Vibrant GUJARAT 10-12 Jan 2024
Gateway to the Future | 10th Global Summit

WHITE PAPER ON

GREEN HYDROGEN POLICY IN GUJARAT STATE

UNVEILING ON: 12TH JANUARY 2024, MAHATMA MANDIR, GANDHINAGAR, GUJARAT

H_2 GREEN HYDROGEN GENERATION

Energy Perspective

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List of Abbreviations

BEV	Battery electric vehicles
FCEV	Fuel Cell Electric Vehicles
GH	Green Hydrogen
GHG	Greenhouse Gases
GOG	Government of Gujarat
GEDA	Gujarat Energy Development Agency
GA	Green Amonia
GAIC	Gujarat Agro Industries Corporation
GSECL	Gujarat State Electricity Corporation Limited
GPCL	Gujarat Power Corporation Limited
IEA	International Energy Agency
MOSPI	Ministry of Statistics and Programme Implementation
MMTPA	Million Metric Tonnes Per Annum
NITI	National Institution for Transforming India
NDC	Nationally Determined Contributions
NAPCC	National Action Plan on Climate Change
NGHM	National Green Hydrogen Mission
PPP	Purchasing Power Parity
RE	Renewable Energy
REC	Renewable Energy Certificates
R&D	Research & Development
RTC-RE	Round The Clock Renewable Energy
SAPCC	State Action Plan on Climate Change
UNFCC	United Nations Framework Convention on Climate Change

Executive Summary

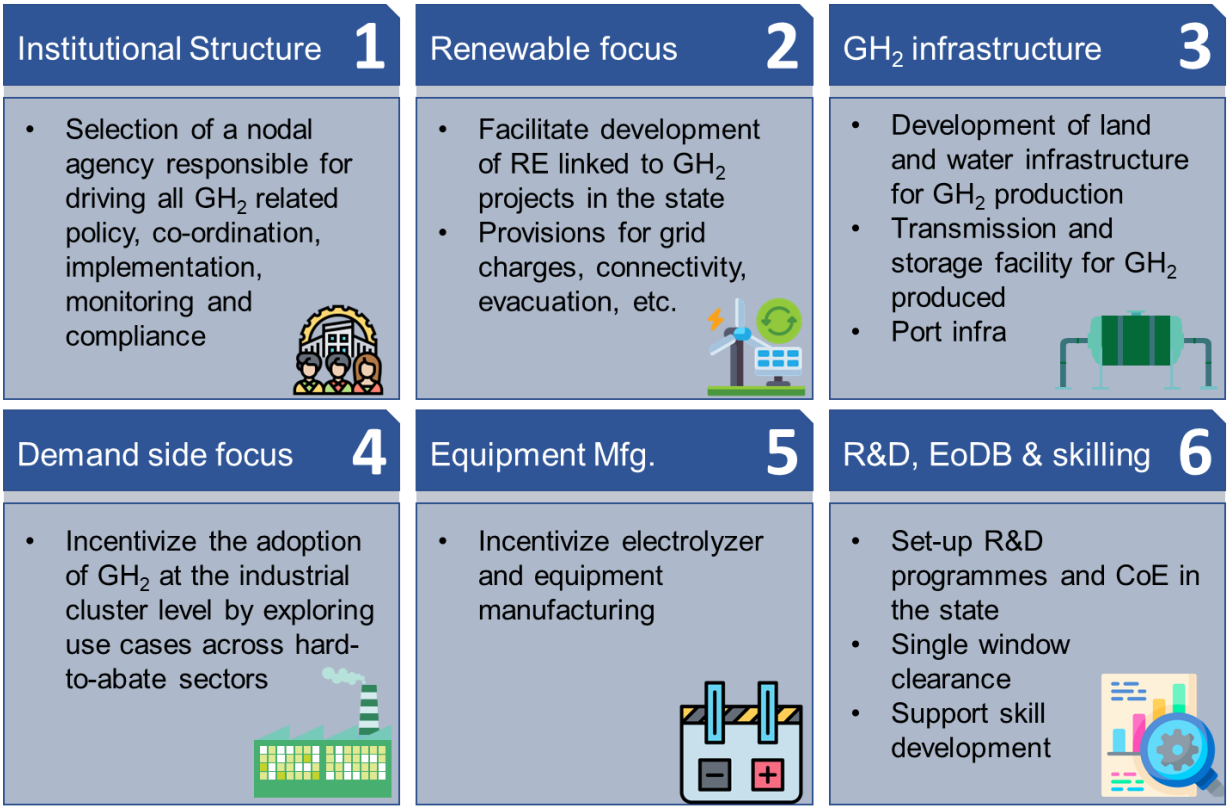
India, facing surging energy demand and being the third-highest global emitter, aims to achieve net-zero by 2070 through the "Panchamrita" strategy, emphasizing a non-carbon intensive approach. Green Hydrogen (GH) emerges as a pivotal focus globally and domestically, leveraging India's abundant renewable resources. Despite a historical dependence on coal and oil, India's transition to green hydrogen is seen as essential to reduce import reliance and cut GHG emissions. The nation's ambitious climate targets for 2030 and beyond align with global efforts, necessitating a shift to a low-carbon economy. However, challenges include high dependence on fossil fuels, particularly coal and petroleum products. The growing renewable energy sector in India, marked by falling prices, positions the country favourably for cost-effective green hydrogen production. The surge in energy demand, especially in key sectors like industry and urbanization, underscores the need for a transition to green hydrogen. Various sectors, including refining, ammonia, methanol, steel, and transportation, present distinct opportunities for green hydrogen adoption. The report emphasizes the twin-fold objective of ensuring affordable and reliable energy while reducing dependence on fossil-based energy. The focus on unlocking green hydrogen opportunities in Gujarat is highlighted, showcasing benefits such as sectoral decarbonization, enhanced energy security, and the creation of a green tech manufacturing hub. The assignment seeks to support policy formulation for green hydrogen production, storage, transport, and usage in the state, aligning with international best practices.

The second chapter covers the current challenges being faced by developers/investors in the sector as well as the steps taken at the national and sub-national level to promote Green Hydrogen in India. India is actively promoting the growth of its green hydrogen sector through national and state-level initiatives, including the National Green Hydrogen Mission (NGHM) and state-specific policies. The NGHM, with an investment of INR 8 lakh crores by 2030, aims to position India as a global hub for green hydrogen production and usage. Several states, such as Maharashtra, Uttar Pradesh, Andhra Pradesh, Gujarat, and others, have formulated or are in the process of formulating their green hydrogen policies, emphasizing production targets, incentives, and infrastructure development.

The recent release of the Renewable Energy Policy 2023 and Land Policy for Green Hydrogen reflects Gujarat's commitment to fostering GH initiatives. Additionally, the Aatmanirbhar Gujarat Scheme for Industry Assistance provides substantial incentives, positioning GH as a thrust sector. The state's strategic advantage includes extensive industrial clusters, upcoming investment regions, and progressive policies, making it a promising hub for GH development. A comparison of Gujarat's current state level initiatives with the action items provided in the GH state level initiatives in India's other states revealed the following gaps:

- While Gujarat has a comprehensive RE policy in place, which came out in 2023, ***there is currently no mention of any specific provisions for RE required for production of GH in the state***.
- There is currently no policy provision for expansion of transmission infrastructure for development of GH/GA production
- Development of GH/GA industrial clusters can be key for ramping up its production within a state and take a first mover advantage in the ecosystem. While not explicitly mentioned in its current policies, ***Gujarat may consider GH Park/Valley in key locations for improving manufacturing competitiveness of focus sectors***
- ***GH production requires large amounts of water and provision of water for such projects is key for sustainability in the long term. This is currently missing in the policy provisions of the state***
- Gujarat can replicate what it has done in the past to attract industries in its state by formulating a smooth application to clearance process for such projects, which is currently not covered in its policies.

The last chapter takes the learnings from the previous chapters and outlines six pillars of policy support options that Gujarat can look into, including the recommended actions across those pillars.



Recommended actions across the policy support pillars

The table below covers the specific action points across the policy support options mentioned above. The actions have been categorized under 3 heads, immediate (0-1 years), short term (1-3 years) and medium term (3-5 years). Since green hydrogen landscape at the international, national, and sub-national level is at nascent stage, policy actions for long term (>5 years) are not considered here.

