HYDROGEN INDIA

| Pages: 24 |
| July 2024 |
Pune | Vol I, Issue 3

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EDITORIAL

Hydrogen is being increasingly recognized as a promising clean fuel for power generation, offering several advantages over traditional fossil fuels. As the lightest and most abundant element in the universe, hydrogen can be utilized in various forms to generate electricity and gas, with minimal environmental impact. One of the primary benefits of hydrogen as a clean fuel is its potential to produce zero greenhouse gas (GHG) emissions at the point of use. When hydrogen is used in fuel cells, it combines with oxygen to produce electricity, with water and heat as the only by-products.

For the sugar and distillery industry, the cogeneration plants can be powered by renewable sources like biomass (bagasse). The electricity produced can be used for electrolysis to generate hydrogen, creating a renewable hydrogen production pathway.

Also, waste from the sugar and distillery processes can be anaerobically digested to produce biogas, which can be a source of hydrogen through reforming technologies. Ethanol, produced by distilleries from sugarcane, can be reformed to produce hydrogen. Thus, an integrated system where ethanol is produced from sugarcane and then reformed to hydrogen can enhance overall efficiency and sustainability.

Besides, vinasse, a by-product of ethanol production, can be used in the production of biogas through anaerobic digestion, which in turn can be a source for hydrogen production. Molasses, another by-product of sugar production, can be fermented to produce ethanol, which can subsequently be reformed to hydrogen.

Though to fully realize the potential of hydrogen energy, all stakeholders need to pitch in. Governments need to create a supportive regulatory environment and provide incentives for hydrogen-based start-ups. Investors need to provide the necessary capital and take a long-term view of their investments. Established energy companies need to collaborate with start-ups and share their expertise and resources. Finally, start-ups themselves need to continuously innovate, learn from their experiences, and stay resilient in the face of challenges.

Cogeneration Association of India (Cogen India) has recently partnered with Xynteo's Energy Leap, to demonstrate its pioneering work with clean hydrogen technology companies in India. Interviews with the Innovation Challenge winner and lead management of Xynteo are covered this time, along with an overview of this initiative.

As the Ministry of New and Renewable Energy (MNRE) progresses on India's National Green Hydrogen Mission, we regularly provide updates on the Mission. The roles of other stakeholders are important too – this time we have profiled the Hydrogen Valley initiative by the Department of Science and Technology (DST).

Asia and Africa, with their unique energy needs and development trajectories, stand to gain significantly from the hydrogen revolution. An article By Asian-African Chamber of Commerce & Industry Foundation (AACCI) explores the current state of hydrogen energy in these regions,

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Cogen India welcomes **Shri Pralhadji Joshi**, Honourable Minister for Consumer Affairs, Food & Public Distribution; and New & Renewable Energy, Government of India.

CONTENTS

ABOUT COGEN INDIA

The Cogeneration Association of India (Cogen India) strives to promote cogeneration and captive power projects in all applicable industrial and commercial sectors, and lobbies for conducive and sustainable policy and regulatory framework. Along with cogeneration, sugar mills in India have also ventured into the production of Ethanol and Rooftop Solar Power Generation, and hold the potential to venture into many new arenas of renewable energy, gradually transferring into Bio-Energy Complexes instead of remaining only a 'Sugar Industry'.

In line with the pragmatic changes by way of the Solar & Biofuel Policy, Cogen India too has added Solar Power with other Bio-Energy & Green Energy resources in the list of responsibilities, to share knowledge and experience, and pursue active interaction with all stakeholders.

Key Action Areas

- Providing advisory services on all aspects related to Bio-Power Projects
- Providing consultancy services for Rooftop Solar Power Projects at Sugar Complexes
- Strategies and measures to promote cogeneration projects in all applicable industrial and bio-power commercial sectors in India
- Capacity building and fuel linkage
- Interacting with Central & State Governments, state electricity boards, regulators, national and international bodies for ensuring sustainable policy framework and tariff rates
- Assisting other sugar-producing countries to set up their cogeneration sectors/projects

Activities

- Inaugural launch of National Cogeneration Awards-2022, followed by National Cogeneration Awards-2023 and 2024 (www.cogenawards.com)
- Successful organization of webinars, training programs/ business meets/field visits in sugar, rice, distillery, paper, food processing, bio-power, waste to energy sectors, etc.

- Quarterly (English) newsletter "Industrial Cogeneration India" - A unique forum for distribution of technical and sectoral information in India/abroad (74 issues have been published till date)
- Sugar Cogeneration Handbook - 2021: Unique literature useful for stakeholders in the New and Renewable Energy sectors

- Member of the COGEN World Coalition (CWC), established in 2022 as an international non-profit association
- New Hydrogen India newsletter, launched in Sept 2023

For further information, refer www.cogenindia.org

'Hydrogen India' Publication is owned by Cogeneration Association of India; **Printed & published** by Mrs. Anita Khatal; Published at c/o MSFCSF Ltd., 1st Floor, Sakhar Sankul, Shivajinagar, Pune – 411005; **Printed** at Innovative Designers & Printers, E-41, Sector 6, Noida 201301, **Editor** – Ms Anita Khuller

Sponsored by: Xynteo India Private Limited
Co-sponsored by: Resurgent India Limited

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its potential impact, and the future prospects for integrating hydrogen into their energy ecosystems. Other international articles talk about US-India partnerships in this sector, and the German and Korean interest in India's hydrogen industry.

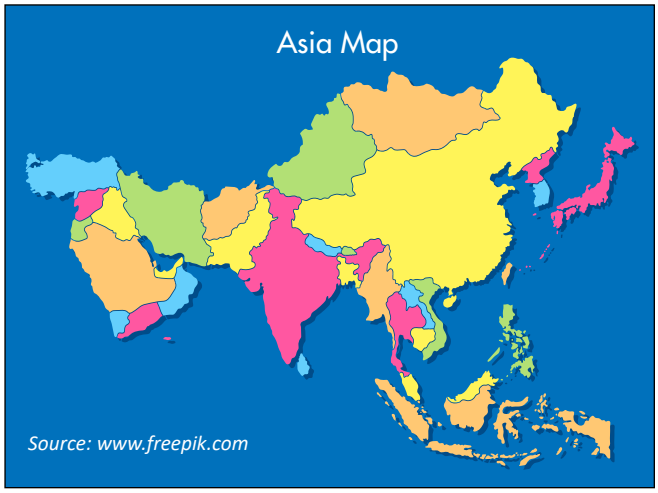
Integrated Research and Action for Development (IRADe) has focused on green hydrogen's role in the decarbonization of India's iron and steel industry, particularly with our country being the world's second largest steel producer. With clean energy finance spearheading India's green initiatives, Resurgent India talks about green bonds. Finally, the State profile covered this time includes Kerala, which is moving quickly ahead.

The Cogeneration Association of India (Cogen India) will play a key role in helping to set up "integrated sugar complexes", focusing on expanding their by-product and revenue base, and invites stakeholders to join hands in this race to lead India's shift to Green Hydrogen. The launch of this HYDROGEN INDIA newsletter in 2023 is a crucial step in raising more awareness in this sector. We request all stakeholders' feedback and support in order to make it more useful for the industry.

The Hydrogen Revolution: Impact on Asia and Africa

Introduction

As the world grapples with the pressing need to transition to cleaner energy sources, hydrogen has emerged as a beacon of hope. Touted as the fuel of the future, hydrogen promises to revolutionize the energy landscape with its potential to drastically reduce greenhouse gas (GHG) emissions. Asia and Africa, with their unique energy needs and development trajectories, stand to gain significantly from the hydrogen revolution. This article explores the current state of hydrogen energy in these regions, its potential impact, and the future prospects for integrating hydrogen into their energy ecosystems.



The Hydrogen Economy: An Overview

Hydrogen is the most abundant element in the universe and, when used as a fuel, produces only water as a byproduct, making it an exceptionally clean energy source. The hydrogen economy encompasses the production, storage, distribution, and utilization of hydrogen as a key energy carrier. There are several methods to produce hydrogen, including:

- **Steam Methane Reforming (SMR)**: Currently the most common method, though it emits CO_2.
- **Electrolysis**: Using electricity to split water into hydrogen and oxygen. When powered by renewable energy, it produces green hydrogen.
- **Biomass Gasification**: Converting organic materials into hydrogen.
- **Photolysis**: Using sunlight directly to split water molecules.

Among these, green hydrogen, produced via electrolysis using renewable energy, is the most sustainable option.

Current State of Hydrogen in Asia & Africa

Asia

Asia, particularly East Asia, is at the forefront of the hydrogen revolution. Countries like Japan, South Korea, and China have made significant strides in adopting hydrogen technologies.

- **Japan**: Japan has been a pioneer in the hydrogen sector, aiming to establish a "hydrogen society." The country has invested heavily in hydrogen infrastructure, including hydrogen fueling stations and residential fuel cells. By 2030, Japan aims to have 800,000 fuel cell vehicles (FCVs) on the road and 5.3 million residential fuel cells installed.
- **South Korea**: South Korea's Hydrogen Economy Roadmap aims to produce 6.2 million FCVs and 1,200 hydrogen refueling stations by 2040. The government has also committed to significant investments in hydrogen production and storage technologies.
- **China**: China, the world's largest energy consumer, sees hydrogen as a key component of its energy strategy. The government has set ambitious targets for hydrogen production and utilization, with plans to establish a comprehensive hydrogen supply chain by 2030. China aims to have 1 million hydrogen-powered vehicles on its roads by 2035.

Africa

In Africa, the hydrogen revolution is still in its nascent stages, but the potential is enormous given the continent's vast renewable energy resources.

- **South Africa**: South Africa is leading the charge in Africa's hydrogen economy. The country has significant platinum reserves, crucial for hydrogen fuel cells, and has developed a National Hydrogen and Fuel Cells Technologies Research, Development, and Innovation Strategy (HySA). South Africa aims to leverage its mineral wealth to become a global leader in hydrogen production and export.
- **Morocco**: Morocco is another African country with ambitious hydrogen plans. The country's abundant solar and wind resources make it an ideal candidate for green hydrogen production. Morocco has partnered with international stakeholders

Source: www.freepik.com

to develop large-scale green hydrogen projects, aiming to become a major exporter of green hydrogen to Europe.

