.60
Rs.2.43/Kwh	2.99	2.75
Rs.2.67/Kwh	3.14	2.90

Electrolyzers energy consumption – 51 Kwh/Kg

Figure 1: LCOH scenarios; Source: CareEdge Ratings

the cost of renewable energy. As seen below, the horizontal axis of the table represents the capital cost for electrolysers, while the vertical axis indicates renewable energy tariffs.

It is inferred from the table that LCOH is influenced not only by reductions in electrolyser capex and renewable energy tariffs but is also sensitive to enhancements in electrolyser efficiency. Considering the waiver of interstate transmission charges, LCOH was estimated at USD 3.74 per kg as of CY23. In the years ahead, CareEgde Ratings opines that reduction in electrolyser cost and efficiency improvement are prerequisites to achieve a targeted levelised cost of USD 2.1 /kg. Additionally, PLI incentives announced by the Government of India (GoI) such as a direct production incentive of up to $0.50/kg of GH_2 production for the first 2 years and an incentive on electrolyser capex of $54/Kw are a welcome move to help achieve targeted LCOH.

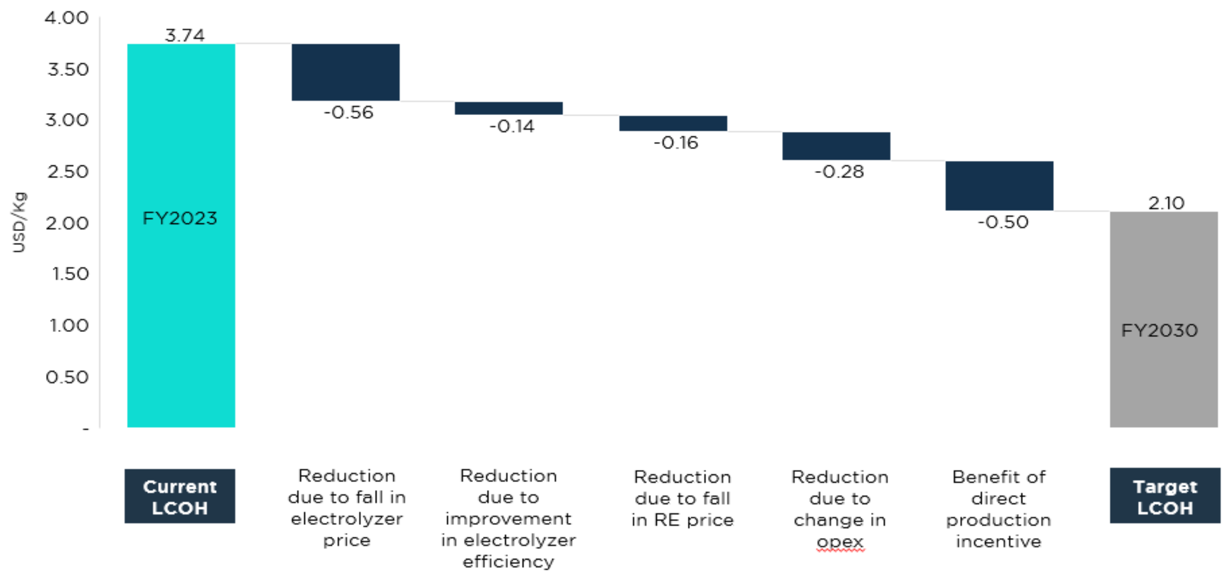

Figure 2: From current LCOH to target LCOH; Source: CareEdge Ratings

CareEdge Ratings believes a significant reduction in the capex cost of renewable energy is unlikely, however, there is adequate headroom for the reduction in the electrolyser cost. Economies of scale, advancement in manufacturing automation, the use of less expensive materials in the stack, and the scaling up of stack sizes shall be the key drivers for the reduction in the cost of electrolysers going forward.

Key demand drivers for Green Hydrogen

The demand drivers for GH_2 can be categorised as

- Near term – Greening the existing grey hydrogen users
- Medium term – Wider adoption for industrial use such as green steel, blending in city gas distribution along with natural gas
- Long term- Application in transportation, shipping, auxiliary power generation etc

CareEdge Ratings has assessed demand potential from two aspects: existing market share in hydrogen demand which is on the horizontal axis and the cost of hydrogen in overall production cost plotted on the vertical axis.

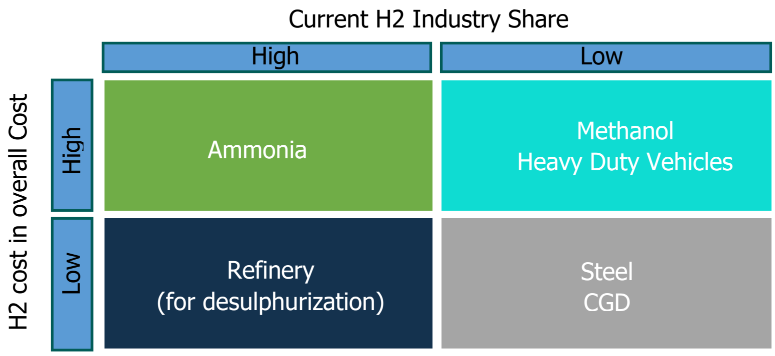

Figure 3: Readiness to absorb GH_2 demand; Source: CareEdge Ratings

Currently, refineries have a high market share of 43% in the overall hydrogen demand of six million metric tonnes in India and the cost of hydrogen in the overall production cost of refineries is low, making it one of the immediate potential users for green hydrogen. It can lead to a potential demand of 2.70-3.00 MMT of GH_2 over FY27-FY30 in refineries. This can further rise basis of the demand for higher desulphurisation in the feedstock.