Policy support options	Recommended action points		
	Immediate Term (0-1 years)	Short Term (1-3 years)	Medium Term (3-5 years)

Institutional structure	• Setting up of a state level modal agency which will be responsible for:
	  ○ Policy implementation, monitoring and measurement activity
	  ○ Co-ordination with central government ministries on regulations, mandates, certifications, production, storage, delivery and usage of green hydrogen
		• Nodal agency to facilitate mapping of resources such as land, water, Renewable Energy, transmission infrastructure etc. at identified potential sites/clusters for the development of Green Hydrogen hubs through relevant State authorities.
		• Nodal agency to facilitate the planning and allotment of government land/water/transmission infrastructure through relevant State authorities for Green Hydrogen Projects	

Renewable energy focus	• Exemption from intra state transmission charges and wheeling charges for a defined period from the date of commissioning of green hydrogen project • Exemption from cross-subsidy surcharge and additional charges • Unrestricted banking to be allowed on a monthly basis for RE projects linked to green hydrogen projects • Banking charges not to be levied for a defined period from the date of commissioning of green hydrogen project	• Support in establishment of appropriate evacuation facility for RE power for green hydrogen projects • Identification of high potential sites for the development of offshore wind energy projects and formulate guidelines for the allocation of such sites to the prospective green hydrogen and green hydrogen project developers	• Capex subsidy for offshore wind projects linked with green hydrogen projects • Exemption from intra state transmission charges and wheeling charges for a defined period from the date of commissioning of green hydrogen project • Exemption from cross-subsidy surcharge and additional charges • Support in establishment of appropriate evacuation facility for offshore wind for green hydrogen projects
GH_2 infrastructure	• Allocation of land as per waste land policy 2023 (already notified) • Exemption on local body land taxes, stamp duty and registration charges for land acquisition and or leasing of land for eligible green hydrogen projects	• Exemption on conversion charges payable for change of land use and conversion of land for eligible green hydrogen projects • Development of large-scale water desalination	• Facilitate the development of hydrogen refuelling stations • Upgrading the port infrastructure for handling green hydrogen and its derivatives

Policy support options	Recommended action points		
	Immediate Term (0-1 years)	Short Term (1-3 years)	Medium Term (3-5 years)
	• Identification and facilitation of the development of water infrastructure for Green Hydrogen Projects. • Guidelines for the allocation of water resources to the prospective Green Hydrogen Project developers • Identify potential regions and clusters near the existing use-case locations for the development of green hydrogen hubs to support large scale production and utilisation of green hydrogen and its derivatives • Facilitate the formulation and implementation of rules, regulations, certifications, and safety standards for the storage and transportation of green hydrogen and its derivatives • Facilitate the approvals and clearances for setting up common infrastructure such as bulk storage and pipeline for transportation of green hydrogen	plants located near the coastline • Development of demineralization plants and water softening/processing plants near the desalination plants as well as existing and future industrial water sources • Facilitate the development of green hydrogen hubs in the coastal areas near the ports for exports of green hydrogen and its derivatives • Facilitate approvals and clearances for the distribution of green hydrogen and derivatives products through the local network of pipelines, high-pressure tube trailers, and liquified hydrogen tankers	shipments (bunkers, pipelines, etc.)
Demand side focus	• Undertake pre-feasibility studies for sectors where green hydrogen can replace grey/blue hydrogen in the short-medium term • Identify key industries within those sectors where initial pilot cases can be run for this fuel switch • Based on learnings from case studies (within state, other sub-national pilots and international experience) define subsidy levels for usage of green hydrogen in the industry	• Per tonne usage subsidy for pre-defined set of years from the date of commissioning of green hydrogen projects linked to hard to abate sectors where grey/blue hydrogen is already in use and shift to green hydrogen can be envisaged	• Subsidies for a pre-defined number of re-fuelling stations to be set up within the state. The subsidy would be applicable for the set of components for the refuelling station such as hydrogen storage tank, hydrogen compressor, refrigeration unit, dispenser, hose and nozzle unit, etc.
Equipment manufacturing	• Electrolyser manufacturing facilities, green hydrogen Project related other plant & equipment manufacturing facilities, manufacturing facilities for plant & equipment related to green hydrogen derivatives, and renewable energy plant & equipment manufacturing facilities shall be treated as	• Guidelines for the allocation of land in such manufacturing hubs as identified in the immediate term • Guidelines for statutory clearances for setting up of manufacturing hubs as identified in the immediate term	• NA

Policy support options	Recommended action points		
	Immediate Term (0-1 years)	Short Term (1-3 years)	Medium Term (3-5 years)
	eligible industries under the Gujarat Industrial Policy 2020 and incentives available to industrial units under Gujarat Industrial Policy 2020 Shall be made available to such facilities • Identification of land for dedicated manufacturing hubs for electrolyser, green hydrogen projects related to other plants & equipment, plant & equipment related to green hydrogen derivatives and other associated components	• Development of dedicated manufacturing hubs for electrolyser, green hydrogen projects related to other plants & equipment, plant & equipment related to green hydrogen derivatives and other associated components	
R&D, Ease of Doing Business (EoDB) and Skilling	• Assist in identification and pre-feasibility studies for green hydrogen pilot projects as highlighted in the previous policy support options. This is to be taken up by government research institutes, educational institutes and private sector and provide fiscal incentives for such programmes on a case-to-case basis • Set-up a single window clearance facility for approvals of green hydrogen and RE linked to green hydrogen projects. The single window clearance facility will take care of: o Facilitate all statutory clearances and permissions from the concerned agencies/state authorities for green hydrogen projects and all associated project o Define the mechanisms for raising and resolving grievances o Single point of contact for all approvals/processes established under the single window clearance o Facilitate environmental clearance on priority • Facilitate the capacity building of State authorities through international cooperation and coordination between various public and private sector entities	• Co-ordinate with ITIs/diploma institutes/engineering colleges to design courses and impart training on the green hydrogen ecosystem in partnership with the industries • Support women participation in educational courses and trainings for the green hydrogen ecosystem through IT Is/diploma institutes/engineering colleges/skill development centres	• Facilitate the development of dedicated skill development centres, focusing on the green hydrogen value chain including renewable energy plant & equipment manufacturing, electrolyser manufacturing, ancillary component manufacturing, project installation and operations & maintenance activities, safety & handling of green hydrogen for consumption etc. through partnership between relevant State authorities, academia, and industries.

The hydrogen demand in India is currently estimated at approximately 6.9 MMTPA, with 53% utilized in petroleum refineries and 44% in fertilizer plants. Gujarat specifically contributes to this demand, consuming an estimated 2.03 MMTPA of Hydrogen in the refineries and fertilizers sector. The NGHM is targeting to build capabilities to produce at least 5 million Metric Tonnes (MMT) of GH per annum by 2030 and envisages the addition of 125 GW of Renewable Energy (RE) generation capacity. Since the state's current share is of 30%, at least 1.5 Mn tonnes of green hydrogen production will be required in Gujarat by 2030, the economic potential of which can be:

Adoption of Green Hydrogen as a fuel source and manufacturing opportunities from electrolyser in Gujarat can result in ***2.4 lakh crore in total investments*** *and potential for* ***creation of 1.8 lakh jobs****. An expected* ***reduction of a cumulative 30 thousand crore worth of fossil fuel imports by 2030*** *can contribute to reduction in dependence on import of fossil fuels*

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1. Green hydrogen as a catalyst for India's Net Zero ambitions

India's growing energy demand is expected to have far reaching implications for the global energy markets in the coming years. The Government of India (GoI) has introduced several reforms in the energy sector while ensuring access to electricity to millions that were earlier underserved. India has been on a path of consistent economic growth, notwithstanding the impact COVID-19 had on global economies. While coal and oil have served as the foundation of its economic prosperity and industrial growth, this has also meant that India's CO_2 emissions have been rising steadily, making India the 3rd highest emitter in the world. However, when looking at the CO_2 emission per capita metric, India is at the bottom of the pile of largest polluters.

With the announcement of the Prime Minister's "Panchamrita" – a five-fold strategy for India to play its part in helping the world get closer to the 1.5º Celsius target at COP26, India looks to counterbalance the ever-growing energy demand of the country with a non-carbon intensive approach to fulfil the same.

Globally, green hydrogen, a source of clean energy and industrial feedstock, is now becoming the key focus of international climate agenda as the cumulative of all the Nationally Determined Contributions (NDC) fall way short of the required reductions in global GHG emissions needed to limit global warming below 2°C by the end of the century.

India is endowed with abundant renewable energy resources, but tariffs for power generated from these sources are falling. The hydrogen production technologies are fast evolving and expected to get cheaper due to a surge in global demand. For India's energy transition to clean fuels, adoption of green hydrogen to generate energy would bring in significant benefits. The transition to a hydrogen economy will not only reduce India's import dependency on hydrocarbon fuels but also provide clean air to its citizens and reduce GHG emissions in absolute terms.

1.1 India's ambitious climate targets for 2030 and beyond

The UK hosted the 26th UN Climate Change Conference of the Parties (COP26) in Glasgow from 31 October 2021 to 13 November 2021. The COP26 summit ("the Summit") brought parties together to accelerate action towards the goals of the Paris Agreement and the UN Framework Convention on Climate Change. The Government of India made its pledge towards achieving "net zero" by 2070. India recently submitted its updated NDC to the UNFCCC with the following commitments[1]:

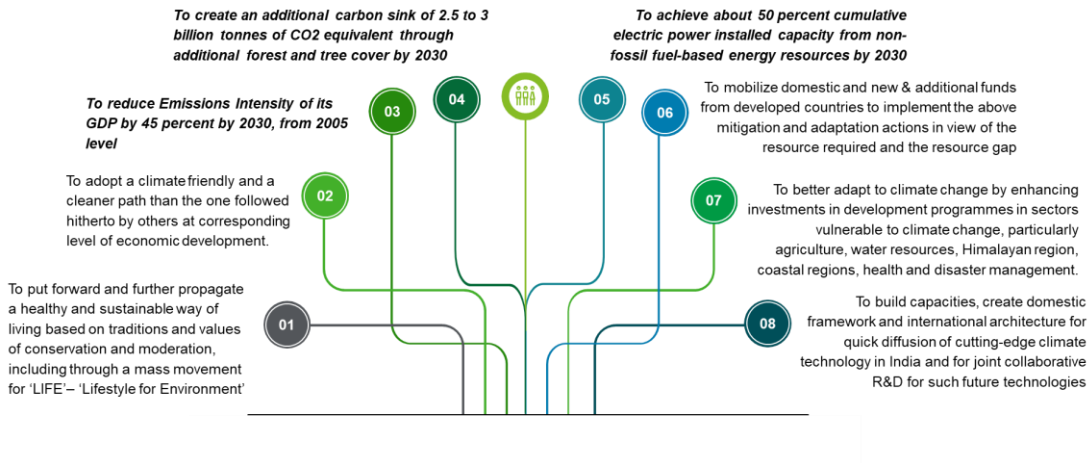

Figure 1: India's updated NDC commitments

[1] Source: https://unfccc.int/sites/default/files/NDC/2022-08/India%20Updated%20First%20Nationally%20Determined%20Contrib.pdf, accessed on 30th November 2023

To facilitate achieving these targets, it is important that India considers energy transition to a low carbon economy and break out from the two-century old historical paradigm since the industrial revolution where economic development was predicated upon the availability of cheap energy. This task gets compounded when we factor in the fact that the world is still to recover fully from the pandemic. While demand in the developed countries and China has picked up, developing countries will take more time to recover. The economic resources for making the transition will be difficult for them to muster on their own.