- **Other African Nations**: Countries like Namibia, Egypt, and Kenya are also exploring hydrogen potential. These nations are investing in renewable energy projects that could be leveraged for green hydrogen production.

Impact on Asia and Africa

Environmental Benefits: The primary environmental benefit of hydrogen energy is its potential to significantly reduce GHG emissions. For Asia and Africa, regions heavily impacted by climate change, this is crucial.

- **Reduction in Air Pollution**: Hydrogen fuel cells produce zero emissions at the point of use, which can dramatically reduce air pollution in densely populated urban areas in Asia. In Africa, where many regions suffer from poor air quality due to biomass burning and fossil fuel use, hydrogen could offer a cleaner alternative.
- **Mitigating Climate Change**: Hydrogen can play a vital role in decarbonizing various sectors, including transportation, industry, and power generation. By integrating hydrogen into their energy mix, both continents can contribute to global efforts to limit temperature rise to below 2°C.

Economic Opportunities: The hydrogen economy presents significant economic opportunities, particularly in terms of job creation and industrial development.

- **Job Creation**: Developing a hydrogen infrastructure requires a skilled workforce, creating jobs in engineering, construction, maintenance, and research. In Africa, where youth unemployment is high, the hydrogen sector could provide much-needed employment opportunities.
- **Industrial Growth**: Hydrogen can drive industrial growth by providing a reliable and clean energy source for heavy industries such as steel and cement production. Asia, with its large industrial base, can benefit immensely from the transition to hydrogen, ensuring sustainable growth.

Energy Security: For many countries in Asia and Africa, energy security is a pressing concern. Hydrogen offers a way to enhance energy security by diversifying the energy mix and reducing dependence on imported fossil fuels.

- **Local Production**: Hydrogen can be produced locally using renewable energy sources, reducing the need for energy imports. This is particularly beneficial for African countries, many of which are heavily reliant on energy imports despite having abundant renewable resources.
- **Resilience**: Hydrogen can be stored and used to generate electricity, providing a buffer against energy supply disruptions. This resilience is crucial for both continents, which face challenges such as natural disasters and political instability.

Technological Advancements

The push towards a hydrogen economy will drive technological advancements in various fields, including renewable energy, electrolysis, and fuel cell technology.

- **Innovation**: Investments in hydrogen R&D will spur innovation, leading to more efficient and cost-effective technologies. This can have a spillover effect, benefiting other sectors such as electric vehicles and battery storage.
- **Collaboration**: The hydrogen revolution necessitates collaboration between governments, industries, and academia. Such collaborations can foster knowledge sharing and accelerate the development and deployment of hydrogen technologies.

Future Prospects

Policy and Regulation: Strong policy frameworks and regulations are essential to support the growth of the hydrogen economy. Governments in Asia and Africa need to develop clear and consistent policies that encourage investment in hydrogen technologies.

- **Incentives**: Providing financial incentives, such as tax breaks and subsidies, can stimulate investment in hydrogen infrastructure and technology.
- **Standards and Safety**: Establishing standards and regulations for hydrogen production, storage, and use is crucial to ensure safety and build public trust.

Investment and Funding: Significant investment is required to build the necessary infrastructure for a hydrogen economy. Both public and private sectors must play a role.

- **Public Investment**: Governments should allocate funds for hydrogen R&D, pilot projects, and infrastructure development. International financial institutions and development banks can also provide funding.
- **Private Sector Involvement**: Encouraging private sector investment through public-private partnerships can accelerate the deployment of hydrogen technologies. Venture capital and private equity firms can invest in innovative hydrogen startups.

Infrastructure Development: Developing a robust hydrogen infrastructure is essential for the widespread adoption of hydrogen energy.

- **Production Facilities**: Building large-scale hydrogen production facilities, particularly for green hydrogen, is a priority. Leveraging renewable energy sources such as solar and wind can make production more sustainable.
- **Distribution Networks**: Establishing pipelines, refueling stations, and storage facilities is critical for the efficient distribution of hydrogen.
- **Integration with Existing Systems**: Integrating hydrogen infrastructure with existing energy systems can facilitate a smoother transition. For example, blending hydrogen with natural gas in pipelines can be a transitional solution.
- **International Collaboration:** Collaboration between countries can accelerate the development of the hydrogen economy. Asia and Africa can benefit from partnerships with more advanced hydrogen economies.
- **Technology Transfer**: Advanced economies can share technology and expertise with developing countries, helping them build their hydrogen capabilities.
- **Trade Agreements**: Establishing trade agreements for hydrogen can create new markets and drive demand. For example, Africa could export green hydrogen to Europe, leveraging its renewable energy potential.
- **Research Collaborations**: Joint research initiatives can pool resources and knowledge, accelerating the development of hydrogen technologies.

Public Awareness and Acceptance: Building public awareness and acceptance of hydrogen energy is crucial for its adoption.

- **Education Campaigns**: Governments and industry stakeholders should invest in education campaigns to inform the public about the benefits and safety of hydrogen energy.
- **Stakeholder Engagement**: Engaging with stakeholders, including local communities, industry players, and policymakers, can build support for hydrogen projects.

Conclusion

The hydrogen revolution holds immense potential for transforming the energy landscapes of Asia and Africa. By embracing hydrogen, these regions can address pressing environmental challenges, boost economic growth, enhance energy security, and drive technological advancements. Achieving this vision requires coordinated efforts across policy, investment, infrastructure development, international collaboration, and public engagement. With the right strategies and commitments, Asia and Africa can become leaders in the global hydrogen economy, contributing significantly to a sustainable and prosperous future.

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US-India Partnership to Promote Green Energy

India's Energy Demand

India is the world's third-largest energy-consuming country with 80 percent of its demand still being met by non-renewable sources. For a rapidly growing economy like India, energy security is one of the key areas where it needs to focus in order to achieve its dream of a US$10 trillion economy. Despite the most formidable energy crisis looming over the world today, India has managed to navigate its way through its multipronged approach of diversification of energy supplies and tapping the potential of lower to zero-emission energy sources. However, the challenge India faces is not just to work aggressively toward its growth ambitions, but also to achieve them in a responsible and sustainable manner.

The current per capita energy consumption of India is one-third of the global average and around half the Asian average. The pace of India's development is only going to double its energy demand by 2040. This is why India needs to tap into alternative energy sources to replace its dependence on non-renewables and switch to cleaner fuels seamlessly without hampering its growth trajectory. The path to clean energy transition has to be smooth and free from technological bumps and breaks. India must therefore explore all forms of clean energy options from low-emission sources like gas to zero-emission sources like wind, solar, and green hydrogen to fulfill its requirements.

US Experience in Clean Energy Promotion

With the objective of accelerating innovations in clean energy solutions, the US Department of Energy (DOE) launched the Energy Earthshots Initiative in 2021 with seven critical sub-components like the Hydrogen Shot, Carbon Negative Shot, and Enhanced Geothermal Shot, amongst others. These area-specific initiatives aim to accelerate breakthroughs of more abundant, affordable, and reliable clean energy solutions within the decade so that the ultimate goal of net zero economy is attained by 2050. The Hydrogen Shot initiative was announced in June 2021, and establishes a framework and foundation for clean hydrogen deployment. Achieving the Hydrogen Shot's 80% cost reduction goal can unlock new markets for hydrogen, including steel manufacturing, clean ammonia, energy storage, and heavy-duty trucks. This would create more clean energy jobs, reduce greenhouse gas (GHG) emissions, and position US to compete in the clean energy market on a global scale.

Where US-India Stand in Energy Partnership

In recent years, the US has been steadily supporting India as it paves its way forward to a more sustainable tomorrow. The close diplomatic ties amongst the two nations showcases that a lot can be achieved collaboratively in the horizon years towards a greener future.

US and India enhanced their focus on the Strategic Clean Energy Partnership (SCEP), which is a more comprehensive and renewed version of the original Indo-US Energy Dialogue of 2005. The US-India SCEP stands on important pillars like Responsible Oil and Gas, Emerging Fuels, Power and Energy Efficiency, Renewable Energy, and Sustainable Growth, and is supported by a host of India's nodal ministries like Petroleum & Natural Gas, Power, New and Renewable Energy, and the Niti Aayog.

The main goal of the SCEP revolves around supporting the development and implementation of energy-efficient policies, best practices to achieve energy efficiency goals, and reduction in GHG emissions. The US DOE and India's Bureau of Energy Efficiency (BEE) are already in the process of working on the sustainable growth of the building sector through the Grid-Integrated Efficient Building (GEB) framework and waste heat recovery.

The upcoming areas that are being brought under the SCEP purview include hydrogen as a potential replacement for fossil fuels, the introduction of biofuels into the value chain, the use of lower emission options like natural gas to bridge India's de-carbonization pathway and carbon markets, and energy transition. The engagements at global forums like The Group of Twenty (G20) – the premier intergovernmental forum for international economic cooperation, Clean Energy Ministerial – a unique partnership of the world's key economies working together to accelerate the global clean energy transition, and the Conference of the Parties (COP), are crucial to help India push its energy transition ambitions towards reality.

The US has committed to support India with technical assistance, aid, and cohesive partnership in the aforementioned areas. Initiatives like the New and Emerging Renewable Energy Technologies Action Platform (RETAP) under the US-India SCEP facilitate collaboration with leading research and development (R&D) institutions across both the US and India. RETAP aims to accelerate key hydrogen technologies, potentially

establishing India as an R&D hub for electrolyzer manufacturing. Also, it will play an important and leading role in the hydrogen economy and the Global Biofuels Alliance (GBA) launched in 2023.

US Priorities in Green Hydrogen

The National Clean Hydrogen Strategy and Roadmap by US DOE, sets out three key priorities: the targeting of strategic, high-impact uses of hydrogen; reducing the cost of clean hydrogen to US$1/kg by 2031; and focusing on the deployment of regional clean hydrogen hubs.

The targeting of strategic, high-impact uses for green hydrogen provides maximum benefits to hard-to-abate sectors, such as the chemical industry, steel industry, transportation, etc., where there is a limitation in alternatives.

