The role of Green Hydrogen in India's energy transition

India is at the crossroads of reducing its energy dependence through imports and addressing climate change. To help tackle these giant issues, India is betting its energy future on green hydrogen, which has the potential to reach less than $1/kg, thereby making India the least costly producer.

India has set an ambitious target at Glasgow COP26 to achieve 'net zero' by 2070. India has committed to reducing the total carbon emission reduction by 1 billion tonnes and the carbon intensity of the economy by 45% with a non-fossil fuel energy capacity of 500 gigawatt (GW) by 2030. To achieve net-zero, India must focus on non-fossil power sources, new mobility solutions, and industrial green hydrogen.

As per projections by the Council on Energy, Environment and Water-Centre for Energy Finance (CEEW-CEF)[1] report, in this scenario when fossil fuel is expected to peak by 2040, green industrial hydrogen production will be at 7 million metric tonnes per annum (MMTPA) by 2040 and 114 MMTPA by 2070 for India to be on track to achieve its net-zero target. This makes the role of green hydrogen in India's net zero journey critical.

Currently, most of India's 6 MMTPA hydrogen is grey, that is, it is mainly produced using natural gas in the refineries and fertilizer industries for captive purposes only.[2] By 2030, India's demand for hydrogen is expected to be approximately 12 MMTPA,[3] implying that green hydrogen could account for 80-100% of the additional requirement.

> **"Green hydrogen production target of 5 MMTPA by 2030 could displace around 11 MMTPA of natural gas or 25 MMTPA of coal, thereby avoiding 34 to 57 MMTCO2/ year by 2030."**

To bolster this energy transition effort, the Government of India launched the National Hydrogen Mission on August 15, 2021, with the aim of meeting its climate targets and making India a green hydrogen hub by taking the first step of setting up an ambitious target of producing 5 MMTPA of green hydrogen by 2030.[4] The mission helps set the path for achieving the key vision of '1-1-1' target, which is $1 per 1 kilogram in 1 decade. According to CEEW's analysis, India will need at least 40 GW of electrolyzers and 100 GW in renewable generation capacity by 2030[5] to meet the production target of 5 MMTPA. Studies estimate that this would require $103 billion in investments at current prices and around 50 billion litres of demineralized water supply.[6] Accenture's 'green hydrogen enabling framework' highlights the key elements that need to come together to make this a reality.

The figure explains how India's promise of green hydrogen to accelerate the transition can be achieved by focusing on six key enablers:

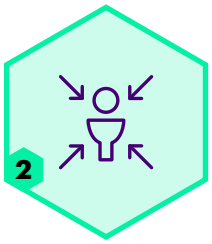
Figure 1: Accenture's Green Hydrogen Enabling Framework

Cheap and abundant renewable electricity and water supply

India must have abundant and affordable green electricity as well as a reliable de-mineralized water supply to ensure there is enough clean energy and water to produce green hydrogen.

Both of these are key drivers and prerequisites of the green hydrogen economy. India's renewable energy (RE) capacity accounted for 114 GW as of July 2022, representing 13% of the country's electricity generation.[7] To achieve its goal of 500 GW of non-fossil energy capacity by 2030, 300 GW installed capacity needs to be solar photovoltaic (PV) based. The capacity growth as of today remains below the required annual solar capacity build rate of 30GW to achieve this target. It is therefore critical that India must focus on building sufficient capacity to be able to spare capacity for green hydrogen while continuing to decarbonize the grid.

In addition, India is the largest groundwater user in the world with more than a quarter of the global consumption. With a growing economy and population, the water demand will increase further in the future. Given the rising demand for green hydrogen, India will need to find the right set of solutions through balanced investments in sustainable desalination, water processing technologies, among others, and policies that protect water availability for society and environment.



Demand

The demand for industrial green hydrogen in India is expected to be between 10-12 MMTPA by 2030, mainly driven by refinery and fertilizer, followed by cement, iron and steel, and chemical sectors.

The primary focus for green hydrogen capacity building and utilization should be replacing the existing grey hydrogen in 'hard-to-abate' sectors such as oil and gas (O&G), iron and steel, chemicals, and cement, which contribute approximately 20% of the overall greenhouse gas (GHG) emissions[8] in India. If India manages to achieve its target and sustains the required capacity building till 2070, it can produce 5% of the global demand by 2030 and 20% by 2070.