1.2 India's primary energy basket: high dependence on fossil fuels

India is one of the largest producers and consumer of coal in the world. Though there was a small decline of nearly 5% during FY21 the consumption has been steadily rising over the past several decades. The total availability of coal in FY21 stood at 956 million tonnes, out of which 75% was produced domestically and rest was imported.

There has been an increasing trend in the net import of coal in the recent years. Net Import of coal steadily increased from 100 million tonnes in FY12 to 217 million tonnes in FY15 and has stayed at these levels ever since. This dependence on coal is further expected to go up as India has repeatedly iterated plans to achieve domestic coal production of over 1 billion tonnes by FY24 with coal blocks being auctioned to private companies to boost domestic production[2]. This is in line with plans expected for commissioning of new coal fired plants in India (7 GW in FY23), the largest the largest such addition since FY18.

Petroleum products consumption has also experienced a steady growth over time. From 148 million tonnes during FY12 to 214 million tonnes during FY20 thereby recording a growth of 45% over a 9 year[3] period. Among all the products the High-Speed Diesel (HSD) accounted for 37% of total consumption. This was followed by Petrol (15%), LPG (14%) and Pet Coke (8%) respectively. Imports of crude oil have increased from 171 million tonnes during FY12 to 226.95 million tonnes during FY20. While import reduced to 198 million tonnes in FY21 on the back of Covid-19, the overall CAGR of net imports of crude oil in the last ten years from FY12 to FY21 has seen to have a growth rate of ~2%.

As per India's energy statistics publication[3] by Ministry of Statistics and Programme Implementation (MoSPI), during FY21, **energy generated from coal accounted for about 73% of the total generation** (in Petajoules) followed by crude oil (9%) and electricity from hydro, nuclear and other renewable energy sources accounted (8%) (natural gas and lignite usage make up the rest 7% and 3% respectively).

The application of coal as the primary choice of energy in the Indian power sector as well as for process usage in core industries has been the prevailing practice. **Electricity sector remains the biggest consumer of raw coal and lignite in India** with this sector consuming as much as ~65% of the total available (produced and imported) coal and ~85% of total consumption of lignite in India[3]. Coal also plays a significant role in India's industrial base because it is the main fuel underpinning a sizeable steel manufacturing capability and a growing cement industry.

The share of natural gas in India's primary energy mix has largely remained flat in recent years at around 6%-8%, overall energy demand has risen rapidly, and there have been significant shifts in demand for natural gas in specific sectors of the economy. The use of natural gas as a fuel in industry has increased about tenfold since 2010, against the background of an overall 50% increase in energy use in the sector.

[2] Source: https://www.spglobal.com/commodityinsights/en/market-insights/latest-news/coal/060322-india-expected-to-commission-10-thermal-coal-power-plants-in-2022-23-add-7010-mw#:~:text=India%20expected%20to%20commission%2010,MW%20%7C%20S%26P%20Global%20Commodity%20Insights, accessed on 09th December 2023

[3] Source: https://mospi.gov.in/documents/213904/1606151//Energy%20Statistics%20India%202022l644825594802.pdf/aed59aac-4d5a-995b-1232-bb68397cd873, accessed on 05th December 2023

1.3 India's rapid RE growth bodes well for green hydrogen production

India's energy mix has been seeing a shift from more conventional resources of energy to renewable sources with solar and wind having shown tremendous growth in the recent years. Over the past five years, solar PV capacity has grown at an average rate of around 60% and wind capacity of around 10%, outpacing the 7% growth in overall installed capacity. This rapid growth reflects government policy support and falling equipment costs. India's total renewable energy installed capacity (excluding hydropower above 25 MW) surpassed the 100 GW mark in August 2021, and currently stands at 179 GW[4].

The policy actions that have facilitated the growth of grid-connected renewables include reverse auctions resulting in progressively falling prices, lower corporate tax rates for developers, renewable purchase obligations mandating utilities to procure a certain minimum purchase of renewable power, investment in transmission infrastructure, and support for solar parks that help reduce project development and land acquisition risks.

While the cost of renewable energy has declined globally as shown earlier, in India it has fallen to a whole new level – India currently has access to among the cheapest renewable energy in the world. A major contributor has been the development of a highly competitive clean energy auction market that allows energy to be freely traded amongst market players.

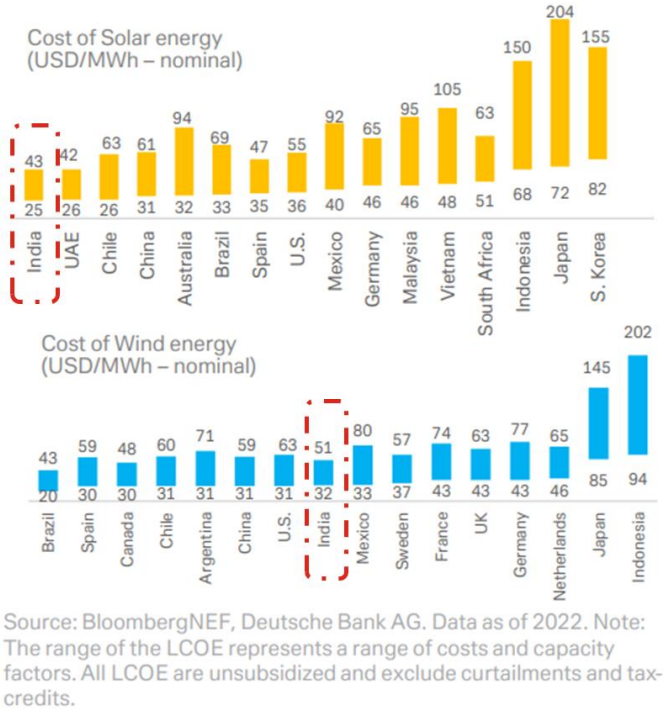

Figure 2: Falling RE prices in India

Falling RE prices and increasing RE installed capacity Y-o-Y will play a big role in making green hydrogen production cheaper in India as compared to other geographies.

[4] Source: https://www.investindia.gov.in/sector/renewable-energy#:~:text=Renewable%20energy%20sources%20have%20a,installed%20capacity%20of%20176.49%20GW., accessed on 10th December, 2023

1.4 The growing energy demand in key sectors

India's population and its scope for long term economic growth confirms rising energy demand more than any other country in the coming decades. Growth in average per capita income and a reduced poverty means that increasing numbers of Indians can afford private modes of transport, clean cooking technologies, modern appliances, and better residential infrastructure. India has experienced a healthy growth in consumption of energy, from a figure of 23,996 Petajoule (PJ) during FY12 to 32,559 Petajoule (PJ) in FY20 i.e., almost 36% in a gap of 8 years (in FY21 total energy consumption fell to 30,171 PJ as end use sectors were deeply affected by lockdowns and muted growth due to Covid-19). Also, electricity consumption increased from 7,85,194 GWh during FY12 to 12,27,000 GWh during FY21, showing a CAGR of 5%. Out of the total consumption of electricity in FY21, industry sector accounted for the largest share (41%), followed by domestic (26%), agriculture (18%) and commercial sectors (8%)[3].

According to IEA's Energy Outlook 2021, over the period to 2040, an estimated 270 million people are likely to be added to India's urban population. This urbanisation underpins a massive increase in total residential floor space from less than 20 billion square metres today to more than 50 billion in two decades' time. This prompts a significant growth in demand for energy-intensive building materials.

Rapid urbanisation is expected to further accelerate transition in household energy use away from solid biomass to electricity. Rising ownership of appliances and demand for air conditioners mean that the share of energy demand taken by electricity in India's buildings sector rises from today's levels to almost 50% by 2040.

The Industrial sector, which currently uses the most energy, would be the largest driver of coal demand and CO_2 emissions in India over the period to 2040, with total direct emissions from the industry sector nearly double, reaching just over 1 Gt CO_2 in 2040. The declining share of agriculture in India's economic output, and the continued use of traditional farming methods, mean that the agriculture sector has seen the smallest amount of growth in energy use[5].

1.5 The rationale for green hydrogen adoption in key sectors

India currently consumes almost 6 million tonnes of grey hydrogen largely concentrated in industrial uses in refining and as feedstock to produce ammonia and methanol. Current hydrogen consumption is almost equally split between refining and ammonia production with a small share of consumption in methanol production. A small quantity of hydrogen, amounting to 0.3 million tonnes, is already being consumed for steel production. Going forward, demand drivers for hydrogen will be highly sector specific. They will depend on whether hydrogen is used as industrial feedstock with no other alternatives or whether it requires adopting new technology and displacing existing fuel or technology. Further, the pace of energy transition, new technology adoption, and the presence of requisite policy and financial support will also determine the demand outlooks for hydrogen.

