ENERGY EFFICIENCY SERVICES LIMITED
A JV of PSUs under the Ministry of Power

INNOVATING ENERGY

Edition 39 | April 2022

Green Hydrogen: Fuel for a sustainable future

Top energy trends from India & across the globe

SCAN THIS CODE TO VISIT ONLINE MAGZINE

CONTENTS

OUR TEAM

PR Team
Animesh Mishra
Karan Gupta

Editorial Team
Ishank Garg
Garima Arora
Mini Tiwari
Ishita Agrawal
Shweta Papneja

Design Team
Anubhav Manna
Jai Kumar
Pradeep Kumar
Minhaz Siddiqui

FOR EDITORIAL DETAILS AND ADVERTISEMENT ENQUIRIES

u_kgupta@eesl.co.in

011- 45801260

Editor's note

Dear Reader,

With an aim to limit the global temperature rise to 1.5 °C, an urgent and swift adoption of multipronged approach is required. The first approach is Energy Efficiency followed by developing clean and environmentally sustainable alternative fuels, transition to newer and promising technologies, switching fuels are of utmost importance. Very recently on 26 April 2022, the country observed a rise in power demand by more than 201 GW and coal supply falling short. This poses a challenge in meeting the ever-growing energy needs, more importantly through clean and sustainable energy resources. Production of hydrogen must be switched to green hydrogen by utilizing renewable energy resources. Storing variable renewable energy by producing green hydrogen overcomes the intermittent nature of renewable energy. Targeting strategic demand centers and supplying green hydrogen through pipeline will not only overcome the challenge of meeting RPO but also reduce transportation costs and emissions, making logistics greener.

Across the world, hydrogen is being regarded as the fuel for the future and a key enabler for sustainable energy security. Hydrogen can also compliment India achieve its targets of generating 500 GW of renewable energy, decarbonising the power sector by reducing dependency on oil and coal, and delivering on its commitment to achieve net-zero carbon emissions by 2070.

The country has outlined aggressive plans to include green hydrogen in its energy mix. The focus was evident in the announcement to demonstrate hydrogen-fueled transportation. Prime Minister Narendra Modi has launched National Hydrogen Mission (NHM) on August 15, 2021. Within eight months of the announcement, the Government notified the Green Hydrogen Policy in February 2022. A month later, Union Transport Minister Nitin Gadkari, who has been championing alternative fuel, drove to the Parliament in a hydrogen-powered car. Minister's office explained on a social media platform that the move was aimed at spreading awareness about Hydrogen-based Fuel Cell Electric Vehicle technology and the benefits of a hydrogen-based economy in India.

Hydrogen had been spoken about for a long time before this, but it is only in the past couple of years that it has truly come into the spotlight in the context of a net-zero economy. Back in 2008, when I was working with Electrical Research and Development Association, hydrogen storage was a topic of academic interest, a topic that required more research & development before real-life applications could be identified. Now, 14 years later, Green Hydrogen is more than just theory; it is potentially the answer to many questions on how we can use alternate energy sources for our industrial and transportation needs. The UK, for instance, has introduced HydroFLEX, a hydrogen-powered train, as a part of its efforts to reduce its emissions. In November last year, there were reports abroad on the launch of a hydrogen-powered bike that's designed to take advantage of the higher energy-to-weight ratio offered by hydrogen fuel cells.

Now, as we gear up to celebrate "***Azadi Ka Amrit Mahotsav***" in India, it is clear that the transition to Green Hydrogen will be crucial in making our country ***aatmanirbhar*** on the energy front.