The second important priority area is towards promoting innovation, stimulating private sector investments, and developing the supply chain so that the costs of green hydrogen can be significantly lowered.

Thirdly, the Regional Clean Hydrogen Hubs (H2Hubs) announced by the US administration is expected to kick-start a national network of clean hydrogen producers, consumers, and connective infrastructure, while supporting the production, storage, delivery, and end-use of clean hydrogen. Funded by the Bipartisan Infrastructure Law (BIL), the H2Hubs will accelerate the commercial-scale deployment of clean hydrogen. This will be helpful in generating clean, dispatchable power, creation of a new form of energy storage, and ultimately decarbonize heavy industry and transportation.

To date, only a very small percentage of hydrogen projects have reached final investment decision (FID) in the US. Achieving the upper end of the projected range will require the industry to overcome significant headwinds in the coming years, including constraints related to power supply and grid integration.

The work by the US-India Hydrogen Task Force (HTF), which is a high-level bilateral collaboration between India's Ministry of New and Renewable Energy (MNRE) and the US DOE, brings industry and academia to explore the latest technologies and adopt business models towards development and deployment of these technologies.

Conclusion

For India, green hydrogen presents a home-grown opportunity as it holds the promise, along with renewables, to ease the burden of expensive energy imports from its economy. US and India have partnered in green hydrogen giving an opportunity for the industry and academia in the two nations to come together in a space, which is completely new to the world in terms of creation, storage, safety, mobility, etc. This partnership will pave the way towards a more sustainable energy sector, and also help bring other countries into the realm who are serious about their commitment to a greener future.

All of this sounds exciting but the path ahead is going to be challenging. The mantra for India should be macro planning and micro implementation, which will highlight the key policy and regulatory aspects at the sub-national level to achieve the net zero commitments. Financing will be an obstacle to India's growth trajectory, but the same can be addressed by bringing blended financing options, including multilateral and bilateral agencies, private sector participation, and engaging the community at the project preparation stage for some of the futuristic and large-scale projects.

The US-India partnership in this space will provide a platform to resolve and take the energy transition collaboration to greater heights. However, it will be crucial for India to aggressively pursue its goal towards a greener tomorrow; making the most of the opportunities provided, by means of its alliances and collaborations with experienced economies and its partners.

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Mr Shekhawat is an experienced Sector Specialist with a demonstrated history of working with key international and national agencies. In his previous role, he was leading the Infrastructure, Energy, Tech and Urban Development initiative in South Asia for the Australian Government and US-India Strategic Partnership Forum (USISPF). In the past he has worked with institutions like the NITI Aayog, Ministry of Housing and Urban Affairs, and USAID as a specialist and practitioner. His experience ranges from providing expert advice on policy strategy, project implementation, and government engagement. He has also worked as a Sector Specialist in capacity building programs by the United Nations and Government of India in several Indian and international projects.

Mr Shekhawat is an MBA in Infrastructure Management and PPPs from Yale School of Management & The Energy and Resources Institute (TERI). He also recently completed his Masters in Sustainable Infrastructure Development and Finance from Schulich School of Business, York University.

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The views expressed in this article are personal.

Hydrogen Valleys
India's Department of Science & Technology Initiative

India's Clean Hydrogen Mission will accelerate the building of a global clean hydrogen economy by reducing end-to-end clean hydrogen costs to US$2 per kg by 2030. This represents a tipping point in making clean hydrogen cost competitive with other energy vectors in different industries across production, transportation, storage, and end-use. Currently, there are 37 Hydrogen Valleys (small-scale to large-scale) across 20 countries[1]. India is a part of the mission as one of the founder countries; currently, the Department of Science & Technology (DST) is the nodal agency for mission innovation.

What is a Hydrogen Valley?

A Hydrogen Valley is a defined geographical area where hydrogen serves more than one end sector or application in mobility, industry, and energy. This typically covers all the necessary steps in the hydrogen value chain, from production (and often even dedicated renewable electricity production) to subsequent storage, and its transport and distribution to various off-takers.

Objective

The objective of a Hydrogen Valley is to demonstrate how the technology development in the entire value chain of hydrogen (production, storage, and transportation) as an energy vector fit together in an integrated system approach through industrial deployment at a small scale. This concept as a national initiative to foster green hydrogen transition, has been taken up by the DST (under the Ministry of Science and Technology).

The specific objectives include:

1. Through research and innovation, including activities related to higher Technology Readiness Levels (TRL), improve the cost-effectiveness, efficiency, reliability, quantity, and quality of clean hydrogen solutions, including production, distribution, storage, and end uses.
2. Strengthen the knowledge and capacity of scientific and industrial actors along the hydrogen value chain, while supporting the uptake of industry-related skills.
3. Carry out demonstrations of clean hydrogen solutions with the view to local, regional, and nationwide deployment, aiming at assessing the resource availability, involving stakeholders, and addressing renewable production, distribution, storage, and use for transport and energy-intensive industries as well as other applications.
4. Increase public and private awareness, acceptance, and uptake of clean hydrogen solutions.
5. Development and commercialization of a new product/process in the hydrogen value chain.
6. Significant improvements in the existing product/process/applications.
7. Substantial quality upgradation, reduced material and energy consumption, cost reduction, and improved competitiveness.
8. Development and deployment of technology or design to satisfy existing occupational health and/or safety standards or improve upon them.

The suggested focus areas covering the entire green hydrogen value chain are listed in Figure 1.

A. Green Hydrogen Production: Further improvements are required, especially in cost reduction and efficiency increase for a variety of green hydrogen production routes, the main workhorse being electrolysis, supported by other routes exploiting direct sunlight such as thermal dissociation of water using concentrated solar energy or through photocatalysis, biomass/biogas or other biological routes. Water electrolysis will be the main technology supported, covering both high TRL types — Alkaline Electrolysis (AEL), Proton Exchange Membrane Electrolysis (PEMEL), Solid Oxide Electrolysis (SOEL), and less mature types — Anion Exchange Membrane Electrolysis (AEMEL) and Proton Conducting Ceramic Electrolysis (PCCEL), and other routes of renewable hydrogen production.

B. Hydrogen Storage and Distribution: It is essential that hydrogen becomes an intrinsic part of an integrated energy system. For this to happen, hydrogen will have to be used for daily and/or seasonal storage providing buffering functions, thereby enhancing the security of supply in the medium term. The strategy also calls for an India-wide logistical infrastructure that needs to be developed to transport the hydrogen from areas with large renewable potential to demand centers across India. The specific areas of support include hydrogen storage, hydrogen in the natural gas grid, liquid hydrogen carriers, improving existing hydrogen transport means, compression, purification, and metering solutions, and hydrogen refueling stations.

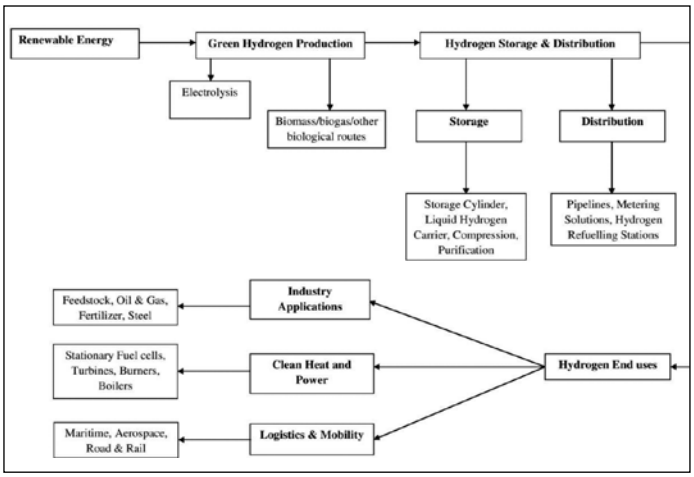

Figure 1. Schematic of HVIC

[1] *https://h2v.eu/*

C. Potential Green Hydrogen End Uses:

i) *Transport*: It should be also stressed that, especially in the case of hydrogen-based transportation, the competitiveness of hydrogen technologies is dependent on research and innovation breakthroughs, on production volumes of vehicles and components, and on the price and availability of hydrogen as a fuel. The areas of research include passenger vehicles, heavy-duty vehicles, waterways, rail applications, and aeronautical applications.

ii) *Clean heat and power*: The overall goal of this pillar is to support Indian supply chain actors to develop a portfolio of solutions providing clean, renewable, and flexible heat and power generation for all end users' needs and across all system sizes; from domestic systems to large-scale power generation plants, which include stationary fuel cells, turbines, boilers, and burners.

iii. *Industry applications:* The areas of research include where hydrogen is primarily used as a component or catalyst in ammonia production, oil refining, steel industry, fertilizers, methanol production, city-gas distribution (CGD), etc.

Timelines & Targets:

Time Period: (5 years: 2024-28)

As per the call for proposals issued in 2023[2] by DST, the small-scale Hydrogen Valley Innovation Cluster (HVIC) broadly aims to achieve:

- Each HVIC should identify and validate technologies to demonstrate hydrogen at an industrial scale and accordingly work out and define year-wise production targets depending on locational/regional strengths, preparedness, and utilization capabilities to minimize storage and transportation.
- Supply to more than one end sector or application [mobility, industry (fertilizer, refinery, CGD, etc.)]/ meet green hydrogen demand for each of the two main applications.
- Financing structure and strategy, including envisaged sources of co-funding/co-financing to be identified for both HVICs and as a future scope.
- Each HVIC will target annual production of green hydrogen up to 500 tons per year through various proven technology routes to be considered on a small scale.
- After the initial phase of five years as envisaged and successful demonstration, each HVIC will plan to scale up to a commercial level.

To realize this goal, the Innovation Cluster will provide funding for Research, Development, and Demonstration (RD&D) activities essential for small-scale demonstration of such technologies through initial support from DST and other funding partners.

Suggested Types of Small-scale HVICs:

The suggested types of small-scale HVICs in a few identified locations/regions that would be considered are given in Figure 2.