- **Refining:** Hydrogen is essential to the petroleum refining industry and is primarily used for desulphurisation of products such as diesel and petrol. In the short to medium term, stringent policy actions on limiting the sulphur content from petroleum products will lead to higher the requirement of hydrogen in desulphurisation
- **Ammonia:** Currently, the majority of the hydrogen feedstock for ammonia is mainly natural gas-based which can be replaced by the renewable-based electrolysis process to form green ammonia. Ammonia's applications can span across ammonia-derived fertilizers and use of ammonia as a hydrogen carrier and fuel for shipping.
- **Methanol:** Methanol is primarily used to produce various chemicals and solvents, and its use can be expanded as fuel for transport in the form of various blends, marine fuel, and cooking.

[5] Source: https://iea.blob.core.windows.net/assets/1de6d91e-e23f-4e02-b1fb-51fdd6283b22/India_Energy_Outlook_2021.pdf, accessed on 09th December 2023

Hydrogen is a main feedstock in the production of methanol and, in India, is currently produced primarily from natural gas. India currently produces only 13% of its methanol consumption. Future demand will rest on emerging demand for speciality chemicals and solvents.

- **Steel:** Hydrogen demand for the steel industry is a matter of technology competitiveness and fuel availability. The DRI process is where there is a potential role for hydrogen to replace fossil fuels, mainly natural gas.
- **Long-Haul Freight and Heavy-Duty Vehicles (HDVs):** Like steel, hydrogen demand for long-haul freight will depend on movement towards low-carbon transportation and the competitiveness of technology options with respect to diesel and against each other. Two technology options exist to electrify HDVs: battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs). Both these technologies are complementary, and their uptake will depend on technology merits, refuelling time constraints, efficiency considerations, costs, and duty cycles
- **Power sector:** High demand growth and renewable penetration introduces the challenges and prospect of flexibility and VRE integration. Hydrogen proponents have also proposed the concept of power-H2-power as another form to provide storage and flexibility. But actual demand for hydrogen will be limited by its competitiveness against other technologies such as battery storage and demand response, in addition to the unique nature of the country's grid and emerging supply and demand structure.

In India, the paradigm shift towards green hydrogen adoption has a twin-fold objective: i) ensure affordable and reliable energy to all and ii) reduce its dependence on fossil-based energy. Though the government has taken initial steps in the form of formulating the National Green Hydrogen Mission and the specific programmes under it, a lot needs to be done to achieve these objectives. This requires a robust roadmap and active involvement of the states.

1.6 Objective of the white paper

Green Hydrogen has emerged as a breakthrough technology with significant potential across multiple applications (transport, industrial - both feedstock and energy, etc.). State governments have a key role to play in helping realize the full potential from this opportunity.

Unlocking green hydrogen opportunities in Gujarat offer significant benefits in the form of decarbonization of key sectors like refining and fertilizers, enhanced Energy security and limiting dependence to commodity and forex volatility (gas imports), exports from the state by promoting establishment of export oriented green hydrogen and derivative units (leveraging Gujrat's coastal infrastructure and renewable potential) and the opportunity to create green tech manufacturing hub – for domestic needs as well as exports.

The assignment thus looks to support policy formulation for green hydrogen production-storage-transport-usage in the state. The white paper covers the priority areas for interventions by the Government of Gujarat, based on a review of policies at the national and sub-national level. This will be followed by assessing the policy support options and recommendations for preferred policy support for the state to consider and finally a broad overview of the economic rationale for the recommended policy actions.

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2. Priority areas for intervention by Gujarat Government

India has come out with policies at the national (National Green Hydrogen Mission) and sub-national level (state level policies that have been finalized e.g., Maharashtra and others that are either in the draft stage e.g., Uttar Pradesh and Punjab) which aims to kick-start the hydrogen economy in the country. Investors and developers are also looking closely at the development of these policies as the sector is in its nascency and there are challenges and roadblocks that persist, which elicit critical asks from the developer/investor community.

2.1 Challenges in Green Hydrogen ecosystem and key asks from the industry

The high cost of manufacturing GH using RE is the most significant barrier to its adoption in India, accounting for around 65% of the entire cost. Low-cost RE plants, local Electrolyser manufacturing and technological advances in Electrolysers can all help to reduce the cost of GH. It is critical for the success of GH to ensure a steady and inexpensive supply of RE. The usage of RE in the grid can lead to a shift in supply and demand hours on a daily load curve. Calculating the ultimate rate for RE to be available in real-time at GH locations is the key challenge, and it varies by state. States also lack rules defining incentives for GH plants and investors have concerns about RE supply continuity over the plant's 20-25-year lifespan.

Through a combination of primary research (in the form of interviews with GH project developers/investors) and secondary research from publicly available information, we have identified the key challenges in the GH ecosystem and the key asks from the industry to mitigate the same, which is discussed in the table below:

Table 1: Key challenges and industry point of view

Key Challenges	Details	Industry point of view
Absence of strong domestic consumption market as barrier for investments	• Awaiting clarity on government policies and incentives • Commercially non-viable to adopt GH without any benefit as production cost of GH is high • Need for external intervention to kickstart demand to support initial GH projects	• Industry-wise mandates to push demand • GH Subsidies and incentives • Development of Carbon Markets
Unwillingness of Consumers to lock into Long-term Offtake Contracts	Consumers and traders of grey hydrogen and downstream products are unwilling to commit to long-term offtake agreements for GH at fixed prices	• Potential gap for a market facilitation institution
Pricing for GH and Derivatives remains a Challenge	Challenge if off takers base their bidding on price of grey hydrogen and add a green premium which is not an accurate and desirable pricing mechanism	• Pricing could be calculated as a weighted average of cost of production (representing seller's side), cost of replacement (representing buyers side/ cost of grey alternatives) and green premium (for example pricing of emissions)
Developers are uncertain about production technologies, associated risks and standard solutions for project development	Companies have experience in only a portion of the GH production value chain. This leads to uncertainty over various technical aspects.	• The government and development-focused institutions can play a role here by supporting projects at the development stage itself

Key Challenges	Details	Industry point of view
Lack of clarity around Green Certification and Regulatory Standards for production In India	While India has a well-established Renewable Energy Certificates (RECs) framework, it will need to be consolidated with other compliances to certify hydrogen produced in India as green	• Harmonization between Global and Indian Green Standards
Domestic equipment manufacturers require support to facilitate robust supply chain locally, but developers prefer ease of imports	Electrolyser manufacturers are reluctance to undertake investments for setting up production units in India, due to lack of a robust domestic supply chain for Electrolyser parts and associated technical challenges and challenges in obtaining key equipment such as instrumentation	• Need to develop strong Electrolyser manufacturing ecosystem in India, considering global supply is limited and heavily concentrated in China (40%). Also, disincentives for imports are non-desirable at this stage.

To reduce GH costs, India needs consistent and low-cost RE, invest in indigenous manufacture of electrolysers and building Hydrogen hubs near demand centres can lower GH transportation costs. India should promote sustainable water usage and utilize industrial/municipal wastewater or seawater for electrolysis. R&D is crucial to improve Electrolysers' efficiency, stack life and reduce water and power consumptions. Encouraging exports of GH and derivatives would require benefits like tax and duty waivers.[6]

2.2 National Green Hydrogen Mission (NGHM)

The NGHM aims to provide a comprehensive action plan for establishing a Green Hydrogen (GH) ecosystem and envisages the addition of 125 GW of Renewable Energy (RE) generation capacity and a total investment of INR 8 lakh crores in the GH ecosystem by 2030. The objectives of NGHM are:

- To make India the Global Hub for the production, usage and export of GH and its derivatives.
- To build capabilities to produce at least 5 million Metric Tonnes (MMT) of GH per annum by 2030, with the potential to reach 10 MMT per annum with the growth of the export market
- Aims to make India a leader in technology and manufacturing of Electrolysers.

Green Hydrogen (GH) Sourcing: It is estimated that currently around 5 MMT of Hydrogen is consumed annually in India for various industrial purposes like petroleum refining, manufacturing of ammonia for fertilizers, methanol production, treatment and production of metals, etc. Most of this Hydrogen is currently sourced from fossil fuels through the process of steam reformation of natural gas, naphtha, etc.

The costs of the Electrolysers and input RE are the two major components of GH production cost. The costs of capital, supply and treatment of water, storage and distribution of GH, conversion of GH to suitable derivatives, and enabling infrastructure would also contribute significantly to the final delivered cost of GH for any particular application. The Mission seeks to undertake the necessary steps to enable cost reduction in all of these aspects. The Mission proposes interventions to boost domestic manufacturing of Electrolysers to ensure the production of Electrolysers in India at significantly lower costs which will also help to enable competitiveness of Made in India Green Hydrogen in the international markets.

[6] Source: https://energy.economictimes.indiatimes.com/news/renewable/green-hydrogen-adoption-in-india-opportunities-challenges-and-the-way-ahead/100177937 , accessed on 14th December 2023

Decentralised GH production will be advantageous to reduce the requirement of its transportation for end-use and it would be explored through Biomass-based hydrogen production systems and Modular Electrolysers connected to rooftop solar or other decentralized RE plants like small hydro, etc.

