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EDITORIAL

The three-day International Conference on Green Hydrogen (ICGH-2024), held from September 11-13, 2024, highlighted the strides the sector is making towards our country's ambitious targets. Inaugurated by Shri Pralhad Joshi, Union Minister of New & Renewable Energy; Consumer Affairs, Food & Public Distribution, the event attracted over 8,500 delegates, including 3,000 plus youth and students. It also featured an exhibition showcasing innovations and technological advancements in the Green Hydrogen sector, with a hydrogen-powered bus and hydrogen internal combustion engine (H2ICE)-powered truck receiving much attention.

Addressing the valedictory session, Minister of State, Ministry of New and Renewable Energy (MNRE), Shri Shripad Y. Naik underlined that India has ushered into a new era of energy transition driven by a shared commitment to advancing the Hydrogen Agenda. Prof. Ajay K. Sood, Principal Scientific Adviser to the Government of India, said, "Our commitment to Green Hydrogen is not just about meeting emission targets, which of course is important. It is about seizing a historic opportunity to redefine our energy systems, create new jobs, and secure a cleaner, healthier planet for future generations", he said.

During his address, Secretary, MNRE, Shri Bhupinder S. Bhalla reiterated, "Green Hydrogen is not just a new energy source, it is a pathway towards a future where clean energy is the norm, and industries are decarbonized. Over the past three days, we've seen how collaboration among policymakers, scientists, and industry leaders can drive innovation and push the Green Hydrogen agenda forward. The discussions and breakthroughs will play a critical role in making India a global hub for Green Hydrogen production, usage, and export. The journey ahead will be challenging, but our collective ambition is strong, and the opportunities are vast."

Shri Pankaj Jain, Secretary of the Ministry of Petroleum and Natural Gas (MoPNG), Government of India stressed on the importance of international cooperation and innovative technologies in advancing the Green Hydrogen economy.

Along with other senior government officials, Mr. Ajay Yadav, Joint Secretary, MNRE highlighted that as many as 13 states have policy provisions for supporting the Green Hydrogen ecosystem. He pointed out the Mission would lead to the creation of 600,000 lakh green jobs, and also stressed on the importance of skilling, safety, pilot projects, research & development, and innovation.

The plenary sessions held during the conference highlighted the initiatives and advancements from the US, European Union, Australia, the Netherlands, and Germany, along with the global perspective as presented by International Renewable Energy Agency (IRENA). These sessions underscored the importance of international collaboration and knowledge exchange in accelerating the Green Hydrogen economy.

The 22 breakout sessions delved into the

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Green Hydrogen: Leading the Charge on Future Renewable Fuels

Hydrogen has emerged as a potential key player in the energy transition, garnering increased attention in recent months. While the primary goal is to rapidly reduce greenhouse gas emissions, it is now clear that the transition away from fossil fuels is more complex than envisaged.

However, renewable energy growth over the past couple of decades, particularly in India, has enabled more aggressive actions towards sustainability. India ranks 4th and 5th globally in wind and solar capacity, respectively, with new policies supporting further expansion. The economic viability of these sources has significantly reduced electricity production costs, and this affordability opens up opportunities to leverage renewable energy in innovative ways, including the production of hydrogen through electrolysis. Hydrogen's potential applications are vast, particularly in hard-to-abate and hard-to-electrify sectors, offering promising solutions for decarbonization efforts.

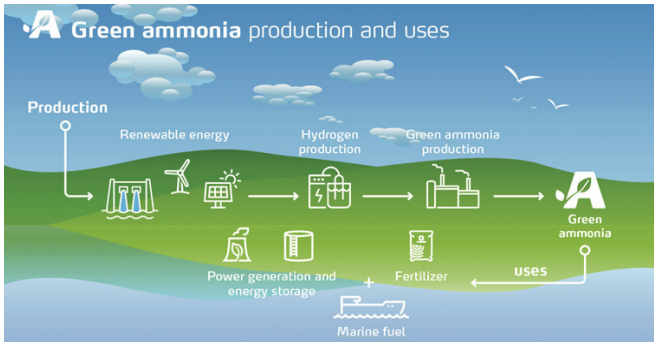
The Global 'Mission Innovation'

Countries worldwide are developing 'hydrogen ladders' to identify optimal applications and assess hydrogen's viability across sectors. Mission Innovation[1], a global initiative comprising 23 countries, aims to make clean energy accessible and advance the Paris Agreement's goals. Its Clean Hydrogen Mission targets reducing hydrogen costs to USD2/kg by 2030 through advancements in production, handling, transportation, and storage. India's National Hydrogen Mission aspires to make the country a global hub for green hydrogen production, usage, and export. As India pursues its goal through this mission, addressing storage and transportation challenges without compromising economic feasibility is crucial. Research at the Energy Consortium by IIT Madras (IITM) is exploring these aspects to support the mission's broader objectives.