The fertiliser sector has the highest market share in hydrogen demand accounting for ~50% of the total hydrogen demand in India.

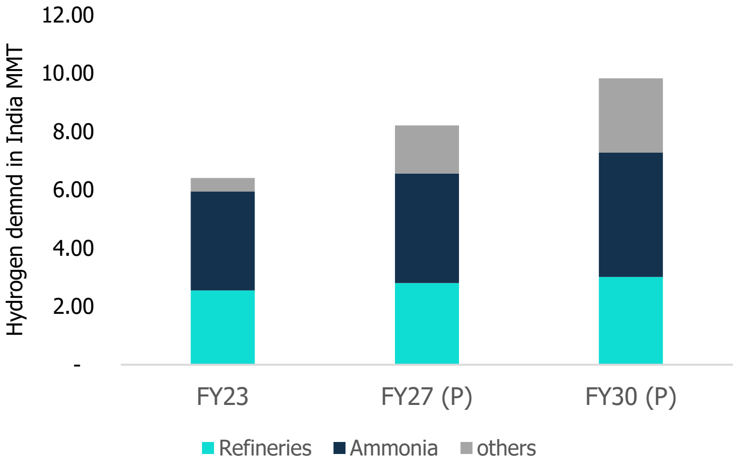

Figure 4: Hydrogen Demand in India over FY27-FY30; Source: CareEdge Ratings

However, the fertilisers are sensitive to the cost of hydrogen as in overall production cost its contribution is high. Hence cost parity of green hydrogen with existing alternatives besides incentivising the demand would be a prerequisite for strengthening the adoption of green hydrogen in Ammonia production and other non-urea-based fertilizers. Adoption of green ammonia can lead to potential demand of 3.75-4.25 MMT of GH_2 over FY27-FY30 with about $1/3^{rd}$ demand coming from non-urea segment which may be an ideal segment for early adoption.

Adoption of green hydrogen for methanol is less economically viable due to the lower cost of imported methanol. Yet, the adoption of green hydrogen in heavy-duty vehicles can be explored in the long term in case of a reduction in the total cost of ownership vis-à-vis electric, diesel and CNG vehicles.

For the steel sector, the proportion of hydrogen cost to total cost of production is much lower. Hence, green hydrogen can partially replace coking coal in blast furnaces and replace natural gas in electric arc furnaces leading to its wider adoption in the steel industry subject to capex for technology upgradation. Green Hydrogen can also be blended with natural gas in city gas distribution. Needless to emphasise, overall green hydrogen demand shall be driven by an increased focus on reducing carbon emissions, requiring continued policy support and industrial acceptance.

Storage and transportation challenges

The low volumetric energy density of GH_2 increases its storage and transportation costs. This is also one of the constraints for its adoption. The development of a manufacturing cluster of GH_2 nearer to the consumption centre may help in addressing this risk. Moreover, the lower cost for transportation of green ammonia and competitive renewable energy cost in India augur well for the port-based facilities for exports of green ammonia.

CareEdge Ratings View

"Cost parity of green hydrogen (GH_2) with alternatives is essential for its wide-scale adoption. A higher capex outlay of around Rs.2.4 lakh crore for one million metric tonnes of GH_2 plant is also one major constraint. Given the limited headroom for reduction in renewable energy capex cost, lowering of electrolyser costs by 35-40%, improvement in efficiency by 12-14% and continued policy support are critical for achieving cost viability of GH_2 to around USD 2.1 per kg. Technological advancement in the electrolyser manufacturing ecosystem, cost reduction in stack material and economies of scale shall be key drivers for cost reduction of electrolysers in future," says Maulesh Desai, Director, CareEdge Ratings.

"From the demand perspective, the absence of long-term offtake arrangement of GH_2 would be the key issue for developers and lenders. Hence, incentivising downstream users of GH_2 over the use of other alternatives would be critical for gradual migration towards GH_2. Refineries can be one of the early users of GH_2 and can lead to a potential demand of 2.70-3.00 million metric tonne (MMT) of GH_2 over FY27-FY30. Ammonia can also be a probable early adopter for GH_2 subject to the price parity of green ammonia with ammonia produced from natural gas. Adoption of green ammonia can lead to a potential demand of 3.75-4.25 MMT of GH_2 over FY27-FY30 of which 1/3rd demand may be from non-urea sector. Besides, green ammonia also holds significant export potential due to competitive renewable energy cost in India if the issue w.r.to its storage and transportation is adequately managed, "says Hardik Shah, Director, CareEdge Ratings.

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