Production of GH through biomass also holds the potential for achieving scale and low costs. Different technological pathways, including biomass gasification and reformation of biogas, etc., are in various stages of development and piloting. The Mission aims to initiate focused pilots to arrive at workable models for biomass-based GH production and its use in various applications.

The Mission will also support and facilitate the building of the required infrastructure for the storage and delivery of GH and its derivatives. Port infrastructure is required to enable exports of GH derivatives, and pipelines to facilitate bulk transport of GH will also be developed. Further, the producers and consumers of GH and its derivatives will be encouraged to pool resources and develop projects in a coordinated manner in the form of large-scale Hydrogen Hubs.

There is a focus on government funding and support for R&D, measures for demand creation and financial support for manufacturing and infrastructure development. Rapid deployment of RE and Electrolysers capacities will be required to achieve economies of scale. Associated infrastructure and regulatory ecosystem need to be established for the delivery of renewable power, and storage, transportation and utilisation of GH for various applications.[7]

Phased Approach: The mission is proposed to be implemented in a phased manner, focusing initially on the deployment of GH in sectors that are already using Hydrogen. The later phase will undertake GH initiatives in new sectors of the economy.

PHASE I (2022-23 TO 2025-26)

Creating demand while enabling adequate supply by increasing the domestic Electrolyser manufacturing capacity. Utilisation in the refineries, fertilizers and city gas sectors will also create a sustained demand to support new investments in GH production. Pilot projects will be undertaken to initiate a green transition in steel production, long-haul heavy-duty mobility and shipping

PHASE II (2026-27 TO 2029-30)

GH costs are expected to become competitive with fossil fuel-based alternatives in the refinery and fertilizer sector by the beginning of the second phase and the potential for taking up commercial-scale GH projects in the steel, mobility and shipping sectors will be explored. It is also proposed to undertake pilot projects in other potential sectors like railways, aviation, etc. The second phase activities would enhance the penetration of GH across all potential sectors

To support the mission's key objective of at least 5 MMT/annum GH capacity, a domestic Electrolyser manufacturing target of 60-100 GW capacity by 2030 has been announced. This is 7.5-12.5 times more than even the global Electrolyser manufacturing capacity of ~8 GW in 2021 (IEA, 2022).[8]

Mission Components: The different mission components are discussed in the table below. The initial outlay for the Mission is INR 19,744 crore, including an outlay of INR 17,490 crore for the SIGHT programme, INR 1,466 crore for pilot projects, INR 400 crore for R&D and INR 388 crore towards other Mission components.

[7] Source: https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/01/2023012338.pdf , accessed on 12th December 2023

[8] Source: https://sarepenergy.net/wp-content/uploads/2023/05/GREEN-HYDROGEN-FINAL-Version.pdf , accessed on 12th December 2023

Table 2: Mission Components of National Green Hydrogen Mission (NGHM)

Demand Creation	Domestic Demand	GoI will specify a minimum share of consumption of GH or its derivative products such as green ammonia (GA), green methanol, etc. by designated consumers as energy or feedstock.
	Export Demand	Global demand for over 100 MMT of GH and its derivatives is expected to emerge by 2030. Aiming ~10% of the global market, India can potentially export about 10 MMT GH/GA per annum. The mission will facilitate export opportunities through supportive policies and strategic international partnerships
	Competitive Bidding	Demand aggregation and procurement of GH and GA through the competitive bidding route
	Certification Framework	MNRE will develop a suitable regulatory framework for certification of GH and its derivatives as having been produced from RE sources
Strategic Interventions for Green Hydrogen Transition (SIGHT)	Incentive for domestic manufacturing of Electrolysers	Two distinct financial incentive mechanisms were proposed with an **outlay of INR 17,490 crore up to 2029-30**
	Incentive for production of GH	
Pilot Projects	Low-carbon steel pilot projects: Outlay of INR 455 crore up to 2029-30	Considering the higher costs of GH at present, steel plants can begin by blending a small percentage in their processes. Further upcoming steel plants should be capable of operating with GH. Greenfield projects aiming at 100% green steel will also be considered.
	Mobility pilot projects: Outlay of INR 496 crore up to 2025-26	Hydrogen Highways for heavy-duty long-haul vehicles on certain routes and necessary production projects, distribution infrastructure and refuelling stations will be built along such highways to enable Hydrogen-fuelled inter-state buses and commercial vehicles. The mission also proposes to support the deployment of Fuel Cell Electric Vehicles (FCEV) buses and trucks and will also explore the possibility of blending GH based Methanol/Ethanol in automobile fuels.
	Shipping pilot projects: Outlay of INR 115 crore up to 2025-26	GH or its derivatives such as GA and Green Methanol as fuel for propulsion and other operations. Prospects include the development of GH/GA refuelling hubs at Indian ports, development and operation of GH/GA fuelled vessels, use of GH/GA to fuel vehicles and terminal equipment at ports
	Other target areas include energy applications, hydrogen production from biomass, hydrogen storage technologies, etc.	
Green Hydrogen Hubs	The mission will identify and develop regions capable of supporting large-scale production and/or utilisation of Hydrogen as GH Hubs and the development of necessary infrastructure for such hubs will be supported. It is planned to set up at least two such GH Hubs in the initial phase with an outlay of INR 400 crore up to 2025-26	

Key Enablers	Enabling Policy Framework	To facilitate the delivery of RE for GH production, various policy provisions including inter-alia waiver of interstate transmission charges for RE used for GH production, facilitating RE banking and time bound grant of Open Access will be extended for GH projects.
	Infrastructure Development	The Mission will support development of supply chains that can efficiently transport and distribute GH. This includes the use of pipelines, tankers, intermediate storage facilities, and last-leg distribution networks for export and domestic consumption.
	Regulations and Standards	The Mission will coordinate the various efforts for regulations and standards development in line with the industry requirements for emerging technologies.
	Research and Development (R&D)	PPP framework for R&D will be facilitated under the Mission and the framework will entail the creation of a dedicated R&D fund, with contributions from Industry and respective Government institutions.
	Skill Development	A coordinated skill development programme that covers requirements in various segments, will be undertaken
	Public Awareness and Stakeholder Outreach	Expansion of GH, especially in public-centric sectors such as transport and city gas distribution, will require concerted public awareness and stakeholder outreach activities.

Integrated Mission Strategy: The Ministry of New and Renewable Energy (MNRE) is responsible for the overall coordination and implementation of the Mission. The Mission Secretariat, headquartered in MNRE, will formulate schemes and programmes for financial incentives to support the production, utilization and export of GH and its derivatives. The Ministry will ensure the planned deployment of RE and GH capacities, support pilot and R&D projects, undertake capacity building and promote international cooperation efforts. An Integrated Mission Strategy will be applied to achieve the Mission objectives where all concerned Ministries, Departments, Agencies and Institutions of the Central and State Government will undertake focused and coordinated steps to ensure the achievement of the Mission objectives.

Role of State Governments and State Agencies: State Governments will play an integral role in the development of the GH ecosystem through project development, manufacturing, setting up RE capacity and promoting the export of GH derivatives. States will be required to put in place fair and rational policies for the provision of land and water, suitable tax and duty structures, and other measures to facilitate the establishment of GH projects.[9]

2.3 State level Green Hydrogen policies

GoI has identified 10 potential states that could be the key enablers in manufacturing GH in India to kickstart the National Green Hydrogen Mission (NGHM) which include Karnataka, Odisha, Gujarat, Rajasthan, Maharashtra, Tamil Nadu, Andhra Pradesh, Kerala, Madhya Pradesh and West Bengal. These states are likely to have GH/ GA manufacturing zones or clusters. These states have been

[9] Source: https://cdnbbsr.s3waas.gov.in/s3716e1b8c6cd17b771da77391355749f3/uploads/2023/01/2023012338.pdf , accessed on 12th December 2023

identified based on the existing steel and fertilizer industries, refineries and ports located there, along with the operational and potential RE generation capacity in the regions.[10]

India's pipeline of GH and GA projects exceeds ~10 million tonnes per annum, with over ~10 GW of Electrolyser manufacturing projects. Maharashtra and Karnataka states lead in the Electrolyser manufacturing capacity, Karnataka state leads in GH/ GA production capacity followed by Tamil Nadu, Andhra Pradesh and Rajasthan. Karnataka leads the GH production investment pipeline followed by Andhra Pradesh and Tamil Nadu. The table below summarizes the state-wise Electrolyser manufacturing capacity, GH/ GA production capacity and GH production investment pipeline.[11]

Table 3: State-wise Electrolyser manufacturing, GH/GA production capacity and GH production investment pipeline

State	Electrolyser manufacturing (MW/Year)	GH/ GA production (Tonnes/Year)	GH production investment pipeline (INR. Thousand Crore)
Karnataka	1500	59,00,025	3717.52
Andhra Pradesh	-	10,00,388	1200.39
Tamil Nadu	-	11,03,000	527.34
Gujarat	-	42,493	33.14
Maharashtra	1500	906	9.13
Rajasthan	-	10,00,000	400
Uttar Pradesh	100	5,05,052	228.94
Odisha	-	1,20,000	20
Himachal Pradesh	-	1,09,516	131.41
Madhya Pradesh	-	5,767	4.54

Maharashtra is the first state in India to **approve a Green Hydrogen Policy in October 2023**. The state cabinet also approved INR 8,562 crore to provide subsidies and benefits for the implementation of this policy. The target of the policy is to produce 500 kilotonne per annum of GH by 2030. The policy aims to attract investment in GH and RE, create job opportunities and develop the state economy.