Accenture's analysis suggests that for first mover companies in areas such as fertilizers (that produce ammonia using hydrogen as a process requirement), the adoption of green ammonia production could result in a green premium between 10% to 50%, which seems steep to be passed on to farmers and consumers without impacting food security. The potential impact on food commodity price can be between 3% to 26%. Therefore, significant policy measures are needed to create a differentiated, protected, and economically viable market for the first mover companies. It is also critical to stroke demand in the right sectors, such as to avoid the immediate adoption of hydrogen 'as-fuel' for short-to-medium range vehicles.

This will result in a dismal destination efficiency of 18% (at lowest) to 37%[9] (at highest) due to losses across the value chain. Effectively, for every GW of capacity used for green hydrogen as a fuel today, less than one GW is available to directly produce decarbonized electricity. Over the years, if India establishes a thriving hydrogen economy, it could explore building capacity for export to meet green hydrogen demand for countries without the required infrastructure and improve its balance of trade.

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Transmission and Distribution Infrastructure

Hydrogen transmission and distribution infrastructure requirements such as pipelines, liquefaction plants, trucks, storage facilities, and compressors are similar to that of natural gas.

In the context of pipelines, for perspective, the United States of America (USA) today has about 2,000 miles of dedicated hydrogen pipelines compared to 2 million miles of natural gas pipelines. India has a natural gas pipeline network of about 17,000 km long and will require an additional 35,000 km network to help natural gas reach 15% of India's primary energy mix. For green hydrogen, we need to develop a network of dedicated hydrogen pipelines to connect renewable-rich regions across the country with industrial clusters for wide transmission and availability. This would be in addition to blending hydrogen at a certain percentage in the natural gas pipeline network. Storage infrastructure will be required to be developed with a focus on surface infrastructure given that India has not yet invested in geological storage at scale.

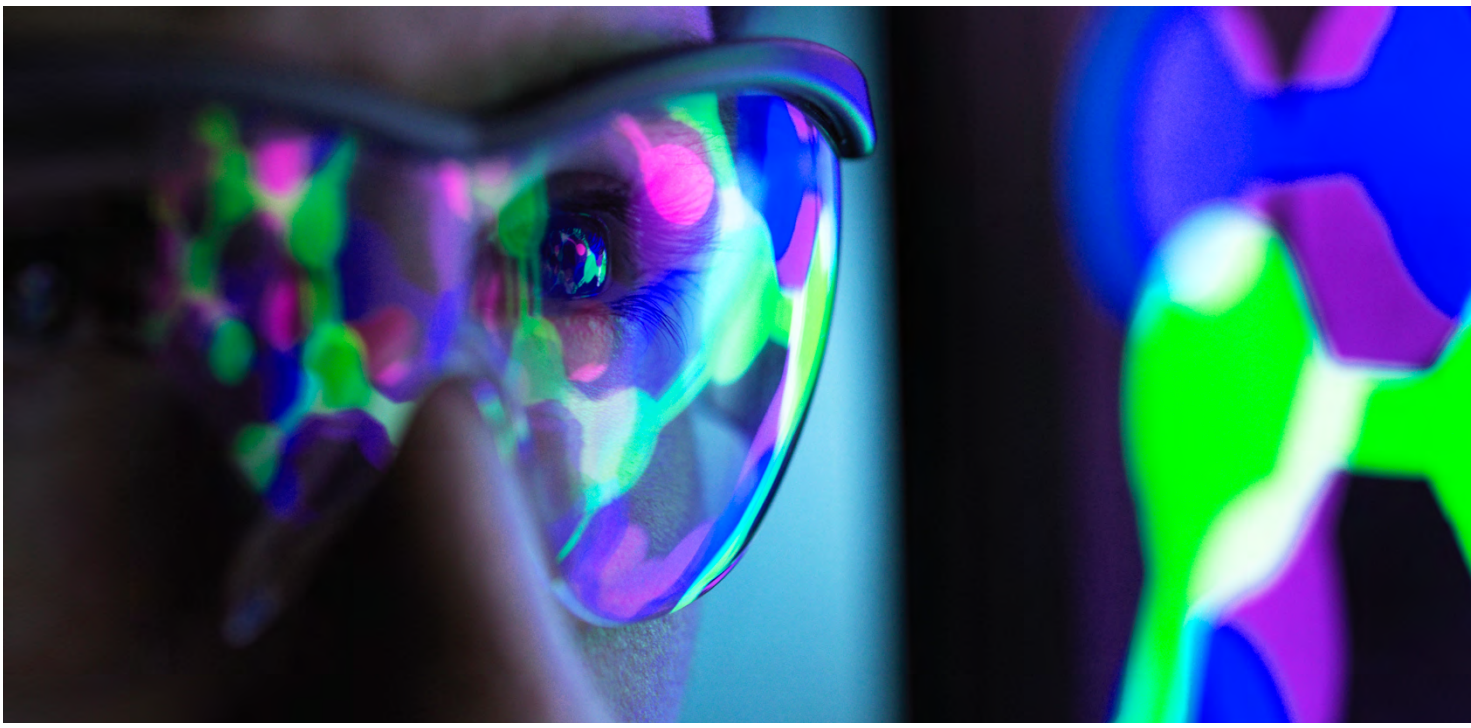
In addition, hydrogen is easy to leak, can cause embrittlement in standard pipes, and must be stored at high pressure for sufficient volumes. To ensure safety in operations, the adoption of new pipeline materials like Fiber Reinforced Polymer (FRP) and the latest compliance with hydrogen specific safety standards and certifications for equipment in production, distribution (via pipelines/trucking or shipping), and storage must be created and adhered to.

