Indigenous Electrolyzer Manufacturing - The Pre-eminent Factor in India's Green Hydrogen Mission

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Abstract

The National Green Hydrogen Mission targets five MTPA green hydrogen production by 2030. The strategic interventions for Green Hydrogen Transition (SIGHT) program incentivizes indigenous electrolyzer manufacturing, with major players entering the sector, aiming for global competitiveness. The article outlines key success factors and strategies for Indian manufacturers to become global leaders in electrolyzer production.

Green Hydrogen Mission

India's National Green Hydrogen Mission aims to produce 5 million metric tons (MTPA) of green hydrogen annually by 2030. The Mission aims to make India the Global Hub for production, usage and export of Green Hydrogen and its derivatives. This will make the country Aatmanirbhar in clean energy and also help reduce India's dependence on fossil fuel imports. However, to become a global dominant player, India also needs to be cost competitive in manufacturing the Green Hydrogen. The government realizes this and is hence supporting the Green Hydrogen Mission with the Strategic Interventions for Green Hydrogen Transition (SIGHT) programme.

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The SIGHT programme lays provision for two distinct financial incentive mechanisms with a total outlay of INR 17,490 crore up to FY30. While the first incentive of INR 13,050 crore is for Green Hydrogen production, the second incentive of INR 4,440 crore is for manufacturing of Electrolyzers. India would need 60-70 GW of electrolysis capacity to meet its Green Hydrogen targets. Given that, electrolyzers contribute to ~30-40% of levelized cost of Hydrogen (LCOH) in the Green Hydrogen value chain, indigenously manufactured Electrolyzers are poised to play a critical role in this mission.

Electrolyzer Manufacturing in India

Electrolyzers are equipment used for the separation of Hydrogen and Oxygen from water molecules, using electricity obtained through renewable energy sources such as solar, wind or nuclear.

Ohmium, a US headquartered renewable energy company setup a 500 MW electrolyzer plant in Bangalore and shipped its first unit of electrolyzer from India to the United States in 2021. This remains to be the only large electrolyzer manufacturing plant in India as of now.

However, SIGHT scheme has given an impetus for indigenous electrolyzer manufacturing. The scheme aims to achieve a lower LCOH thereby ensuring global competitiveness and enhancing domestic value chain in the sector. Manufacturing of efficient and high-quality Electrolyzers is being incentivized under this scheme. The cost of an electrolyzer is divided between stack (30-40%) and Balance of Plant, BoP (60-70%). A certain minimum Local Value Addition (LVA) ranging from 30% in 1st year to 80% in 8th year depending

upon Technology type will have to be demonstrated to be eligible for the incentives.

Solar Energy Corporation of India (SECI) is the implementing agency for this scheme. Around mid of 2023, it issued the first tender for development of 1.5 GW Electrolyzers manufacturing capacity. The tender got over-subscribed with 21 companies bidding for developing a total of 3.4 GW annual Electrolyzer manufacturing capacity. Reliance Electrolyser Manufacturing, Adani New Industries, L&T Electrolysers and Bharat Heavy Electricals are among the larger companies who have bid for the tender. The other 17 companies that have bid for incentives under the scheme include Hild Electric Private, Ohmium Operations, John Cockerill Greenko Hydrogen Solutions, Waaree Energies, Jindal India, Avaada Electrolyser, Green H2 Network India, Advait Infratech, ACME Cleantech Solutions, Oriana Power, Matrix Gas and Renewables, HHP Seven, HomiHydrogen, Newtrace, C. Doctor & Company, Pratishna Engineers and LiveHy Energy.

Many of these companies are already at various stages of setting up electrolyzer manufacturing plants in India:

- Larsen & Toubro (L&T) has entered into an Electrolyzer Manufacturing Binding Agreement with McPhy Energy, a France-based leading electrolyzer technology and manufacturing company. L&T has also initiated building an Electrolyzer factory in Hazira, Gujarat. It plans to hive off this electrolyzer manufacturing business into a separate entity and offload a stake to Indian Oil Corporation Limited (IOCL).
- Adani New Industries has signed a development and licensing agreement with Melbourne based Hydrogen Cavendish Renewable Technology for commercialization of Electrolyzers in India. Adani is currently setting up a 5 GW electrolyzer manufacturing plant in India.
- Ohmium is planning to increase its Bangalore manufacturing capacity from 500 MW to 2 GW
- Greenko Group and Belgium's John Cockerill are jointly developing a 2 GW per year electrolyser manufacturing plant in Kakinada, Andhra Pradesh, India.
- Pune based H2E Power has set up a small 50 MW plant in 2023 and is expected to ramp up capacity to 200 MW in 2024.
- Reliance and Denmark-based Stiesdal have formed a partnership to develop and manufacture hydrogen Electrolyzers in Jamnagar, Gujarat.

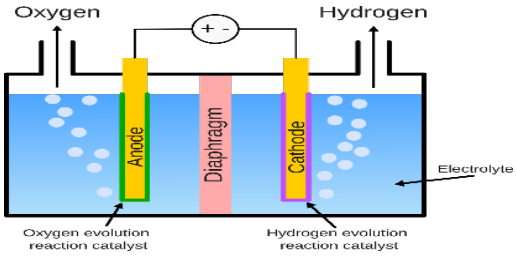

Fig 1. Alkaline Water Electrolysis

Electrolyzer Technologies Available

While there are multiple technologies available for electrolyzers, Alkaline Water Electrolyzer (AWE) and Proton Exchange Membrane (PEM) Electrolyzers are the most mature and available at commercial scale.