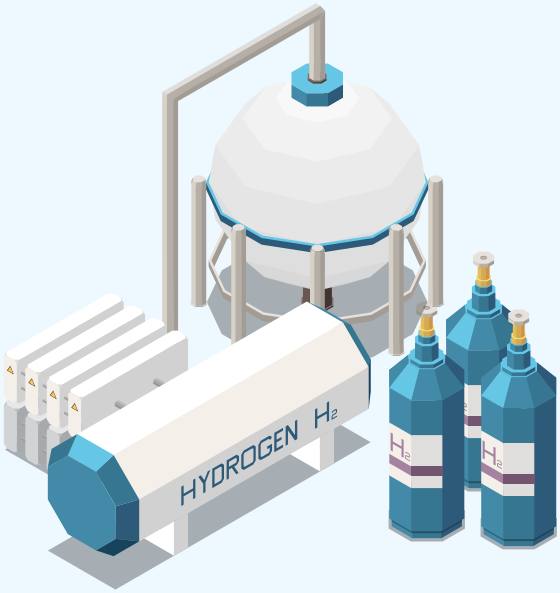
The Government of India has set a target of producing 5 million tonnes of Green Hydrogen by 2030. This is at once a challenge and an opportunity for the public and private sectors to find ways to produce Green Hydrogen for $1/kg and then develop wide-scale commercial solutions for our industrial needs. This might sound ambitious, but it is certainly doable. If we want inspiration, we need look back only so far as the Mars Mission, which we accomplished against all odds.

The co-existence and co-usage of renewable energy and Green Hydrogen will yield not just tangible environmental benefits such as net-zero and reduced emissions but also improvements in important socio-economic indicators such as health, gender neutrality, and employment, besides opening new opportunities for startups across the country.

In this newsletter, we have tried to examine different aspects of green hydrogen, including its potential, benefits, and avenues for swift adoption. For this, we have invited, as guest authors, both international and national experts who work on policy, commercial and well proven technologies.

The article '***Green hydrogen can reduce our imports dependence and mitigate emissions***' explores the myriad use cases of hydrogen and its economic and environmental benefits. In '***Three routes to Hydrogen adoption in rail,***' we look at how hydrogen can be a part of the rail decarbonisation journey. The article, '***Clean backup power solutions with hydrogen fuel cell systems***' talks about hydrogen as a clean alternative to traditional diesel and gas solutions for reliable backup power supply for data centres, hospitals and industrial applications. '***Exploring a solar - hydrogen based cooking system for remote, undeveloped and backward communities in India***' deep-dives into the potential of solar-hydrogen-based cooking systems. Finally, '***How will green hydrogen be a watershed moment for India's energy transition***' provides an overview of this highly versatile solution in decarbonizing various sectors.

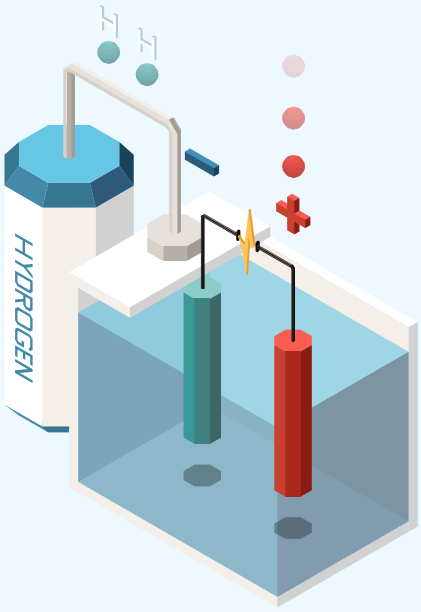
India has already taken a giant stride towards tapping the immense potential of hydrogen with the launch of the National Hydrogen Mission and the Green Hydrogen policy. I hope this newsletter will synergize the efforts of all concerned private and government stakeholders in achieving the climate targets we have set for ourselves.



HYDROGEN STORAGE

HYDROGEN -POWERED TRANSPORT

HYDROGEN GAS STATION



WATER ELECTROLYSIS

GREEN HYDROGEN CAN REDUCE OUR IMPORTS DEPENDENCE AND MITIGATE EMISSIONS

The Russia-Ukraine conflict and the resulting surge in prices of crude oil and natural gas have yet again highlighted the importance of energy security for developing countries like India. In FY2019-20, fossil fuels constituted more than 25 per cent of India's import bill. However, the foundations of India's economy cannot perpetually hinge on the vagaries of the oil-and-gas markets. Moreover, fossil fuels are responsible for the emission of greenhouse gases. In view of the need to decarbonise the economy, Green Hydrogen can allow India to reduce imports of fossil fuels and achieve the "***Panchamrit***" commitments made at COP26.