4 Technology and Innovation

Electrolyzers form a large part of the total cost of hydrogen production. Today, it constitutes about 33% to 57% of the total cost of hydrogen production, depending on the technology used and its sourcing.

The remaining cost is divided between renewable electricity, transmission, and storage costs. The cost of green hydrogen today is 4.5- 5.5 $/kg. To achieve the 1-1-1 target, in addition to cheap available renewable power, the electrolyzer stack life must double and its efficiency must improve up to 80% from the current 66.5%, resulting in the overall cost reduction. This can be enabled through the development of technology partnerships, research and development (R&D) programs, and focus on internalizing the electrolyzer manufacturing and associated supply chain levers.

For India, prioritizing R&D capital allocation and upskilling capabilities focused on green hydrogen will be critical. According to the Ministry of New and Renewable Energy, the government will allocate $21.5 million for R&D focused on green hydrogen by 2024.[10]



Policy

The task of setting up a flourishing hydrogen economy will require urgent and critical policy interventions. Currently, there are 30 major projects in India with an announced capacity of ~280,000 (MT)/year.

However, most of the announced projects are still in the preliminary stages, and only approximately 8,000 MT/year of capacity will be available by 2024. The planned capacities so far will require unprecedented growth, that is ~20x announced capacities to meet the target of 5 MMTPA of green hydrogen production by 2030, which in turn will require massive investments and a conducive policy framework within a short timeframe. With policy interventions in the form of the first set of green hydrogen announcements in February 2022,[11] the following are the key highlights:

1. Green Hydrogen/Ammonia manufacturers to purchase renewable energy from the power exchange or set up renewable energy capacity anywhere.
2. Open access to renewable energy will be granted within 15 days of the receipt of the application.
3. 25-year waiver of inter-state transmission charges for the projects commissioned before June 30, 2025.
4. Set up bunkers near ports to store green ammonia for export and use by the shipping sector.

In addition, we need policy interventions focusing on electrolyzer manufacturing and associated components through Production Linked Incentive (PLI) schemes as well as for driving domestic production by introducing certain mandatory consumption rates for green hydrogen fertilizers and refineries.

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Finance

To gallop towards the ambitious green hydrogen targets, the necessary capital will need to be activated through grants, sovereign green bonds, and global climate finance commitments, where the government can play a key role in early market development.

As per CEEW analysis, the industrial green hydrogen (not considering the investment in RE capacity) will require an investment of approximately 1,500 billion USD for India over the years till 2070 for achieving its net-zero target, resulting in 114 MMTPA industrial green hydrogen capacity.

The green hydrogen national strategies of Japan and the European Union (EU) are the early adopters of global climate finance commitments and government grants which have helped them build momentum for their respective green hydrogen targets and India can certainly borrow a leaf from their experience.