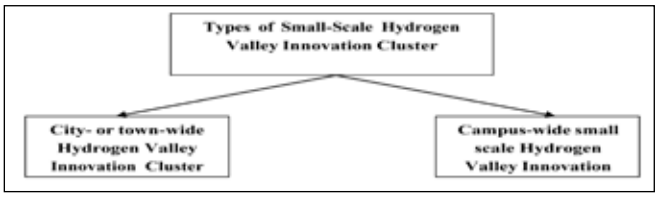

Figure 2. Suggested types of small-scale HVICs

Consortium of Entities

Each hydrogen valley would necessitate a consortium of multiple entities in the HVIC Phase, where the industry will be the ultimate off-taker of the technologies successfully demonstrated in the valley, and would later invest in large-scale manufacturing and deployment of these technologies. Therefore, a consortium that includes one or more commercial enterprises as a member will be a pre-requisite.

So consortiums must include the following (mandatory):

1. Lead applicant who will drive the consortium – should be a national institute of high repute/national R&D lab/organization having demonstrated capabilities in terms of expertise and activities in the hydrogen domain.
2. Industry participation is mandatory. However, industry partners willing to contribute towards the funding in the entire hydrogen value chain, especially for production, would be preferred.

In addition to the above partners, the consortium may also include eligible Indian entities (with expertise in the hydrogen sector) such as:

- Knowledge Clusters who are already engaged in stakeholder consultation in the green hydrogen ecosystem.
- Industries working on the hydrogen value supply chain.
- Central/state government supported or recognized (public or private) academia and urban or other local bodies.
- National/State-funded R&D labs.
- Central/state government recognized not-for-profit (societies/trusts or research foundations), having research and innovation as one of the imperative mandates; R&D centers recognized as scientific industrial research organizations (SIRO) by DSIR with industry partners.
- GOI-funded incubators/startups incubated as recognized Tech Business Incubators in the hydrogen domain.

For further details, please contact:
Ministry of Science & Technology
Department of Science & Technology
Technology Mission Division (Energy Technology Cell)
Technology Bhawan, New Mehrauli Road
New Delhi – 110016
Website: https://dst.gov.in/

[2] *Guidelines for HVICs: Revised Document for "Call for Proposals on Hydrogen Valley Platform in India" by DST*

Germany and Korea Interact with Indian Green Hydrogen Industry

In 2023, Sustainable Projects Developers Association (SPDA) took a pivotal initiative in the direction of promoting exports of green hydrogen and its derivatives from India by linking the exports with Article 6.2 of the Paris Agreement. This concept was brought to the focus of the concerned ministries in India – Ministry of New and Renewable Energy (MNRE), Ministry of External Affairs (MEA), and Ministry of Environment, Forests and Climate Change (MoEFCC). Recognising SPDA's initiative, the Government of India began discussions with several countries, including Japan, the European Union (EU) and its Member States, Singapore, Korea, etc.

Subsequent to the sharing of draft inter-country agreements, several rounds of negotiations have taken place at the G2G levels. Accordingly, interactions with industry were planned to understand the views of the stakeholders.

German Delegation

An interaction between a German delegation and leading Indian green hydrogen industry representatives took place on 27 May 2024. The discussion explored collaboration and addressed key concerns related to green hydrogen procurement and utilization of Internationally Transferred Mitigation Outcomes or ITMOs. The German delegation, with representatives from Federal Ministry (BMWK), KFW and their Consultant assisting the Ministry on Article 6 and Carbon Credits, expressed interest in procuring ITMOs generated within India. However, the primary concern was to avoid double-counting of emission reductions and the need for a standardised baseline for green hydrogen emissions to determine ITMO value.

Indian industry, including representatives from Acme, Avaada Group, Enfinity, Essar, Greenko, NTPC, Renew, Hygenco, Sembcorp, Torrent Power, Ocior, and many others, highlighted and explained the importance of offtake agreements along with ITMOs. Long-term offtake agreements are critical for supply at competent rates, considering the price difference between Green Ammonia and Grey Ammonia. The importance of viability gap funding to bridge the cost disparity between grey and green hydrogen solutions was vividly highlighted.

Industry representatives also advocated for a more realistic ITMO price reflecting existing market prices, and a linkage to established global carbon markets like the EU Emissions Trading System (EU ETS). Lenders expressed reservations about financing projects relying on low-priced ITMOs, further strengthening the industry's support for the bundled offtake and ITMO model as the most viable and preferred pathway to drive the green hydrogen revolution forward.

This key interaction underscores the ongoing discussions and complexities involved in establishing a mutually beneficial partnership between India and Germany in the green hydrogen space. Both nations are committed to finding a solution that accelerates the global green energy transition while prioritising economic and environmental considerations. Further rounds of discussions will continue to take place in the near future.

Business Visit to Korea

As per Energetica India, SPDA, in collaboration with the Embassy of India Seoul and the Korea Chamber of Commerce and Industry (the largest business chamber in Korea), successfully organized a business visit in February 2024, of Indian green hydrogen and derivatives' producers to Korea, underscoring the global push for green hydrogen.

The Indian business delegation, led by an MNRE representative, included key officials from leading companies like Acme, Avaada Group, Hygenco, and Torrent Power. The event also garnered support from Solutions for Our Climate (SFOC), underscoring the commitment of both nations to sustainable solutions for a cleaner future.

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Green Hydrogen's Role in Decarbonization of India's Iron & Steel Industry

Background

India is the world's second largest steel producer with a crude steel capacity of 154 Mt and production of 118 Mt (2021). The per capita steel consumption is 77 kg (world 233 kg, China 700 kg). India's steel industry consumed around 70 Mtoe of energy and the emissions were 252 Mt of CO_2 in 2019. The demand for steel will increase as the growth rate for finished steel is high in India. There are three technologies commonly used. Blast Furnace-Basic Oxygen Furnace (BF-BOF), Direct Reduced Iron (Coal)-Electric Arc Furnace (DRI-coal-EAF) and Scrap-Electric Arc Furnace (Scrap-EAF). CO_2 emissions per ton of steel by these technologies range from 2.5-2.85, 3.1 and 0.5-1 tCO2 per ton of crude steel respectively. However, if natural gas is used, the emissions by DRI-coal-EAF can be reduced to 1-1.5 tCO_2 from 3.1 tCO_2. Green hydrogen-based technologies have emissions as low as 0.05 tCO_2 per ton of crude steel. Given the target of Net Zero by 2070, we explore the role of green hydrogen in the industry.

India's Current Initiatives

The National Green Hydrogen Mission in India supports setting up pilot projects in the steel sector to promote the use of green hydrogen. The mission focuses on various thrust areas, including the use of 100% hydrogen in the DRI process, hydrogen injection in blast furnaces, and substitution of fossil fuels with hydrogen in a gradual manner. The mission focuses on developing a roadmap for green hydrogen deployment in the country and fostering collaborations between industry stakeholders, research institutions, and government agencies to drive the adoption of green hydrogen technologies in the steel sector.

The Mission focuses on using hydrogen in DRI processes, blast furnaces, and gradually substituting fossil fuels with hydrogen; companies like Nippon Steel and Tata Steel are conducting trials to inject hydrogen into blast furnaces. This process has shown potential in reducing coke consumption and emissions. Initiatives like the Swedish Hydrogen Breakthrough Ironmaking Technology (HYBRIT) and H_2green steel are pioneering the use of green hydrogen in DRI plants and EAFs. These projects aim to produce fossil-free steel using green hydrogen, with significant emission reduction targets. Studies have shown that the cost of steel production using green hydrogen technologies can be 10% to 60% higher in Europe and up to 120% more expensive globally. The cost depends heavily on the price of hydrogen and green electricity. The share of EAFs in steel production is projected to increase by 2030, as they are considered more environment-friendly compared to traditional blast furnaces as they use electricity instead of coal, leading to lower carbon emissions. Currently, India is in its developing stage and does not have enough scrap for EAF.

The expansion of DRI plants using green hydrogen technology is expected to contribute to decarbonization efforts, by producing iron using hydrogen as a reducing agent. The implementation of supportive policies and regulations by the Indian government can further drive the adoption of low-carbon steel-making technologies, for which the National Green Hydrogen Mission provides a framework.

Key Aspects

Shaping the future of decarbonization in the Indian steel industry

Recently, European Union (EU) has thrown a challenge to all exporters by announcing the Carbon Border Adjustment Mechanism (CBAM), where all exporters would have to declare the CO_2 content in the exported goods, starting with steel, aluminum, cement, fertilizers, etc. The adoption of green hydrogen-based technologies, such as hydrogen injection in blast furnaces and H_2-DRI-EAF processes, is expected to increase significantly by 2030. This transition will be crucial in achieving sustainability targets and reducing

environmental impact. Government policies and regulations such as National Green Hydrogen Mission, India's Nationally Determined Contributions (NDCs) commitments, and then Net Zero emissions by 2070, and other sustainability programs, provide a framework for promoting green practices in steel manufacturing.

The industry will require substantial investments in sustainable infrastructure and technology upgrades to support these decarbonization initiatives – in green hydrogen production, renewable energy integration, energy efficiency increase in the entire production chain, and carbon capture technologies to reduce emissions. The H_2-DRI technology, currently at Technology Readiness Level 6, requires significant advancements in production, storage, and transport infrastructure for scaling up. The cost of green hydrogen and the necessity of high-grade iron ore can make Indian steel less competitive than before. The Indian steel industry would require investments in the range of USD700-800 billion to achieve emission reduction targets through the adoption of green hydrogen and other low-carbon technologies.

Partnerships that focus on knowledge sharing, collaboration, and technology transfer, along with joint R&D projects, could accelerate the adoption of sustainable practices.