Green Hydrogen is obtained from water by using renewable energy and has wide applications in industry, mobility and power. It can be a viable option for long-range heavy-duty vehicles such as trucks and buses. Blending Green Hydrogen in natural gas pipelines in 15-20 per cent volume proportions can reduce natural gas consumption and CO_2 emissions. In the power sector, Green Hydrogen can complement battery storage in minigrid and microgrid applications.

National Green Hydrogen Mission: The first step in the right direction

In his 2021 Independence Day speech, India's Prime Minister announced the National Green Hydrogen Mission (NGHM). The government then notified the ammonia/hydrogen policy in February 2022 – the first step toward NGHM. Both the policy and the mission aim to reduce the cost of Green Hydrogen by creating demand for it and encouraging domestic manufacturing of components such as electrolysers.

The Green Hydrogen/ammonia policy notified targets of producing 5 MTPA of green hydrogen by 2030. Achieving this target would reduce India's liquefied natural gas (LNG) imports by 68 per cent, save INR 40,000 crore in import bills, and reduce India's GHG emissions by 1.6 per cent. The NGHM will also help achieve India's 500 GW non-fossil energy target since producing 5 MTPA of green hydrogen alone needs at least 100 GW of renewable power.

Green Hydrogen opens up export opportunities for India

There is a global surge in the use of Green Hydrogen across various end-use applications. According to the Council on Energy, Environment and Water (CEEW), about 33 countries have announced hydrogen missions or are developing national-level policies and strategies for hydrogen. In a net-zero scenario, the global demand for electrolysers is expected to be 850 GW by 2030. This opens up an export market worth INR 32 lakh crore, and India can carve out a healthy market share by foraying early into the manufacturing supply chains. The trade volumes for Green Hydrogen and derivatives like ammonia and methanol are also expected to increase. India is strategically placed to become an exporter of Green Hydrogen and its derivatives to large consumers of energy like Japan, Singapore and South Korea, who do not have enough cost-competitive renewable energy to meet their climate commitments.

Green Hydrogen-derived fuels can create significant refuelling opportunities for flights and ships originating from or transiting through India. The International Air Transport Association (IATA) has committed to net-zero by 2050. The enforcement of the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) and the Carbon Border Adjustment Mechanism (CBAM) could also provide an opportunity for India to blend sustainable aviation fuel in flights headed for the EU and other countries. The International Maritime Organisation, meanwhile, aims to halve greenhouse gas emissions by 2050. As ships need frequent refuelling, green ammonia as a maritime fuel could present India with significant refuelling opportunities.

Green Hydrogen mission faces many challenges

To succeed, NGHM will need heavy capital investments and easy access to huge amounts of affordable finance. Green Hydrogen blending in refineries and fertilisers will increase the retail price of petroleum commodities and fertilisers, which will impact citizens. Safety and regulatory standards for hydrogen are a prerequisite for single-window clearance of Green Hydrogen projects. Currently, there are none.

To reduce the cost of Green Hydrogen, the central government has waived interstate transmission charges for Green Hydrogen projects. However, the financial health of many state DISCOMs is not encouraging, and offering similar incentives, the interstate wheeling of renewable energy will be a challenge. On the export front, with countries like Australia, Saudi Arabia and Chile already establishing bilateral agreements with Europe and East Asia, India's prospects as a clean-fuel exporter will largely depend on its competitiveness with other countries.

The success of NGHM will depend on how well India overcomes the aforesaid challenges. A vibrant Green Hydrogen economy could greatly help India become atmanirbhar in energy supply and meet its panchamrit commitments. The Mission is, therefore, a step in the right direction and must be appreciated.