The government of Uttar Pradesh has directed officials of the Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA) to prepare an **effective draft for the Uttar Pradesh Green Hydrogen Policy 2023**. UPNEDA will coordinate with the Irrigation Department to create water reserves near small and big rivers in the state and use rainwater to produce GH. The state has received investment proposals worth INR 2.73 lakh crores from 20 companies to set up units in the GH sector in Global Investors Summit (GIS) 2023.[12]

Earlier, Uttar Pradesh Government has published draft Uttar Pradesh Green Hydrogen Policy 2022 with the vision of 100% GH/GA consuming state by 2035. Some of the targets mentioned in the Policy are to reduce GH cost to USD 2/Kg in the policy period and make efforts to decline it further to USD 1/Kg in long-term and achieve 20% GH blending in total hydrogen consumption of the state by 2028 for existing fertiliser and refinery units, reaching 100% by 2035.[13]

The State Government of Andhra Pradesh notified **"Andhra Pradesh Green Hydrogen/Green Ammonia Policy - 2023"** to mitigate carbon emissions and ensure a sustainable future with the target of GH production upto 0.5 MTPA or GA production upto 2.0 MTPA in the next 5 years.[14]

[10] Source: https://www.moneycontrol.com/news/business/economy/government-lists-10-states-for-green-hydrogen-manufacturing-9439561.html , accessed on 12th December 2023
[11] Source: https://static.pib.gov.in/WriteReadData/specificdocs/documents/2023/sep/doc2023915253001.pdf , accessed on 12th December 2023
[12] Source: https://economictimes.indiatimes.com/industry/renewables/uttar-pradesh-cm-yogi-adityanath-asks-officials-to-start-work-on-state-green-hydrogen-policy/articleshow/103256324.cms , accessed on 12th December 2023
[13] Source: https://upneda.org.in/MediaGallery/UPGH2_policy_II.pdf , accessed on 12th December 2023
[14] Source: https://www.nredcap.in/PDFs/2023/GO_Ms_No_14_Dt_20_06_2023.pdf, accessed on 12th December 2023

The Punjab State Government has notified **draft of Punjab Green Hydrogen Policy 2023** to make Punjab a preferred destination for investment in the GH production and marketing with conductive eco-system with a target to produce 100 Kilo tonnes per annum of GH/GA by 2030. It aims to develop innovative manufacturing capacities of producing GH, such as biomass gasification, electrolysis of wastewater, hydrogen fuel blending, etc.[15]

The Rajasthan State Government has **approved the draft and announced, "Rajasthan Green Hydrogen Policy 2023"** and policy notification will be issued soon by the Energy Department. The Policy seeks to promote GH generation by prioritising the utilization of RE in the State and has set a target of producing 2000 Kilo tonnes per annum of energy by 2030 and will provide various facilities to investors.[16]

Tamil Nadu will release a policy on Green Hydrogen soon and aims to be the global GH hub in the near future. Three companies - Acme, Petronas and Hygenco have already shown their strong interest in setting up their units in the State. The investment by the three companies can collectively bring in INR 1 lakh crore in GH. The policy will contain all aspects of manufacturing of electrolyser, incentives, the right technology and applications.[17]

Himachal Pradesh State is formulating a Green Hydrogen Policy that would promote the use of GH and establish the state a leading hub for its production. The key objective of the policy would be to attract investments in large-scale RE projects and ensure a consistent and sustainable supply of green electricity for electrolysis. The State Government has entered into a memorandum of understanding (MoU) with Oil India Limited (OIL) that will enable the production of GH and GA on a pilot basis. National Hydroelectric Power Corporation (NHPC) is also setting up a GH mobility project in the Chamba district on a pilot basis. The project will feature a dedicated solar plant, an Electrolyser unit for GH production and GH storage system with a dispenser. Once the plant is functional, there are plans to introduce hydrogen-driven buses operated by the Himachal Road Transport Corporation (HRTC). [18]

The **Gujarat government has also announced a new policy for green hydrogen manufacturing and the draft policy will be ready soon**. GoG has also recently published its land policy for GH manufacturers - Gujarat's Policy 2023 for leasing out government fallow land for green hydrogen production using non-conventional energy sources such as solar, wind and solar hybrid energy. Gujarat has also announced a number of incentives for businesses that invest in the state's GH projects. Reliance and Adani groups have signed MoUs with the government of INR 5.6 lakh crore and INR 4.13 lakh crore respectively. Annually, this will produce 3 million tonnes of renewable hydrogen. Other businesses, such as ArcelorMittal and Torrent, have also signed MOUs for investment in green energy initiatives. The location of GH plants will be determined by factors including the availability of land, water resources, transmission and evacuation facilities and port accessibility.[19]

[15] Source: https://www.peda.gov.in/assets/media/news/GH_Policy.pdf, accessed on 12th December 2023
[16] Source: https://timesofindia.indiatimes.com/city/jaipur/cm-approves-draft-of-green-hydrogen-policy/articleshow/103725192.cms, accessed on 12th December 2023
[17] Source: https://www.thehindubusinessline.com/news/tn-to-release-a-policy-on-green-hydrogen-in-two-months/article67135284.ece, accessed on 12th December 2023
[18] https://www.thehindu.com/news/national/other-states/himachal-pradesh-takes-aim-to-lead-in-countrys-clean-energy-transition-mulls-a-new-green-hydrogen-policy/article66873484.ece
[19] https://theprint.in/india/gujarat-to-launch-new-green-hydrogen-policy-draft-to-be-ready-in-2-months/1600672/

Madhya Pradesh Renewable Energy Policy 2022 mentions the benefits for the production of GH and Electrolyser manufacturing units commissioned on or before 31st March 2027 as follows:[20]

Table 4: Benefits related to GH in Madhya Pradesh Renewable Energy Policy 2022

Particular	Investment < INR 50 Crore	Investment => INR 50 Crore
Production of GH using electrolysis process or any other commercial process that uses RE power	Eligible to avail general incentives as per respective policy of Industry/ MSME Department	Eligible to avail special incentives earmarked for RE Equipment manufacturing sector under Industrial Promotion Policy
Electrolyser manufacturing units using RE power for manufacturing of Electrolyser	Eligible to avail general incentives as per respective policy of Industry/ MSME Department	Eligible to avail special incentives earmarked for RE Equipment manufacturing sector under Industrial Promotion Policy
Electrolyser manufacturing units using non-RE power for manufacturing of Electrolyser	Eligible to avail general incentives as per respective policy of Industry/ MSME Department.	

The scope of **Odisha Renewable Energy Policy 2022** also covers GH/GA projects. Odisha State is contemplating the development of GH/GA hubs to meet the demands of sectors like the petrochemical/fertilizer/steel industry, long haul transport, city gas distribution as well as for export. The incentives and concessions for GH/GA Projects are in accordance with the National Policy. In addition, Grid Corporation of Odisha (GRIDCO)/DISCOMs will supply RE power for GH production. **The Government of Odisha is planning to come up with a separate Policy for the development of an ecosystem** for GH/GA in the State. Additional incentives may be provided for the production of GH/GA under the Industrial Policy Resolution until the State comes up with a separate policy.[21]

2.4 Review of state wise Green Hydrogen policies

A detailed policy review of different State GH polices has been conducted and the sections below consists of comparative analysis of state GH policies. The data for Rajasthan GH Policy 2023 (Draft) is limited as official policy document is not publicly available yet. The Maharashtra GH Policy 2023 document is only available in Marathi language and translated in English has been done for the policy review in the below sections.

Review of state wise GH policies overview

The below table summarizes the state-wise green hydrogen policy information related to time period of policy implementation, policy targets, eligibility of projects and dedicated fund for policy implementation

Table 5: State wise GH policies overview

Parameter	Uttar Pradesh	Andhra Pradesh	Maharashtra	Rajasthan	Punjab
Operative Period	5 Years	5 Years	Until announcement of new policy	10 years	Until amended or superseded

[20] https://rumsl.mp.gov.in/wp-content/uploads/government_policy/2022/08/English-Policy.pdf
[21] https://energy.odisha.gov.in/sites/default/files/2022-12/3354-Energy%20dept._1.pdf

Parameter	Uttar Pradesh	Andhra Pradesh	Maharashtra	Rajasthan	Punjab
Policy Targets	• Reduce GH cost to USD 2.0/Kg and efforts to decline it to USD 1.0/Kg in long-term • Achieve 20% GH blending in total state's hydrogen consumption by 2028 for fertilizer and refinery units and reach 100% by 2035	• GH production up to 0.5 MTPA or GA production up to 2 MTPA • Eco-system for GH/GA production • Setting up of GH and GA and related equipment manufacturing facilities	500 kilo tonnes per annum (kTPA) of GH by 2030	2000 kTPA energy production by 2030	100 kTPA of GH/ GA by 2030
Eligible GH/ RE Projects	-	Production of GH/GA by using RE and/or Biomass in any of following ways: • Open access and Captive route from co-located or differently located RE plant • Third-party sale/Power exchange • Procuring from AP DISCOMs • Mix of any of the above	• Open Access route from RE and receiving RE from third parties • RE procured within State/outside State • Procuring RE from licensed power transmission companies • Projects obtaining RE from power exchanges • Using 100% RE from municipal solid waste and biomass	• RE extraction through power grid network. • RE and GH production at a single location (700 KTPA). • RTC RE Power Generation (800 KTPA). • Residence of RE through RVPN network (500 KTPA).	Project allotment committee to evaluate techno-commercial conditions in bidding documents for projects through competitive bidding/ DPR for project proposals

Parameter	Uttar Pradesh	Andhra Pradesh	Maharashtra	Rajasthan	Punjab
GH Fund	'Green Hydrogen Ecosystem Fund' to raise corpus through green cess to support small infrastructure projects and ecosystem development	-	INR 8,562 crore to provide subsidies and benefits for policy implementation	-	'Green Hydrogen Ecosystem Fund' to raise corpus through green cess to support small infrastructure projects and ecosystem development

Review of state wise GH policies on based on support infrastructure

The table below summarizes the state-wise green hydrogen policy information related to support infrastructure for RE and GH including GH Hub, RE generation infrastructure, electricity transmission for GH projects and storage and transport Infrastructure for GH projects.