Win-win Benefits

Hydrogen boasts the highest calorific value among fuels, but suffers from poor volumetric energy density due to its gaseous nature. Liquefaction, requiring high pressures (>13.1 atm) and low temperatures (<33 K), is necessary to improve this density. However, storage and transportation under these conditions are challenging and expensive.

Hydrogen carriers offer an alternative. Promising options include methane (25 wt% H2), ammonia (17.6 wt% H2), and metal hydrides (<12.5 wt% H2). Green ammonia, produced through electrochemical nitrogen reduction, is particularly promising due to its high hydrogen content, ease of liquefaction (240 K at atmospheric pressure), and existing global infrastructure.



Source: https://www.weforum.org/agenda/2021/01/green-ammonia-stop-fossil-fuels/

Our research faculty at IIT Madras (IITM) are contributing to the national green hydrogen mission in multiple ways. We have ambitions to set up a Hydrogen Resource Hub at our Discovery campus. These efforts are already underway and will see us establishing the capability to evaluate a typical hydrogen application by mimicking the entire value chain on a pilot scale. We are planning to study green hydrogen production with transportation as one sector in mind, and are collaborating with Hyundai for this initiative. There are other numerous active research activities exploring the use of sea water electrolysis, solid oxide electrolyzer cells as well as hydrogen as a fuel, at IITM.

Susstains Engineering, an IITM-incubated startup, recently won ArcelorMittal's XCarb®[2] challenge for their unique approach that proposes biochar as an alternate to coal used in blast furnaces for steel making. XCarb® is designed to bring together all of ArcelorMittal's reduced, low and zero-carbon products and steelmaking activities, as well as wider initiatives and green innovation projects, into a single effort focused on achieving demonstrable progress towards carbon neutral steel. Alongside the new XCarb® brand, ArcelorMittal has launched three XCarb® initiatives: the XCarb® innovation fund, XCarb® green steel certificates, and XCarb® recycled and renewably produced, for products made via the Electric Arc Furnace route using scrap.

[1] https://mission-innovation.net/

[2] https://corporate.arcelormittal.com/climate-action/xcarb

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Clean Hydrogen Alternative for Phasing Out Diesel Generators

Today, India faces the challenge of balancing its growing energy demand with the transition towards sustainability, especially with reference to its commitments towards decarbonization and increasing the use of renewable sources.

India's evolving energy landscape: Push towards Net Zero

India's energy landscape is complex and constantly evolving, marked by a strong push towards sustainability while managing the needs of a growing economy. India also faces challenges related to energy security, given its dependence on imported fossil fuels. The country is working to diversify its energy supply and increase domestic production, but despite progress, access to energy remains a challenge. Addressing India's energy needs involves ensuring a reliable, affordable, and sustainable energy supply while balancing environmental concerns with economic growth.

Hydrogen is the answer to India's growing hunger for clean energy

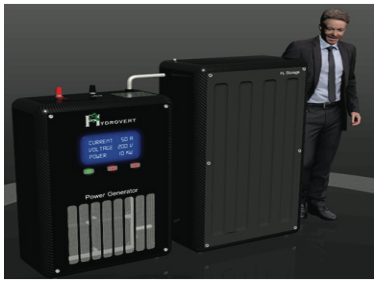
We believe that hydrogen is one of the most promising technologies that will help the country chart a path towards decarbonization, besides potentially generating economic opportunities. According to NITI Aayog, the hydrogen industry in India could generate over US$150 billion in revenue and create approximately 1.5 million jobs by 2050. The report also suggests that hydrogen could meet a significant portion of India's total energy needs by 2050, reducing the country's dependence on imported fossil fuels.

However, one of the challenges with renewable energy sources such as solar and wind, is their intermittent nature. During periods of excess renewable energy generation, clean hydrogen can be produced and stored for later use. This stored clean hydrogen can then be converted back to electricity using hydrogen fuel cell electricity generators, providing a reliable backup power source and enhancing grid stability. The Ministry of New and Renewable Energy (MNRE) in India also highlights the importance of hydrogen storage to help manage the variability of renewable energy.

According to India's National Clear Air Programme, 18% of city pollution is contributed by diesel generators (DGs). In fact, the Commission for Air Quality Management has banned the use of DGs for the industrial and commercial sectors in the National Capital Region.

Hydrovert's hydrogen fuel cell electricity generators

Hydrovert is addressing the need for hydrogen-based stationary power generators. Its generators are being developed to ensure reliable energy supply, especially in regions with limited electrical infrastructure or where grid supply is unreliable.