An AWE contains water and a liquid electrolyte solution such as Potassium Hydroxide (KOH). When current is applied to the alkaline cell stack, the Hydroxide ions (OH-) move through the electrolyte solution form cathode to anode of the cell. Hydrogen gas bubbles are generated at the cathode while Oxygen get generated at the anode.

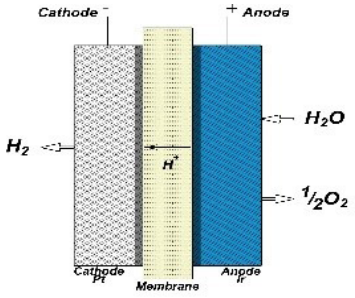

Fig 2. Proton Exchange Electrolysis

China currently dominates alkaline electrolyzer manufacturing in terms of scale and cost competitiveness. This has been achieved due to localization of their supply chain and end to end integrated manufacturing which includes the electrode manufacturing and assembly. These plants come in modular sizes and are available at MW-level scale.

PEM Electrolyzers contain a proton exchange membrane that uses a solid polymer electrolyte. When an electrical current is applied to its cell stack, water splits into Hydrogen and Oxygen. The Hydrogen protons pass through the membrane to form Hydrogen molecule on the cathode side.

US and Europe are the key players in PEM Electrolyzers. These Electrolyzers use precious metals (Iridium and Platinum) within the PEM stack and

hence are more expense than AWEs. However, the gap in pricing is reducing and PEM Electrolyzers offer a few advantages in certain end applications:

- PEM Electrolyzers are more efficient and have longer lifespan as electrolyte solution in AWEs are more corrosive and the electrodes have a shorter lifespan.
- PEM electrolyzers have fast response times, making them well-suited for applications that require rapid changes in Hydrogen production. PEM electrolysers take less than five minutes to start while AWEs can take up to 50 minutes. This would largely affect Hydrogen generation in AWEs in case of intermittent green power supply at an offsite location.
- Solid Oxide Electrolyzer Cells (SOECs) is another type of Electrolyzer which is slowly gaining traction in which Solid ceramic materials are used as electrolytes. These have potential for high efficiencies but also have high capital costs and face challenges related to material durability and thermal cycling.
- Similarly, Anion Exchange Membrane (AEM) Electrolyzers is a new and relatively niche Electrolyzer Technology. Research related to durability, performance, and cost are underway on this relatively new technology.

Key Success Factors for Indian Players

Governments across the globe are laying policies for driving production capacities of Green Hydrogen. The European Union set a target of producing 10 MMTPA of Green Hydrogen domestically and importing another 10 MMTPA by 2030. Such government policies are only going to increase the demand for Electrolyzers. All global Electrolyzer manufacturers including ITM Power UK (PEM - 1 GW), Thyssenkrupp Germany (AWE - 1 GW), Nel Norway (PEM & AWE - 500 MW) have hence announced large capacity expansions to meet this need. Based on announced projects, the global capacity is projected to grow from the current ~6 GW to 60 GW in the next 10 years.

India with its objective to emerge as a cost-effective global Electrolyzer supplier must grab this opportunity. The Indian manufactures should take advantage of the China+1 sentiment and consider the following to become a global leader in this sector:

Choice of Technology: The electrolyzer market is currently primarily split between the two older technologies: AWEs and PEMs with AWEs having the dominant share. Today, AWE technology is cheaper, with an average cost of USD 700-1,100 per kW and has an efficiency of ~70% (producing 0.021 kg H2 per kWh). PEM technology costs between ~USD 1,200-2,000 per kW, having an efficiency of ~60% (producing 0.018kg H2 per kWh). However, as technology for PEM advances, it is expected to achieve parity with AWE (~USD 500 per kW) by FY2030. Similarly, SOECs and AEMs are other fast evolving technologies who could become relevant in the coming years. Hence, it will be crucial for the Indian players to invest in relevant Technology basis their target market.

Technology Partners: Indian players would need to foster the right partnerships with global Technology players to accelerate their learning curve. As technological advancements develop quickly with time, it would be pertinent of Indian players to have the right partnerships for them to be manufacturing cost-efficient high-quality electrolyzers.

Secure Raw Material Supply: Supply chain constraints can have a significant impact on the availability and cost of raw materials used in electrolyzer catalysts and membranes. For instance, Platinum and Iridium are two critical raw material for PEM Electrolyzers and their supply is highly concentrated with South Africa which supplies over 70% of platinum and over 85% of iridium required globally.

As earlier mentioned, the cost of an electrolyzer is divided between stack (30-40%) and Balance of Plant, BoP (60-70%). India already has an established ecosystem in BOP components such as power electronics, analysers and fabricated processing equipment. Even for the electrolyzer stack, India has capabilities to build the commonly used components like end plates, bipolar gates, gaskets, sealing's etc. Hence with the right sourcing strategy, India can quickly indigenize a large part of electrolyzer manufacturing.

Conclusion

The government of India is incentivizing manufacturing of Green Hydrogen which can help India insulate itself from global disruptions in the Oil & Gas supply chain and also safe on fuel imports. Indigenous electrolyzers is critical to this mission without which India cannot provide a cost-effective solution. Hence, India needs to become a global competitive player in electrolyzer manufacturing. Through the right choice of Technology, Partnerships and establishing a robust supply chain, India can become a beneficiary of the China+1 Strategy.