Given these key enablers, we must acknowledge where we are today and what lies ahead. If we compare the national hydrogen strategies of various countries with that of India, Japan established the hydrogen vision much earlier in 2017-18 than other countries and introduced early policy interventions and investments. The EU and most European nations framed their targets and policy interventions for green hydrogen in 2020 during the COVID-19 pandemic.

India, despite a delayed start in 2021, has an inherent advantage of low-cost renewable energy power generation, which combined with the right policy and investment interventions can catapult the green hydrogen mission.

Indian companies have responded well to this opportunity. For instance, Reliance Industries Limited has announced a project with a commitment of $75 billion for creating infrastructure specifically for producing green hydrogen at scale and to competitive against grey or blue hydrogen by 2030. In the meanwhile, it will reuse its refinery plants to convert the existing hydrogen production capacity of 1.06 MMTPA of grey hydrogen to blue hydrogen. With the detailed second set of green hydrogen policy interventions expected to be presented by the end of 2022, some of the key teething issues to help internalize the hydrogen value chain shall be addressed. But the core of the message is clear – a massive opportunity that awaits precise and swift actions.

Figure 2: Comparison of selected national green hydrogen targets, installed capacities and government announced investments, Accenture Research

	Installed capacity & electricity cost (present)				Green H2 commitments 2030			
	Total installed capacity (GW	Renewables' installed capacity (GW)	% Capacity RE	Electricity cost (USD/ KWh)	National H2 strategy announcement	Planned RE capacity (GW)	Electrolyzer capacity (GW)	Government investment committed
India	452	134	30	0.0475	2021	500	15	USD$0.18Bn
EU	980	438	46	0.150*	2019-20	1323	40	USD$4.3Bn
Germany	234	131	56	0.078	2020	330	5	USD$10.3Bn
France	136	55	40	0.090	2020	75	6.5	USD$8.3Bn
Portugal	21	14	66	0.185	2020	17	2.5	USD$1Bn
Japan	351	103	29	0.111	2017-18	136	20	USD$6.5Bn
Spain	110	59	54	0.052	2020	154	4	USD$1.8Bn
Netherlands	42	17	41	0.134	2020	38	4	USD$0.08Bn

Source: IRENA 2021, GH2, TERI, Bloomberg NEF, ResearchGate, EVwind, Various Govt. Websites[12,13,14]

Way forward

The 2030 mammoth green hydrogen production target can only be achieved with technology deployment through the cooperation of public and private enterprises, along with policy and economic support from the government.

Following are the steps that Indian enterprises will need to take to ensure that they are on track to maximise this opportunity:

Energy transition roadmap: Industries specifically oil and gas, cement, iron, and steel among others, require a strong alignment of their energy transition roadmap with their strategy, so that their transition to green hydrogen is embedded in their business growth plans.

Capital efficiency: Companies should evaluate their investments in electrolyzers and renewable projects with detailed technology and commercial risk assessment. Effective capital project management through digital technologies can help optimize both time and budget. Companies should adopt a 'set-measure and track' philosophy commencing from the design stage itself.

Pricing: An 'internal carbon price' strategy will help companies make wise capital allocation decisions towards building their renewable energy portfolio and investment towards green hydrogen projects.