Table 6: State-wise green hydrogen policies review on support infrastructure for RE and GH

Parameter	Uttar Pradesh	Andhra Pradesh	Maharashtra	Rajasthan	Punjab
GH Hub/ Electrolyser/ Equipment Manufacturing	Development of GH/GA industrial clusters/hubs/valleys	GH/GA production units, Fuel Cell production, GH equipment manufacturing facilities are to be treated as eligible industries under schemes by Industries Department	MEDA to support land banks identification for development of hubs/clusters of GH and derivatives	-	• GH parks development • Machinery for baling, collection and transportation of biomass • Infrastructure support to fuel cells for promoting GH buses
RE Generation	Promote RE primarily solar to cater demand to produce GH. Incentives provided in 'Uttar Pradesh Solar Energy Policy 2022' shall apply	Incentives available under State's solar/wind/wind solar hybrid policy available to RE plants to be established for GH/GA production	-	-	Promote deployment of solar energy plants to produce GH

Parameter	Uttar Pradesh	Andhra Pradesh	Maharashtra	Rajasthan	Punjab
Electricity Transmission Connectivity	Expansion of transmission infrastructure to facilitate development of GH/GA production units	-	-	-	Expansion of transmission and distribution infrastructure to facilitate development of GH/GA production units
Storage and Transport Infrastructure of GH	Promote development of GH ready pipelines to transport GH/GA to feasible distances	• GH/GA producers allowed to set up bunkers near Ports for storage and land shall be provided by port authorities • Developers to comply with standards/ guidelines by GoI	-	-	• Development of GH ready pipelines to transport GH/GA to feasible distances. • Promote blending of GH with grey hydrogen. PNG in existing industries to achieve at least 8% of GH in consumption mix by 2030.

Review of state wise GH policies based on electricity charges

The table below summarizes the state-wise green hydrogen policy information related to benefits of exemptions in various types of electricity associated charges including intra-state transmission charges, Wheeling charges, surcharges, electricity duty, etc.

Table 7: State-wise green hydrogen policies review on exemptions in electricity associated charges

Parameter	Uttar Pradesh	Andhra Pradesh	Maharashtra	Rajasthan	Punjab
Intra-state transmission charges exemption	50%	25% for 5 years from CoD for power procured from RE located within the State (maximum INR 10 Lakhs/MW/year of installed Electrolyser capacity)	50% for 10 years	50% for 10 years for 500 kTPA RE Plants GH Projects	50%
Wheeling charges exemption	50%	-	50% for 10 years	100%	50%
Cross-subsidy surcharge exemption	100%	100% reimbursed for 5 years	100%	100% for 10 years on purchasing RE	100%

Parameter	Uttar Pradesh	Andhra Pradesh	Maharashtra	Rajasthan	Punjab
				from third parties	
Distribution charges exemption	100%	-	-	50% for 10 years for 500 kTPA RE Plants GH Projects	-
Additional surcharges exemption	-	-	100%	100% for 10 years on purchasing RE from third parties	100%
Electricity duty exemption	-	100% for 5 years	100% for 15 years	-	100% during construction
Banking provisions	-	-	Banking charges/facilities are referred to the MERC guidelines	No prohibition on capacity of captive power plants and on banking of generated electricity	Banking facilities for GH production units purchasing power from independent power plants

Review of state wise GH policies for land and water allocations

The table below summarizes the state-wise green hydrogen policy information related to land and water allocation for GH production and RE generation projects.

Table 8: State-wise green hydrogen policies review on land and water allocation for GH production and RE generation projects

Parameter	Uttar Pradesh	Andhra Pradesh	Maharashtra	Rajasthan	Punjab
Government land for GH or RE production	• Within GH/GA clusters/hubs/valleys, state to provide land to GH/GA units at priority, if available. • Necessary regulatory support	• Land for RE and GH/GA Plants on priority basis • GH/GA plants can be developed in any proposed industrial zones/parks	-	-	Panchayat Lands for GH Projects and biomass storage as per policy of Department of Rural Development and Panchayat
Land Allocation Policy/guidelines for GH Projects	Land at concessional rates for GH/GA production or RE planned for GH	Government land lease rate of INR 31,000/acre/year with escalation of 5% every two years during	Priority of land allotment for GH projects	Priority of land allotment for GH production from treated or brackish water	GH/GA Projects can only be allowed in safe zones of Punjab

Parameter	Uttar Pradesh	Andhra Pradesh	Maharashtra	Rajasthan	Punjab
Exemption on land taxes	100%	-	100%	-	-
Exemption on stamp duty	100%	100%	100%	-	100%
Exemption on land use conversion charges	100%	100%	100%	-	No CLU and EDC Charges for change of agriculture land to industrial use
Water infrastructure for GH Projects	Expand water supply infrastructure to facilitate development of GH/GA production units	Facilitate water allocation on priority as per Industrial Water Supply Policy/Guidelines	Water to GH projects will be made available at reasonable rates	-	Preference to GH/GA plants utilising treated sewage water instead of fresh water

Review of state wise GH policies for CAPEX, Production Linked Incentives and other benefits

The table below summarizes the state-wise green hydrogen policy information related to capital financial incentives and benefits including capital subsidy, State's Goods and Services Tax (SGST) exemption, Production linked Incentives (PLI) and Other Monetary Incentives.

Table 9: State-wise green hydrogen policies review on PLI incentives and benefits

Parameter	Uttar Pradesh	Andhra Pradesh	Maharashtra	Rajasthan	Punjab
Financial Support	30% one-time grant for technology acquisition subject to a maximum of INR 5 crores for R&D centres and industries	-	1% interest subsidy on financing for GH projects	-	• Incentives in "Punjab Industrial and Business Development Policy 2022" available to GH/ GA units • Incentives to GH/GA units- NRSE Policy 2012
CAPEX Incentives	Subsidy for Electrolyser capacity (Applicable for Electrolyser, not whole system) > 50 MW • 2023 - 60% • 2024 - 55 • 2025 - 45% • 2026 - 35 • 2027 - 20% • 2028 - 0%	-	• 30% Subsidy (maximum INR 60 Lakhs/vehicle) for first 500 GH fuel cell vehicles of MSRTC • 30% Subsidy for hydrogen refueling stations (maximum INR 4.5 crore/station) • 30% Subsidy in GH production plants (up to 3 units with	-	• Subsidy (INR 15 crore /project, INR 3 crore /TPD-Biomass to GH • 20% subsidy (maximum INR 50 Lakhs/vehicle) for first 100 GH fuel cell trucks/buses • Subsidy of INR 50/kg to first 10 industries for consuming GH • 20% subsidy (maximum INR 3 crore) to first 10 hydrogen

Parameter	Uttar Pradesh	Andhra Pradesh	Maharashtra	Rajasthan	Punjab
			capacity >50 KTPA)		refuelling stations
State's Goods and Services Tax (SGST)	100% reimbursement for GH/GA production	100% reimbursement for GH/GA production	-	-	-
Production linked Incentives (PLI)	Subsidy of INR 3500/tonne Urea for every tonne of Green Urea produced beyond 10% blending share in total production	-	GH blending in gas - INR 50/kg subsidy for 5 years	-	-
Other monetary Incentives	50% reimbursement of employer's contribution to EPF and ESI	-	"Package of Scheme of Incentives" for GH and derivatives production plants like electricity tariff concession	-	-

Review of state wise GH policies for Ease of Doing Business and Skilling

The table below summarizes the state-wise green hydrogen policy information related to initiatives for improving Ease of Doing Business, Skill Development and Research & Development (R&D).