Projected Shares & Cost

Different steel-making technologies in India

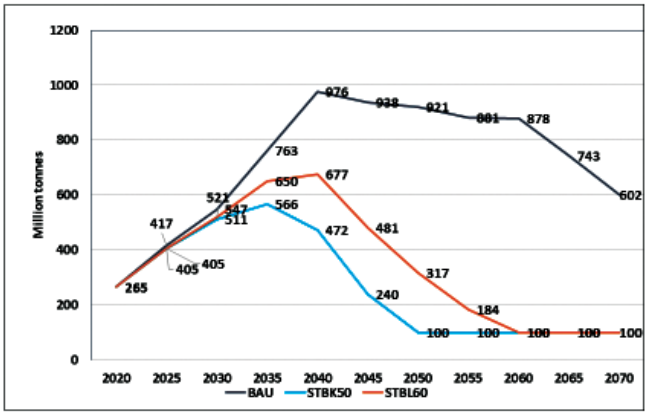
Integrated Research and Action for Development (IRADe) developed a model to determine the roadmap for decarbonizing steel industry. The projected shares of different steel-making technologies in India by 2030 play a crucial role in the decarbonization efforts. Starting from the current technology mix, it charts two optimal cost minimizing low-carbon pathways, considering the Net Zero goal by 2050 and 2060.

By increasing the share of green hydrogen-based technologies, EAFs, and DRI plants in the steel-making process, India can make significant strides towards decarbonizing its iron and steel industry by 2030. The figures give the emissions trajectories of the scenarios and the technologies selected. The cost of green hydrogen has been assumed to be USD5.37/kg in 2035 falling to USD2.75/kg by 2050.

The scenarios for integration of renewable power, either directly through the grid or through site-based hydrogen production, are also considered. In the long

CO_2 Trajectory for the Indian Steel Industry

Scenario	Peaking Year	Peak CO_2 MT
STBL50	2035	566
STBL60	2040	677

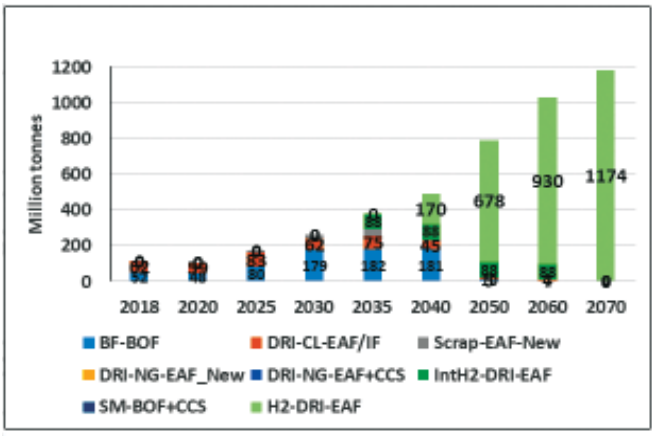


BAU: Business as usual with no constraint on CO_2 emissions.

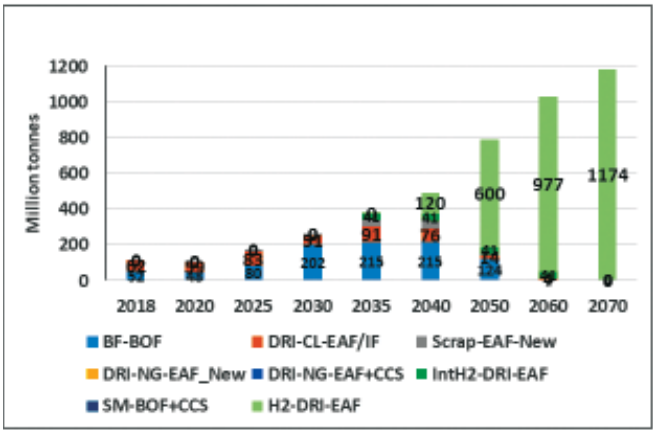
STBL50: CO_2 emissions peak in 2035 and then declined gradually to stabilize at 100 MT in 2050 and continue thereafter

STBL60: CO_2 emissions peak in 2040 and then declined gradually to stabilize at 100 MT in 2060 and continue thereafter

Technologies Selected in Both Scenarios



STBL50 Scenario



STBL60 Scenario

20 YEARS Integrated Research and IRADe Action for Development

DEPARTMENT OF SCIENCE & TECHNOLOGY

run, site-based hydrogen production is advantageous. However, the allocation of Rs 80,000 crores for the GH2 mission, if well spent, could bring forward the transition earlier than indicated here.

Conclusion

The road ahead is not without challenges. Effective policy support and substantial investment in infrastructure are needed, such as for hydrogen transport, storage, and building substantial renewable energy capacity, for scaling up hydrogen-based steel production. The adoption of hydrogen can reshape the global steel value chain, open new trade routes, and bring economic shifts in regions with higher renewable energy sources. Transition to hydrogen-based production requires addressing social implications such as job shifts and ensuring that the reduction of carbon-intensive capacity aligns with the growth of green steel production.

Green hydrogen thus presents a promising solution for decarbonizing India's iron and steel industry. The Indian government's initiatives and the industry's growing recognition of the need for change, position green hydrogen as a viable pathway for a sustainable steel sector. As technology advancements bring down costs and production scales up, green hydrogen is poised to play a transformative role in decarbonizing India's iron and steel industry, ensuring its continued growth on an environmentally responsible path.

IRADe, in collaboration with FICCI (Federation of Indian Chambers of Commerce and Industry), organized a webinar in May 2024 on 'Decarbonization pathways for the Indian steel industry: Role of green hydrogen'. 300 participants from around the world attended it, including Shri Ajay Raghava, Adviser, Ministry of Environment, Forest and Climate Change, panelists from International Energy Agency (IEA), Organisation for Economic Co-operation and Development (OECD), Dr Jyoti and Kirit Parikh of IRADe, steel industries such as Jindal Steel, and IIT Bombay. The lead presentation was given by Dr. Anjana Das, Senior Advisor, IRADe.

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The above article has been summarized by IRADe from the report supported by the Department of Science and Technology (DST).

Germany and Korea Interact... contd from pg 10

The Indian delegation emphasized India's readiness to support Korea's ambitious decarbonization goals, offering competitive prices for fuels such as green hydrogen, green ammonia, and green methanol. An invitation was extended to Korean counterparts to explore mutually beneficial opportunities, including establishing joint ventures with Indian organizations, facilitating technology transfer, engaging in joint research & development (R&D) efforts, and signing offtake agreements.

During the discussion, the MNRE representative presented India's National Green Hydrogen Mission's ambitious targets and its preparedness to supply green hydrogen and its derivatives.

Adding to it, Shri Amit Kumar, Ambassador of India to the Republic of Korea, highlighted the seminar's usefulness in bringing together a wide range of participants from government, businesses, utility, financial and legal circles with interest in the green hydrogen space. The seminar as well as B2B meetings fostered substantive discussions on collaboration for green hydrogen in India, exports to Korea, standards setting, technology, R&D, etc.

About SPDA

Established a decade ago, the Sustainable Projects Developers Association, SPDA is an independent industry association committed to promoting India's energy transition. It provides a neutral platform for policy advocacy, discussions and consensus building on issues critical to the development of the renewable and green fuel sector. SPDA represents more than 40 member companies across the gamut of renewables and green fuel industry including solar, wind, hybrid, BESS, green hydrogen and green ammonia sectors, providing assistance in policy evolution and healthier investment climate for renewable energy and green fuel projects and services.

For further information, refer - https://spdaonline.com/

National Green Hydrogen Mission: An Update

Portal Launched

A dedicated portal for the National Green Hydrogen Mission was launched on May 8, 2024, which will serve as a one-stop location for information on the Mission and steps taken for the development of the Green Hydrogen (GH) ecosystem in India. The portal was launched jointly by Principal Scientific Advisor to Government of India, Prof. Ajay Kumar Sood, and Secretary, Ministry of New and Renewable Energy (MNRE), Shri Bhupinder S. Bhalla. The portal can be accessed here: **www.nghm.mnre.gov.in**

Quality Control

On the same day, the government held a workshop on "Quality Control in Green Hydrogen: Standards and Testing Infrastructure" at New Delhi. The workshop convened by MNRE, deliberated on actions needed to create a homogeneous ecosystem for GH production processes through clear quality standards. The steps to create a network of GH testing facilities were also discussed.

Two reports[1] were also released on the occasion – One on "Green Hydrogen Standards and Approval Systems in India" and another on "India's Green Hydrogen Revolution", and are available on the portal. A brief synopsis of these will follow in the next volumes of Hydrogen India.

Guidelines for Pilot Projects

GH Use in Shipping Sector: The Mission has enunciated the need for taking up pilot projects in the sector, to be implemented through the Ministry of Ports, Shipping and Waterways (MoPSW) and the Scheme Implementing Agencies (SIAs) nominated under this initiative. The objectives of these pilot projects are to:

- Support the deployment of safe and secure operations of GH and its derivatives as fuel for ship propulsion, including bunkering and refuelling at ports, on a pilot basis, and to study their effectiveness and performance;
- Validate the technical feasibility and performance of GH and its derivatives-based ship propulsion in real-world operational conditions;
- Evaluate the economic viability of the use of GH and its derivatives in the shipping sector; and
- Identify areas for improvement.

The Shipping Corporation of India (SC) or its successor, in case of disinvestment, will be the Implementing Agency for retro-fitting of the existing ships. The component on creation of bunkers and refuelling facilities will be implemented by the agency nominated by MoPSW.

GH Use in Iron & Steel Sector: To assess the potential for the use of Green Hydrogen and its derivatives in the steel industry, the Mission supports setting up of pilot projects in the steel sector. These pilot projects will be implemented through the Ministry of Steel (MoS) and the Scheme Implementing Agencies (SIAs) as elaborated under this Scheme

Other MNRE announcements in May include:

- Request for Selection (RfS) for the Production and Supply of Green Ammonia in India through Cost-Based Competitive Bidding under the Strategic Interventions for Green Hydrogen Transition (SIGHT) Scheme.
- MNRE has waived off the requirement of being on the Approved List of Models and Manufacturers (ALMM) on solar modules and Revised List of Models and Manufacturers (RLMM) on wind turbines, for renewable energy facilities used for GH production. This is applicable to those renewable energy projects that are not only situated within an export-oriented unit (EOU) or special economic zone (SEZ) but also provide electricity only to GH (or its derivatives) production facilities situated within these demarcated zones. The aforementioned exemption from ALMM and RLMM will be applicable to all such renewable energy projects that meet all the prerequisites and are operational by December 31, 2030.