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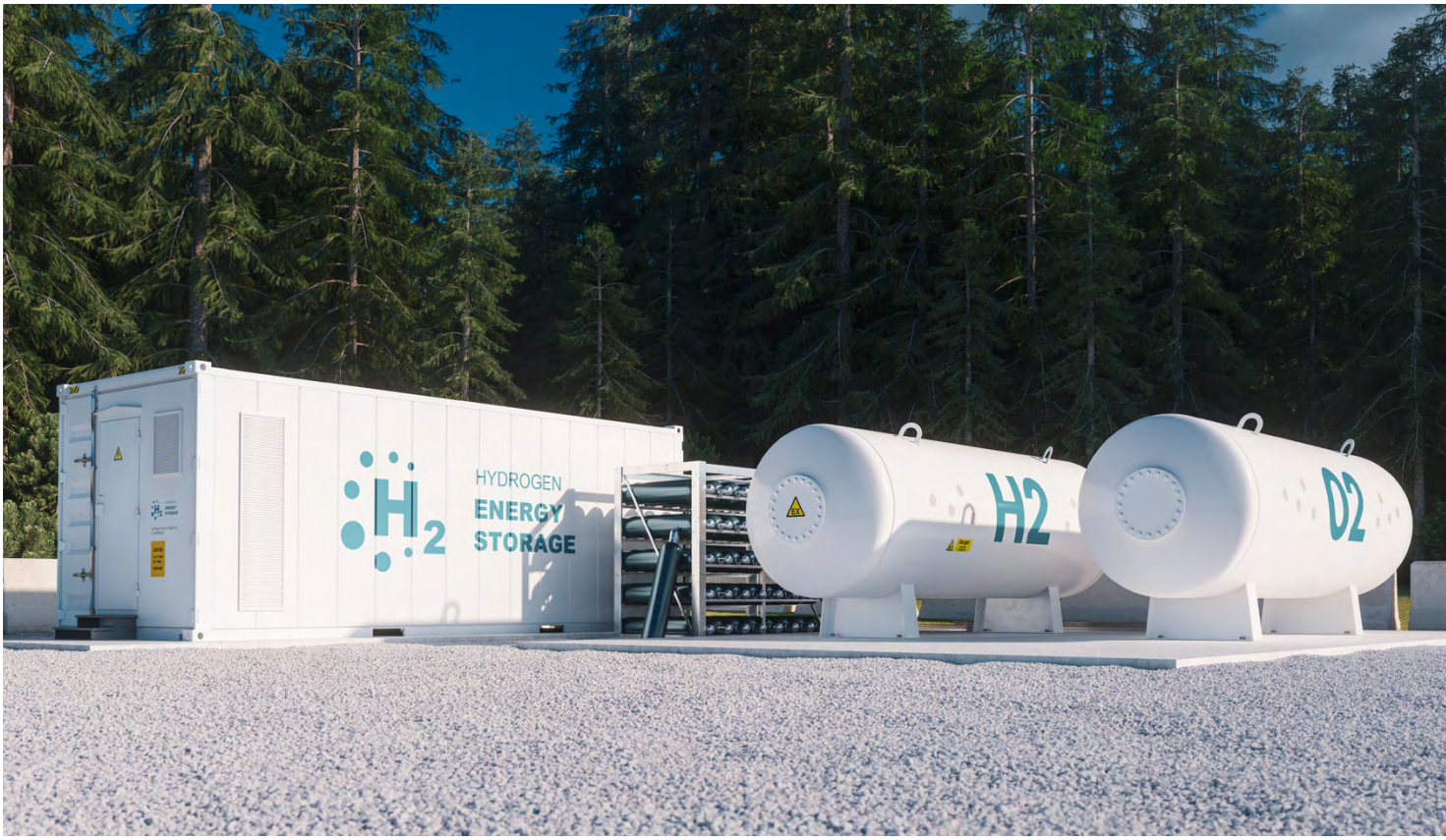
At Accenture, we work closely with our partners to help our clients achieve their sustainability objectives and deliver value-led outcomes. We work with diverse partners - from the largest software and cloud companies to small, disruptive innovators. We also work with global organizations such as the International Renewable Energy Agency (IRENA),[15] World Economic Forum (WEF)[16(i),(ii),] United Nations Global Compact (UNGC), and World Business Council for Sustainable Development (WBCSD). In addition, we have made strategic minority investments in businesses such as Arabesque S-Ray to accelerate our clients' ability to benchmark and evaluate sustainability impact, and Reactive Technologies to help utilities accelerate the transition to low-carbon energy.

Accenture has been playing a key role in providing solutions to the natural gas transmission businesses worldwide with its strategy, Industry X, and customer-end/enterprise solutions. The hydrogen distribution and storage requirements will require a more sophisticated approach and Accenture's extensive experience in natural gas distribution and storage shall serve as a natural extension to host the right capabilities and experience for value realization to its clients moving towards their green hydrogen led transition.



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Authors

Hari Shankaranarayanan
Managing Director,
Lead - Energy, Accenture in India

Preeti Kaushal
Managing Director,
Lead - Sustainability, Resources,
Accenture in India

Ankesh Nagar
Business Strategy Consultant –
Energy, Accenture in India

Key contributors

Areena Makker, Business Strategy Analyst –
Energy, Accenture in India

Prakriti Dinesh, Business Strategy Analyst –
Energy, Accenture in India

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