THREE ROUTES TO HYDROGEN ADOPTION IN RAIL

Countries around the world are trying to figure out effective and viable ways to decarbonize their industries and infrastructure. The UK, for one, has committed to reduce its emissions to net-zero by 2050. As a part of its efforts in this direction, it developed HydroFLEX, the country's first mainline hydrogen-powered train. Based on the Class 319 electric multiple unit, the HydroFLEX vehicle is fitted with hydrogen fuel tanks, a fuel cell, and battery pack to provide independent traction power capable of operation with zero carbon emissions.

Hydrogen offers significant potential to help decarbonise railway networks by replacing diesel power systems and eliminating emissions at the point of use. The advantages of using hydrogen as an alternative fuel are well-known. As early as 2008, the European Commission had identified hydrogen as one of the technologies that could help achieve a 60-80% reduction in greenhouse gases by 2050. Today, if you wish to use hydrogen as a part of your rail decarbonisation journey, there are three available pathways to choose from.

1. The Big Bang: Everything shiny and new

New trains powered by fuel cells from green hydrogen are a good solution, especially when battery power is insufficient for long distances or conventional electrification isn't financially viable.

However, this approach entails the additional cost of new trains and the fuel infrastructure to power them. Whilst hydrogen production serving only a rail site may be viable, investments work better when they are a part of a holistic strategy to share asset costs across rail and road transport.

Then, there are hidden costs. Replacing serviceable diesel trains and locomotives, perhaps midway through their 40-plus year lifespan, will entail balance sheet costs as diesel asset values reduce to near zero.

Building, maintaining, and repairing hydrogen systems, fuel cells, and battery energy storage will require reskilling the workforce. Furthermore, most commercial hydrogen available is seen as "dirty", being fossil fuel-based. Using renewables to generate hydrogen at scale is not yet a mature technology.

While several automakers are manufacturing vehicles on a commercial scale, and several train manufacturers are offering vehicles to the market, there are still many barriers to achieving hydrogen adoption through this method in isolation.

2. The Supernova: The birth of something new from something old

Existing rail fleets often contain a significant proportion of diesel rolling stock, which are environmentally unpopular. Moreover, this stock has long lifespans, leaving fleet owners with the challenge of dealing with assets that have their lives cut short by environmental pressures. The "Supernova" route to hydrogen adoption utilises retrofits existing diesel engines with hydrogen fuel-cells for emission-free operations. This solution can lower barriers to hydrogen adoption by enabling cost savings. Firstly, the cost of an entirely new vehicle is avoided. Secondly, the balance sheet impact is mitigated as vehicle and loco asset lives are not written off early. Thirdly, it yields savings on people investments, since the vehicle remains largely the same and doesn't require as extensive re-training as for a completely new fleet.

However, the challenges about hydrogen source and infrastructure investments, as mentioned in the Big Bang approach, still apply.

3. The Gravity Slingshot: Using the environment to speed up progress

Just like the gravity of planets enables us to slingshot spacecraft across the solar system, we can use the existing railway environment to propel the transition to hydrogen rail transport.

At any point in time, railways often have many diesel trains and locomotives with a long remaining lifespan. This fleet inertia can be seen as a costly barrier to large-scale hydrogen adoption. However, it can also be an opportunity to drive hydrogen adoption in an evolutionary manner rather than a revolutionary one, by burning hydrogen instead of diesel in existing engines. It is perfectly possible to create a Hydrogen Internal Combustion Engine (H_2ICE) and modify existing diesel engines to run on hydrogen.

Lowering many of the barriers to large-scale hydrogen adoption, this option reduces the initial upfront investment in vehicles. Instead of replacing entire drive trains, we are simply modifying existing engines. It also offers people-cost benefits, as the training requirements are much simpler. Like with the fuel-cell retrofit option, existing fleet lifetimes are preserved or extended instead of being cut short.