For further details, refer the complete guidelines and documents mentioned above on MNRE's portal (www.nghm.mnre.gov.in)

[1] https://static.pib.gov.in/WriteReadData/specificdocs/documents/2024/may/doc2024510336301.pdf
https://static.pib.gov.in/WriteReadData/specificdocs/ ocuments/2024/may/doc2024510336201.pdf

Green Hydrogen Valley Projects Approved

STATE UPDATE

The Department of Science and Technology (DST), Ministry of Science and Technology, Government of India, has approved funding of Rs 50 crore[1] each for four upcoming green hydrogen valley projects in India.

"Based on the merits and preparedness of the recommended Hydrogen Valley Innovation Clusters (HVICs), DST has decided to allocate up to Rs 50 crore per cluster over five years," a senior government official told a leading media agency[2] on the condition of anonymity.

The official added that the Department is supporting four green hydrogen valleys this year, one each in Kerala, Pune, Bhubaneshwar, and Jodhpur.

The Bhubaneswar-HVIC will produce hydrogen through the electrolyser mode and will be targeting the steel and mobility sectors. Pune-HVIC will take the bioethanol and electrolyser track of hydrogen production and plans to target the fine chemicals and mobility industries.

Whereas, Jodhpur-HVIC will be producing hydrogen through biomass and electrolyser methods. Target applications for this include hydrogen internal combustion engines and blending in city-gas production. This project will produce ammonia as well in its plants.

The DST invited proposals from agencies to set up hydrogen valleys under the Mission Innovation, which is a global initiative of 23 countries and the European Commission to catalyze action and investment in research and development to make clean energy affordable and accessible for all.

A hydrogen valley is a defined geographical area where hydrogen serves more than one end-sector or application. It covers steps in the hydrogen value chain from production to storage and its transport and distribution to various off-takers.

The aim behind setting up such valleys is to boost research, innovation, and capacity of scientific and industrial actors in the area, and demonstrate clean hydrogen solutions with the view to local, regional, and nation-wide deployment.

Kerala Surges Ahead

HVIC

As of 1 June 2024, Kerala has secured funding approval for its Green Hydrogen Valley project from India's DST. This initiative is part of Kerala's ambitious plans to position itself as a leader in green hydrogen production and export. With proposed hydrogen valleys in Kochi and Thiruvananthapuram, the state aims to create a robust ecosystem for hydrogen innovation and application.

The DST's approval followed an extensive review by an expert panel committee, which evaluated the detailed project report (DPR) for the HVIC proposal on March 8, 2024, recommending it for financial support.

In Kerala, the hydrogen valleys are expected to serve diverse applications, particularly in the transport sector. The state's technical bid under the Ministry of New and Renewable Energy's (MNRE) National Green Hydrogen Mission Scheme has already qualified, indicating a strong foundational plan. The financial bid is pending, which will be a critical determinant of the project's viability.

Pilot Project

As of 10 June 2024, Cochin Port Authority (CoPA) is focussing on inviting Expressions of Interest shortly to execute a green hydrogen pilot project, which is expected to start production within a year. "Cochin Port already has existing capabilities and rich experience of handing liquid cargo, especially chemicals like ammonia. The port therefore will be in an advantageous situation to build a bunkering facility for green hydrogen and its derivatives", B Kasiviswanathan, Chairman, CoPA said.

CoPA, Indian Ports Association and industry stakeholders will work together on these proposals.

The 'Harit Sagar' - Green Port Guidelines aim to achieve a zero carbon emission goal by establishing 'Green Ammonia' bunkers and refuelling facilities at major ports by 2035. With its exceptional connectivity to domestic and international shipping routes, Cochin could serve as a potential testing ground for green hydrogen initiatives. This gives Cochin an opportunity to emerge as a "Lighthouse Port," setting a precedent for other ports to lead the green hydrogen transition.

Highlighting the progress at VO Chidambaranar Port Authority (VOCPA), Tuticorin in the development green

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[1] *1 crore = 10 million*

[2] *ETEnergyWorld on 3 June 2024*

India's First Clean Hydrogen Technology Accelerator

HYDROGEN INDIA interviews Vipul Kumar, Senior Partner, Xynteo

As Asia's first clean hydrogen technology accelerator, how did the idea of Energy Leap originate?

India is aiming for net zero by 2070, and hydrogen demand is set to skyrocket – we're talking close to 400% growth from current levels by 2050. Large industrial sectors such as fertilizer, refinery, transport and steel, will need clean hydrogen for decarbonization. It was evident in our program design that a technology commercialization ecosystem was lacking in India. So a collaborative initiative was required to nurture high-potential, scalable technological solutions and bring them to the market.

Acknowledging these challenges, Xynteo, in collaboration with anchor partner organizations such as SED Fund and Technip Energies, conceptualized Energy Leap as a platform to accelerate the production and utilization of clean hydrogen. This platform leverages Xynteo's experience and expertise in leading industry coalitions such as Vikaasa and Build Ahead.

Is Energy Leap a global initiative or only in India/Asia?

Energy Leap's primary focus area is currently India. However, we engage with international partners to identify scalable clean hydrogen technologies looking for growth opportunities in India, and support Indian clean hydrogen technology companies in gaining market access to international markets.

How successful has Energy Leap been in bringing stakeholders together?

We began by establishing a robust network of technology providers, accelerators, venture capitalists (VCs), and process technology companies. Our partners include Technip Energies, SED Fund, the Research and Innovation Circle of Hyderabad, IIT Madras Energy Consortium, and Energy Systems Catapult, among many others. Together, we have developed an ecosystem that is unlocking pilot projects and growth funding opportunities

Now, we're scaling up our operations by bringing more relevant stakeholders to the table, including government representatives, clean hydrogen producers, renewable energy companies, heavy industries, institutional investors, and raw material suppliers.

What technologies are required in the short term and long term to propel the clean hydrogen sector in India?

I firmly believe that technological solutions and efforts that go into developing the solutions must align with market needs. In the near future, we're looking at sectors already using hydrogen – think fertilizers, oil refining, and new use cases such as clean ammonia for export. We need to focus on making the electrolyser system cheaper and producing feedstock chemicals such as methanol more cost-effectively. Down the line, we've got to unlock large demand for clean hydrogen. That means developing technology to produce sustainable aviation fuel, synthetic methane, and e-diesel, and to enable hydrogen fuel-cell usage in heavy-duty transportation and power sectors.

Besides the IITs, how did Energy Leap "find" clean hydrogen start-ups? How does your expert panel evaluate them for the Innovation Challenge?

Firstly, we've built strong relationships with corporates, regional accelerators, and VCs who send us clean technologies for our consideration. Secondly, we discover new technologies through the annual Innovation Challenge competition, which is a 2-3-month sprint to identify promising technologies addressing specific long-term challenges in the clean hydrogen sector.

As part of Innovation Challenge, we have an expert panel that evaluates the novelty of their ideas, technical feasibility, market alignment, scalability potential, and the track record of the founders and their teams.

What made Suzhiyam Industries, the winner of Energy Leap's inaugural Innovation Challenge, unique?

Suzhiyam Industries ticked all the boxes in both technological and business aspects. They possess commercially proven small-scale gasification

contd on pg 18

Unleashing Innovation: Clean Hydrogen Pioneers at Energy Leap

Today, it is evident that clean hydrogen holds the key to unlocking a sustainable, decarbonized future. And as Asia's first clean hydrogen technology accelerator, Energy Leap is forging a path toward this vision by uniting industry leaders, innovative start-ups, and forward-thinking investors. We invite you to meet three of the six brilliant start-ups in our inaugural cohort, engaged in driving the production of clean hydrogen across the value chain.

Prasah: Leading the way in fuel cell-powered drones

Founded in 2021 and headquartered in Pune, India, Prasah is an R&D company dedicated to developing cost-competitive fuel cells to replace internal combustion engines. Pankaj Kumar, the founder and a passionate engineer, is leveraging 15+ years of deep technical expertise in fuel cell technology to build India's first fuel cell-powered high payload drone. This drone is designed for applications in construction, agriculture, and mining industries, addressing the lack of reliable power sources for heavy payload drones.

Key highlights of Prasah's journey include collaborations with esteemed institutes like Indian Institute of Technology (IIT) Bombay, College of Engineering Pune Technological University (COEP), and Indian Institute of Science (IISc) for indigenizing critical components and lowering raw material costs. Prasah has also designed and developed an indigenous bi-polar plate for fuel cells and built a 12 kW fuel cell stack capable of powering an 80 kg drone. Currently in the development stage, with their technology validated in lab settings, Prasah has established strategic partnerships to scale up the manufacturing of fuel cells for drone applications.

www.prasah.com

Hydrovert: Innovating clean power solutions

Hydrovert, established in 2021 and based in Pune, India, is developing hydrogen fuel cell-powered stationary power generators as a clean alternative to diesel generators. The start-up, founded by Dr. Satyajit Phadke and Supriya Patwardhan, focuses on creating advanced hydrogen powertrains for mobility and energy storage applications.

Dr. Phadke specializes in material science and electrochemistry, and has a PhD from University of Florida. Hydrovert's innovative hydrogen-battery hybrid powertrain is a promising solution for decarbonizing built environments and powering a range of mobility applications, including last-mile logistics.

Hydrovert has garnered significant support, being awarded multiple grants such as the Nidhi Prayas Grant, Startup India Seed Grant, Cummins Corporate Social Responsibility (CSR) Grant, and the RM Tulpule Charitable Trust Grant. The start-up was also a finalist in the Bharat Petroleum Innovation Challenge. With their technology tested in relevant environments, Hydrovert is poised to revolutionize hydrogen mobility and energy storage use-cases.

www.hydrovert.in

Suzhiyam Industries: Transforming waste to hydrogen

Suzhiyam Industries, headquartered in Chennai, India, was founded in 2018 by Vivekanandan J, who is a passionate combustion engineer. This innovative start-up is focused on increasing the efficiency and reducing the cost of hydrogen production from biomass sources. By improving processes in the biomass supply chain and gasification technology, Suzhiyam aims to address the pressing issue of municipal waste management while producing clean hydrogen.