Stationary fuel cell generators ensure:

1. **Zero carbon emissions:** Water vapor is the only by-product, assuming the hydrogen production method is clean (electrolysis, bio-hydrogen, etc.).
2. **Zero-noise:** No noise is generated, enabling indoor installations.
3. **Ease of use:** It is a plug-and-play solution, enabling easy integration into existing infrastructure.
4. **Low maintenance cost:** Since the generator does not have complex moving parts, maintenance costs are low.
5. **Scalability:** The system can be sized based on the energy and power requirement of the application. The power is determined by the size of the fuel cell, which can range from few kilowatts (kW) to few megawatts (MW). The energy stored is determined by the size of the cylinder. Both can be scaled independently. Therefore the increase in size only increases the cost marginally, unlike a battery energy storage system which has limited scalability.

Economic viability: Comparison with diesel and natural gas generators

For any type of power generation systems [diesel, natural gas (NG) or hydrogen fuel cell], operational costs or fuel expenses are the biggest contributor by far over the lifetime of the system. The cost of fuel and efficiency of the system affect the operational cost predominantly.

	Diesel	Natural gas	Hydrogen fuel cell
Fuel cost	INR92/liter	INR79/kg	INR300/kg
Fuel efficiency	20%	25%	50%
Fuel consumption per kWh produced	0.4 liter/ kWh	0.26 kg/ kWh	0.0625 kg/ kWh
Operating cost (INR/ kWh) of electricity produced	36.8	20.5	18.8

Table 1: Comparison of cost of electricity with alternatives

Though the capex of hydrogen systems is relatively higher compared to natural gas gensets and DGs, increased demand and the emergence of disruptive technologies, both in components and manufacturing processes, are

expected to lead to the reduction in the cost of fuel cell generators. Currently, for applications that require the use of a generator for over 8 hours, hydrogen generators are far more cost effective compared to other alternatives.

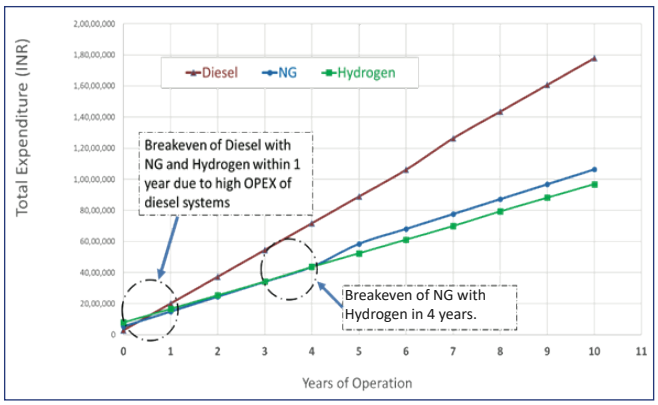


Figure 1: TCO comparison of Hydrogen FC generators with alternatives (Diesel and CNG) (200 kVA system)

Industries and commercial establishments in many of India's states today are facing the reality that their power needs cannot be reliably fulfilled by the electricity grid. It is clear that DGs must be phased out due to their high localized emissions and noise pollution. This offers significant opportunity for hydrogen fuel cell-based generators to replace diesel and natural gas gensets in India.

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Contact us to learn more about our solutions (www.hydrovert.in)

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decreased delivery times and the highest durability in the market. The company is competing with global giants like Toyota, Bosch, Ballard, and Proton to optimize the fuel cell production process, positioning itself as a formidable player in the global hydrogen technology race.

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The Path Forward

As Energy Leap continues to nurture these innovative start-ups, we remain committed to our vision of accelerating the transition to clean hydrogen. By bringing together visionary companies, established industry leaders, and forward-thinking investors, Energy Leap is fostering an environment of collaboration and innovation. Together, we are working towards a future where clean hydrogen plays a central role in decarbonizing industries, transforming mobility, and creating a more sustainable world.

We look forward to sharing more updates on the progress of our cohort and the exciting developments in the clean hydrogen sector. Stay tuned for future showcases as we continue to highlight the brilliant minds shaping the future of energy.

For more information about Energy Leap and our initiatives, visit www.xynteo.com/our-universes/energy-leap

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Compared to liquid hydrogen and metal hydrides, electrochemically produced ammonia can be synthesized, stored, and transported in near-ambient conditions. It can be directly combusted with zero carbon emissions or cracked into hydrogen when needed. This process is more eco-friendly than steam methane reformation, which releases tons of carbin dioxideinto the atmosphere.

Green ammonia production uses renewable energy, supporting green hydrogen initiatives. It can be produced centrally using nitrogen and water, then shipped to where hydrogen is needed. Ammonia cracking can be done chemically at 673-873 K, with research ongoing for ambient electrochemical cracking.

The versatility of hydrogen across various applications such as power generation and chemical processes can further help bring down these sectors' carbon footprint. These factors make ammonia a viable candidate for large-scale hydrogen storage and transport in a decarbonized energy system.

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