The company employs a process that involves gasification of municipal solid waste (MSW) and agricultural waste through oxygen and steam, followed by steam reformation to produce synthesis gas. This is then converted into hydrogen using the Fischer-Tropsch reaction. Suzhiyam Industries has been recognized for its

groundbreaking work, being the winner of Energy Leap's inaugural Innovation Challenge and a runner-up at Venturise 2022. Currently, their technology is validated in lab environments, and they continue to seek ways to scale their solutions.

www.eesan.in

The Path Forward

Energy Leap's mission is fuelled by the belief that collaboration is the cornerstone of sustainable progress. By fostering synergies between industry titans, agile start-ups, and visionary investors, we are cultivating an ecosystem that transcends traditional boundaries. This convergence of diverse perspectives, expertise, and resources is igniting a powerful wave of innovation, poised to reshape the energy landscape for generations to come.

To our inaugural cohort of start-ups, we extend our deepest gratitude and unwavering support. Your pioneering spirit, relentless pursuit of excellence, and unwavering commitment to a sustainable future inspire us daily. To read more about the rest of our cohort, watch this space next quarter.

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

Unleashing Innovation...contd from pg 16

technology, and have a robust plan to improvise existing technology to produce and sell bio-hydrogen at commercially attractive prices. On the business front, they are deeply engaged with the micro, small and medium enterprise (MSME) segment, and their technology has the potential to unlock demand for bio-hydrogen from this underserved market.

What advice would you give other up-and-coming start-ups in the clean hydrogen sector?

Emerging clean hydrogen start-ups should intensely focus on the following to be successful in their technology development and venture-building efforts:

1. Understand market needs and identify clean hydrogen value-chain focus areas, 2. Develop commercially viable solutions, 3. Build strategic partnerships, which are very crucial as we are building clean hydrogen energy systems, 4. Focus on solution scalability to reduce costs, and 5. Collaborate with stakeholders to test product-market fit and increase visibility.

What were the challenges faced, or are being currently faced, in this initiative?

The platform's market adoption has been slower than anticipated. We have so far concentrated heavily on the innovation and technology side of the platform, demonstrating key proof points by identifying and onboarding promising clean hydrogen technologies. This strategy has enabled us to engage with a broader range of stakeholders in the green hydrogen sector and conceptualize project ideas. We are steadily building momentum and achieving greater market adoption for the platform.

What are Energy Leap's plans to accelerate the commercialization of these game-changing innovations?

Energy Leap will continue to actively foster an expansive and diverse network of stakeholders to rapidly bring cutting-edge technologies to life. We will continue to work with our innovation network to discover new clean hydrogen technologies. We will bring on board more corporates from renewable energy, steel and refinery sectors to co-create pilot projects. We will continue to engage VC, private equity and impact investor communities to unlock funding for promising innovations. It's all about getting everyone on the same page and testing these groundbreaking technologies.

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

Energy Leap Innovation Challenge Winner

Interview with Suzhiyam Industrial Machines

(left to right) ***Anandarajeshwaran J and Vivekanandan J***

Congratulations on winning the Innovation Challenge award earlier this year! Tell us about your journey till date – what's your background and earlier experience prior to starting Suzhiyam Industrial Machines? What inspired you to start Suzhiyam?

Vivekanandan J: I am the director of the company and a passionate mechanical engineer with an MS in aerospace from IIT Madras, specializing in combustion. My experience as principal combustion engineer at GE, USA's gas turbine division lends itself to the product development know-how of the company.

Anandarajeshwaran J: I am the co-founder of the company, a second-time entrepreneur with an MBA in operations research, and I bring IT automation experience from PayPal. My first stint as an entrepreneur was a software development start-up established in 2003, which experimented with handheld systems five years before the smartphone revolution started in 2007. We are brothers from Madurai, Tamil Nadu, and we started Suzhiyam Industrial Machines in 2018.

Suzhiyam's first commercial installation was for a food processing company in Bengaluru in 2020. The initial success was in R&D and manufacturing of solid fuel burners for industrial process heating equipment. But later the business strategy evolved into manufacturing machines for converting waste to solid fuel. India generates huge amounts of agricultural waste and municipal solid waste (MSW). The waste accumulated so far and being generated on a daily basis is enough to replace 70% of India's industrial fossil fuel imports. Suzhiyam's vision is to be the market leader in replacing fossil fuel usage in industries with EnerPell – a solid fuel generated from waste.

The plan is to apply for 8 patents by November 2024. With grants from Xynteo, we are moving towards green hydrogen generation, which is at TRL 4 with the company. Within the next 2 years we want to generate green hydrogen from EnerPell on an industrial scale. Green hydrogen has a much bigger potential for India in terms of export market share.

Can you explain your technology for producing clean hydrogen from waste? How do you source the waste? What are the main advantages of your method compared to other hydrogen production techniques?

We deploy gasification burners for industrial clients, generating green hydrogen from municipal and agricultural waste through extended gasification and steam reforming. Our experience gives us an edge in this space, uniquely using both waste types for higher yields.

Sourcing feedstock is challenging. We partner with waste management companies, establishing plants in dump yards to ensure continuous MSW supply, which has higher calorific value and is more cost-effective than agricultural waste.

Our approach contrasts with the standard electrolyser method, which requires rare earth metals and substantial water. Our gasification process uses 1/10th of the water, doesn't need rare earth metals, and runs on carbon-neutral EnerPell from MSW. This enables 24/7 operation regardless of climate conditions.

Unlike electrolysers, which stress local water supplies and real estate, our process removes waste from dumps and can utilize any unused land near municipal dump yards. This helps waste management plants reclaim land and prevent dump expansion, offering a more sustainable and efficient solution for green hydrogen production.

How far along are you in the development process? What's your current technology readiness level?

Our journey began with simulation-based models using data from our gasification burners. These simulations provided crucial metrics, including energy requirements, hydrogen generation volume, and other key parameters for industrial-scale plant operations. We've successfully implemented a lab-scale model to measure composition.

Our process comprises three components:

1. Gasification of MSW – TRL 9
2. Steam Reforming – TRL 4
3. Pressure Swing Adsorption (PSA) – TRL 9 (using off-the-shelf commercial products)

With Xynteo's funding, we're progressing towards setting up a 2 kg/hour green hydrogen plant using MSW.

The technological challenges are minimal, and we have a clear roadmap to overcome them. Our primary hurdles are funding-related, specifically for procuring the PSA unit and data acquisition kits. Xynteo is facilitating connections with interested third parties to bridge this gap.

What impact do you hope your technology will have on the clean energy sector?

Our success will disrupt two sectors 1) fertilizer, and 2) energy exports.

The ammonia-based fertilizer sector will be the first to be disrupted in terms of pricing, as imported ammonia can be replaced with locally sourced green ammonia. Green hydrogen will be India's first fuel to be exported. Rapid scaling up will ensure India becomes the largest exporter of green hydrogen.

What are your plans for scaling up the technology? How

contd on pg 21

Clean Hydrogen: Catalyzing India-UK Innovation and Collaboration

In an increasingly interconnected world, the pursuit of clean energy solutions knows no borders. In May 2024, experts from India and the United Kingdom (UK) convened virtually to explore a shared vision: harnessing the potential of clean hydrogen to drive economic growth and combat climate change. The UK's Energy Systems Catapult's Innovating for Transport and Energy Systems (ITES) partnership (which forms part of the India-UK Net Zero virtual centre), hosted this landmark webinar in partnership with Xynteo's clean hydrogen technology accelerator Energy Leap, to explore the space and build links to promote Indo-UK collaboration in clean hydrogen technology and innovation.

High profile speakers from British High Commission in India, Indian Institute of Technology (IIT), Madras, Council on Energy, Environment and Water (CEEW), The Manchester Metropolitan University, Energy Systems Catapult, and Kirloskar Oil Engines Limited shared their insights at the webinar.

As the virtual meeting room buzzed with ideas, it became clear that the India-UK partnership in clean hydrogen is more than just diplomatic goodwill—it's a strategic alliance with the potential to reshape the global energy landscape.

Dr. Deepak Yadav (Programme Lead, CEEW) painted a compelling picture of how this collaboration could unfold. "Technology can be UK-based, with manufacturing that can be India-based," he suggested, outlining a future where British innovation meets Indian production prowess.

But the opportunities don't stop at large-scale manufacturing. Dr. Aravind Kumar Chandiran (Associate Professor, Department of Chemical Engineering, IIT Madras) pointed out an often-overlooked goldmine: India's vibrant micro, small and medium enterprise (MSME) sector. "Seventy per cent of components in the Indian automotive sector are made by the MSME sector for original equipment manufacturers (OEMs)," he noted. "Can we strategically move MSMEs into the hydrogen manufacturing ecosystem?" This shift could rapidly build a robust, agile supply chain for hydrogen technologies, leveraging India's existing manufacturing expertise in new and exciting ways. Dr. Chandiran added, "India has a software base that can enable this transition much faster. Can we repurpose their expertise to digital platforms that SMEs require?" The potential here is enormous: imagine smart grids optimising hydrogen production and distribution, or AI-driven systems managing complex hydrogen supply chains.

The foundation for this collaboration is already stronger than many realise. Dr. Patricia Pinto, Ph.D. (Science & Innovation Adviser, UK Science and Innovation Network, British Deputy High Commission) shared an encouraging statistic: UK-India research collaboration surged by 60% between 2019 and 2022. This existing research relationship could be the springboard for groundbreaking hydrogen innovations.

On the policy front, the UK's experience in establishing the world's first Low Carbon Hydrogen Standard could prove invaluable as India develops its own regulatory framework. Rahul Sahai (CEO, Kirloskar Oil Engines Limited) emphasized the need for "deliberation on quality and safety standards" between the two countries, highlighting an area ripe for knowledge exchange.

Skills development emerged as another crucial area for collaboration. Amer Gaffar (Director of the Manchester Fuel Cell Innovation Centre, The Manchester Metropolitan University) revealed that they've already "supported 150 SMEs in India" in hydrogen-related fields. This expertise could be the basis for comprehensive knowledge transfer programs, helping both countries build the workforce needed for a hydrogen-powered future.

Funding, too, could see interesting cross-pollination. Jack Landers, First Secretary, Science, Climate, Space & People, Deputy Head of Science, Technology and Innovation Network (SIN), British High Commission in India, described initiatives "incentivizing research and small programs between GBP 10-100,000 grants for small companies to get off the ground in the hydrogen market." Such models could be adapted or expanded for joint India-UK funding schemes, giving a boost to innovators in both countries.

India's ambitious hydrogen vision

India has set its sights on becoming a global hub for clean hydrogen production, utilization, and export. The National Green Hydrogen Mission (NGHM), launched in 2023 with a substantial investment of US$ 2.4 billion, underscores the country's commitment to this goal. India's strategic advantages are compelling: the world's fastest-growing large economy, abundant solar resources, a skilled workforce, and a competitive manufacturing base. India aims to position itself at the forefront of the global hydrogen economy, leveraging its unique strengths to drive innovation and scale.

UK's strategic hydrogen ambitions

While facing different resource dynamics, the UK shares India's enthusiasm for clean hydrogen. The UK Hydrogen Strategy, initially unveiled in 2021 and updated in 2023, sets an ambitious target of 10 GW of low-carbon hydrogen production by 2030. This vision is backed by significant funding, including a GBP 240 million Net Zero fund for hydrogen projects and a GBP 1 billion Net Zero Innovation Portfolio. The strategy reflects a nuanced understanding of the role hydrogen can play in its energy transition, balancing innovation with practical implementation.

The collaboration is already taking shape in specific sectors. The UK's work on "living labs in pharmaceutical sectors and decarbonization" offers a template that could be replicated or expanded with Indian partners, potentially leading to breakthrough applications of hydrogen in various industries.

However, Dr. Chandiran offered a word of caution and a call for focus. "We need to come out with a roadmap to foster collaboration," he urged. "If we can identify five most important components which we want to indigenize... there are some technologies that need to be identified and pushed through government funding." This targeted approach could help channel resources effectively, accelerating progress in key areas.

As the webinar drew to a close, the speakers reiterated that the India-UK hydrogen partnership isn't just about two countries working together—it's about combining complementary strengths to solve one of the world's most pressing challenges. From the bustling tech hubs of Bengaluru to the wind-swept coasts of Scotland, this collaboration could be the catalyst that turns the hydrogen economy from a promising concept into a world-changing reality.

For further details, please refer: www.xynteo.com/our-universes/energy-leap

Interview with Suzhiyam... contd from pg 19

does your solution fit into the broader clean hydrogen value chain?

The pilot plant we are establishing will provide us with some key and critical numbers for the scaling up. At this juncture the scale up to which we can grow is not yet known. Hydrogen for fertilizer production is where we believe our immediate commercial success will come from. Contrary to popular opinion, we believe that green hydrogen will never be a viable or feasible mobility solution.

What challenges do start-ups face, and your company in particular, in India?

Without letting the tech industry evolve, government bodies in India and other stakeholders have already finalized regulations and policies—this is creating problems, and will complicate issues further in the very near future. This will thwart all out-of-the-box thinking by tech companies like ours.

How has the Innovation Challenge award helped your company to grow?

Until December 2023 our green hydrogen efforts were put on hold due to lack of funding and expert connects. The Innovation Challenge award has put it back on our work table with a new perspective. The expertise and market insight that the Xynteo team is offering us has changed our view of commercial aspects of the green hydrogen market space.

A success with our first pilot will ensure that we will be able to attract the required investments, which we are unable to do now. Upon completing the pilot we will be able to file up to 4 patents.

How attractive is the hydrogen market in India in terms of technology development, pilot, finance, and offtake support?

To be frank, the hydrogen market that we are able to access is very nascent. Though plants are being deployed, majority of them are on pilot scale or experimental. Sustained production, cost at large-scale production, supply of feed—all this is just being figured out.

What is your vision for the company? Where do you see Suzhiyam Industrial Machines in five years?

Our vision is to become India's leading green hydrogen supplier and technology provider from MSW by 2027. Our short-term goal is to achieve revenue of INR3.5 crore[1] by March 2025, and our long-term goal is to be listed on SME IPO (Small and Medium Enterprise Initial Public Offering) by March 2029.

For further information, refer www.eesan.in
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[1] 1 crore = 10 million

Driving Sustainability: Green Finance Initiatives in India

Viewpoint Article by Shri Gadia, Managing Director, Resurgent India

India's ambitious journey towards a sustainable future is set to be capital-intensive and intricate. It will require significant efforts in scaling up renewable energy installations, modernizing infrastructure, and enhancing energy efficiency across various sectors.

India's recent inclusion in the JP Morgan bond index fund is projected to generate significant interest from foreign portfolio investors (FPIs) in **long-term sovereign green bonds**. In addition, the Reserve Bank of India has authorized FPIs to invest in these bonds through the International Financial Services Centre (IFSC), enhancing market confidence even further. India has also pioneered the issuance of Green Masala Bonds, which are rupee-denominated bonds issued outside of India. These bonds have been used to raise capital for green projects within the country, allowing Indian companies to tap into international markets to finance their renewable energy and sustainable development projects.

Recognizing the importance of green finance, the RBI has taken a proactive stance by introducing a framework for accepting green deposits. These interest-bearing deposits are designated for environment-friendly projects, ensuring a dedicated and streamlined flow of funds towards sustainable initiatives. Nonetheless, these green deposits may not be attractive to retail savers if they are offered lower interest rates to offset the higher risks associated with green lending.

Under current norms, for loans totalling Rs 10,000 crore, banks must allocate Rs 4,000 crore towards **priority sector lending (PSL)**. There is a growing consensus on the need to revisit PSL norms to encompass green project funding, exploring new areas, and raising the limits. Presently, renewable energy projects up to Rs 30 crore qualify for PSL status; most lenders engage in such funding on a small scale without incentives. Lenders have advocated for a review of these norms to better support financing for sustainability and green projects.

Non-transition risk is another significant challenge faced by companies that are hesitant or slow to adopt sustainable practices. Companies lagging in this regard could face heightened financial and reputational risks as investors and consumers increasingly prioritize green initiatives. Global firms like BP and Shell have faced mounting pressure to shift their focus towards renewable energy sources, and their slow progress has led to investor activism and negative publicity.

In stark contrast, companies that proactively **embrace sustainability** have reaped substantial benefits. Ørsted, a Danish energy company, transformed its business model from fossil fuels to renewable energy, particularly offshore wind farms. This strategic pivot has not only enhanced its market valuation but also positioned it as a leader in green energy.

However, the effectiveness of such transitions can be jeopardized if green funds are misallocated or misused. Misallocation or **misuse of green funds** can severely undermine the objectives of green finance. Moreover, the phenomenon of "greenwashing" — where companies or financial products falsely claim to be environmentally friendly — can mislead investors and diminish trust in green finance. This can also undermine investor confidence and market integrity, as funds are diverted to less impactful projects, reducing the overall effectiveness of green finance initiatives

Project finance for green initiatives also encounters challenges due to **repayment schedules** that are not aligned with the cash flow needs of the projects. For example, renewable energy projects often require substantial upfront capital investment, with returns generated over a long period. Traditional financing structures with short-term repayment schedules can create liquidity issues, leading to project delays and increased costs. To address these issues, there is a pressing need for more flexible and realistic financing structures that align with the unique cash flow dynamics of green projects.

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Green Hydrogen Valley... contd from pg 15

hydrogen projects, Susanta Kumar Purohit, Chairman said the port is planning to close the tender for a 60 KW electrolyser with an aim to commission next quarter.

Affordable, accessible and reliable renewable power is essential for the success of green hydrogen projects. The Government of Kerala's Department of Energy will play a critical role in promoting green hydrogen pilots, leading to the development of green hydrogen hubs.

Vikas Narwal, Deputy Chairman of CoPA and Managing Director of the Indian Ports Association said that shipping vessels, exports and domestic use in fertilizer units and refinery complexes could be the priority off-takers for this pilot.

Private Sector Interest

In Jan 2024, it was announced that ReNew Power, one of India's largest renewable-energy developers, had proposed to build a 2 GW green hydrogen and ammonia project in the southwestern state of Kerala. The plant was being planned in three phases with a combined production capacity of 1.1 million tons of ammonia (NH_3) or 220,000 tons of H_2 annually. The first phase will produce 100,000 tons of NH_3 a year, followed by the two phases adding a capacity of 500,000 tons each.

If a final investment decision is made this year, the plant could start producing its first volumes of ammonia as early as 2027. The facility will cost Rs 264 billion ($3.18 billion), excluding the 5-6 GW of renewables needed to power the 2 GW electrolyser. The plant is set to be sited near the state-owned Vizhinjam deep water port in the state capital, Thiruvananthapuram, which is scheduled to complete construction on its first phase this year after years of delay.

Kerala's state government had allocated $24 million in its 2023 budget to support the development of two hydrogen hubs in Thiruvananthapuram and Kochi. The Indian federal government also announced this month that it would hold an annual auction to subsidize 550,000 tons of green ammonia production.

ReNew Power had applied for subsidies in India's first national green hydrogen auction but failed to secure any funds when the winners were announced. Japanese conglomerate Itochu had also agreed to import 400,000 tons of green hydrogen-based ammonia annually from India.

Sources: The Hindu, eqmagpro.com, and planet.outlookindia.com

Energy Leap
WITH xynteo

INVITATION TO PARTNER WITH ENERGY LEAP

Energy Leap is an exclusive platform conceptualised and facilitated by Xynteo to enable production and utilisation of clean hydrogen in India by accelerating the commercialisation of breakthrough clean hydrogen technologies.

Are you a leading project developer, heavy industry, or automotive company looking for technological solutions to produce, transport or utilise clean hydrogen or its derivatives ?

Are you a venture capitalist or private equity investor or project financier, looking for opportunities to invest in clean hydrogen technologies and projects?

Are you a clean hydrogen technology company looking for growth capital and market access?

WHAT WE DO

Energy Leap is forging a dynamic marketplace for industries, investors and innovators to collaborate and deploy cutting edge clean hydrogen solutions.

We empower industry and investor partners to harness state-of-the-art clean hydrogen technology solutions, driving business growth.

We empower innovators to unlock markets and secure capital for their breakthrough technology solutions.

LEARN MORE

Contact us: energyleap@xynteo.com

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