Table 10: State-wise green hydrogen policies review Ease of Doing Business, Skill Development and R&D initiatives

Parameter	Uttar Pradesh	Andhra Pradesh	Maharashtra	Rajasthan	Punjab
Improving Ease of Doing Business	• 'Industrial Investment & Employment Promotion Policy 2017' for GH/GA investments in fertiliser units • Exemptions in 'Scheme for Promoting Establishments of Private Industrial Parks 2017' for GH/GA units. • Web application for online clearances/NOCs • Single window clearance platform • Incentives in 'Make in UP' for GH/GA projects	• Single desk portal for time bound statutory clearances • GH/GA production exempted from obtaining NOC/Consent for establishment under pollution control laws from APCB	-	-	• Initiatives in "Punjab Industrial and Business Development Policy 2022" applicable • "Invest Punjab Business First" Portal for single unified interface for all regulatory and fiscal services • Simplify and reduce checklist of various regulatory services at all levels of processing
Skill Development	Skill development programme to	• Introduce courses of	-	-	-

Parameter	Uttar Pradesh	Andhra Pradesh	Maharashtra	Rajasthan	Punjab
	build capacity of the state and train workforce to be ready for GH/GA transition	GH/GA production and manufacturing of GH equipment and ancillaries • Develop digital platform with database of available manpower to match skilled manpower			
R&D and Innovations	Establish CoE with different academic and research institutions and industries	-	-	Subsidy of 30% (maximum INR 5 crore) for setting up research centre	• Budget for R&D Activities for GH/GA • CoE with different academic and research institutions and industries • R&D activities to find sustainable and economical solutions for GH transportation
Pilot Project	Technology demonstration and proof of concept pilots for GH applications	Technology demonstration and proof of concept pilots for GH applications	-	-	Technology demonstration and proof of concept pilots for GH applications

2.5 Learnings from state wise Green Hydrogen policies

Currently, around 5 MMT of Grey Hydrogen is consumed annually in India for various industrial purposes sourced from fossil fuels. With improving Electrolyser technologies, declining RE costs and decarbonization agenda, there is increasing attention on the production of GH through RE powered electrolysis and is now being considered at the forefront of global decarbonization efforts for its derivative products and new use cases such as the clean fuel. India is seeing huge traction from both the policy side and from private players, and GH/GA is expected to play a central role in India's decarbonization journey. Indian Government has announced National Green Hydrogen Mission (NGHM) to give momentum to the growth of the sector which aims to make India the global hub for the production, usage and export of GH and its derivatives.

Several Indian States have announced GH Policies including Maharashtra which is the first state to approve a GH Policy. A comparative analysis of Uttar Pradesh GH Policy 2022 (Draft), Andhra Pradesh GH & GA Policy 2023, Maharashtra GH Policy 2023, Rajasthan GH Policy 2023 (Draft) and Punjab GH Policy 2023 (Draft) is done in the above section of this report based on data available publicly including policy overview and targets, support infrastructure for RE and GH, exemptions in electricity associated charges, land and water allocation, subsidies, PLIs and other benefits and ease of doing business and Skilling. The findings of the policy review are discussed in brief below:

- It is observed that **most of the policies have set the target of achieving GH production capacity in MPTA/KTPA by the end of policy operative period** and Uttar Pradesh GH Policy 2022 (Draft) mentioned about GH cost reduction target and GH blending target in total state's Hydrogen consumption.
- The **eligible GH/GA projects for availing policy benefits are the ones using RE and/or Biomass in as a mean of green electricity** including open access route, receiving RE from third parties, RE procured within State/outside State, obtaining RE from power exchanges, etc.
- **Uttar Pradesh and Punjab have made separate Green Hydrogen Ecosystem Fund to support policy implementation** and Maharashtra has approved INR 8,562 crore for policy implementation.
- Multiple policies have planned **development of GH/GA industrial hubs/parks/clusters/valleys for GH/GA production** as well as GH equipment manufacturing, fuel cells manufacturing, etc.
- Expansion of transmission infrastructure to facilitate development of GH/GA projects is only highlighted in GH policies of Uttar Pradesh and Punjab.
- **Few policies like GH policies of Uttar Pradesh, Andhra Pradesh and Punjab mentions about the plans for storage and transport Infrastructure** of GH in terms of GH ready pipelines to transport GH/GA and set up of bunkers near Ports for storage.
- **The electricity charges waivers are almost similar in all the State GH polices analysed** including exemption in intra-state transmission charges, wheeling charges, cross-subsidy and additional surcharges, electricity duty and banking provisions. In some State GH policies, Banking is not addressed specifically for GH.
- There are **several waivers on taxes and duties related to land which are similar in almost all the State GH policies analysed** which includes exemption in land taxes, stamp duty and land use conversion charges. Uttar Pradesh, Andhra Pradesh and Punjab also mention about the government land use for GH/RE production.
- **Multiple State GH Policies are providing capital subsidies on Electrolyser manufacturing, fuel cell vehicles, hydrogen refuelling stations, biomass of GH projects, industries consuming GH, etc**. Uttar Pradesh and Andhra Pradesh also mention 100% reimbursement of SGST for GH/GA production. Very few States have announced Production linked Incentives (PLI) in their respective GH policies that have been analysed.
- **State GH Policies also emphasized in improving ease of doing business** by promotion policies/ schemes for GH/GA projects, single window clearance platform, online clearances/NOCs, simplifying and reducing checklist of various regulatory services, etc.
- **Some State GH Policies also mention about developing R&D activities** by establishing Centre of Excellence (CoE), subsidy for setting up research centre, budget for R&D activities for GH/GA, etc.

2.6 Gujarat's existing landscape for green hydrogen development

Gujarat possesses a strategic advantage with its substantial local market for hydrogen, cost-effective RE available within its RE parks and abundant water resources owing to its extensive coastline. The state has supporting legislations in place that already provide some amount of support for a green hydrogen ecosystem.

2.6.1 Renewable energy policy 2023

In October 2023, Government of Gujarat launched the Renewable Energy Policy 2023 (RE Policy 2023) which is strategically designed to attract investments in the RE sector within the state. In pursuit of this objective, the policy proactively addresses a range of critical issues and key modifications include adjustments to the eligibility criteria for establishing RE projects under the captive route, the removal of

limitations on the installed capacity of RE projects tied to sanctioned load/contract demand and the extension of the Gujarat Wind Solar Hybrid Power Policy 2018.[22]

Table 11: Gujarat Renewable Energy (RE) Policy 2023 key highlights and initiatives

Key Highlights	• Covers all major renewables and encourages setting up of RE projects based on Wind, Solar and Wind-Solar Hybrid technologies • Policy operative period: up to 2028 or till notification of new policy, whichever is earlier • The policy aims to achieve 50% target of RE capacity by 2030 • Anticipated investments would be ~INR 5 lakh crores • Land utilization would be approximately 4,00,000 acres • The benefits under policy will be applicable for a period of 25 years from the date of commissioning or the lifespan of the RE project • RE projects can be set up for captive use, third party sale or sale to DISCOMS • GEDA shall act as the State Nodal Agency (SNA)
Key Initiatives	• Conversion of existing or under-construction standalone wind or solar power plants into hybrid projects is allowed • The policy promotes RE parks which includes solar, wind and hybrid parks. The RE project may be setup on private land or government waste land allotted by Revenue Department/SNA. • Introduced Green Power Supply - 100% RE supply on consumer requisition at Green Power Supply Tariff as determined by GERC from time to time. • Option of net metering or gross metering available for rooftop projects. • The settlement of RE against consumer's consumption shall be carried out on billing cycle basis. • State Government may allocate government waste land at concessional rates to RE projects supplying power to the distribution licensee for the consumers of Gujarat. • Cross-subsidy surcharge and additional surcharge shall not be applicable to captive power projects. • Power can be exported out of Gujarat through ISTS connected projects in accordance with applicable rules and regulations of central government/CERC. • No capacity restriction for setting up of RE projects with respect to the consumer's contracted demand • Energy banking facility on billing cycle basis shall be allowed upon payment of applicable banking charges as determined by GERC from time to time

2.6.2 Gujarat's land policy for green hydrogen

In line with the Government of India's Green Hydrogen Mission initiative, GoG in May 2023, issued a Policy on leasing of government waste land for GH production (using non-conventional energy sources). The main objective of this Policy is to incentivize setting up of GH manufacturing units in Gujarat and promote new technologies and methods for production of GH. The Policy provides various terms for optimal and efficient use of waste land for production of GH.[23]

Table 12: Gujarat Land policy for Green Hydrogen key highlights and eligibility

Key Highlights	• Land lease for 40 years for solar/wind/wind-solar hybrid energy plant for GH production • Land use restricted to specified purposes, lease revocation for other uses • High-power committee to recommend applicants based on expert committee suggestions • Applicant bears all project expenses towards roads, power, etc., inside or outside the land allotted • Annual rent of INR 15,000 per hectare per year with 15% increase in every three years • 1 Lakh Hectare Land - For state government companies to develop RE sources. • No sub-leasing allowed

[22] Gujarat Renewable Energy Policy 2023: https://guj-epd.gujarat.gov.in/uploads/Gujarat_RE_Policy-2023.pdf , accessed on 14th December 2023

[23] Gujarat Land Lease Policy for Green Hydrogen Projects: https://revenuedepartment.gujarat.gov.in/downloads/gr_08052023_a1.pdf, accessed on 14th December 2023

Eligibility	• Applicants must apply for land allotment for GH production of at least 0.1 MMTPA • 50% in 5 Years and 100% in 8 Years - GH production capacity to be achieved • INR 50 crore per 0.1 million Tonne - Security to be deposited to state Government • Minimum qualifications in RE and hydrogen utilization along with net worth requirements • A pre-feasibility report is required • Verification by a committee of experts constituted by Gujarat Power Corporation Limited (GPCL)

2.6.3 Aatmanirbhar Gujarat Scheme for Industry Assistance

Government of Gujarat has introduced the Aatmanirbhar Gujarat Schemes 2022 for Assistance to Industries. This scheme is applicable from October 2022 to October 2027, encompasses all industries and anticipates attracting investments of approximately INR 12.50 lakh crore in the state. The initiative aims to generate employment opportunities for around 15 lakhs.

Recognising the significance of certain sectors in alignment with the Aatmanirbhar Bharat initiative, the state has identified nine key sectors, including the GH ecosystem, sustainability and mobility as thrust manufacturing sectors. These sectors have been strategically chosen based on the state's competitive strengths and advantages, such as geographical location, resource availability, raw material accessibility, existing manufacturing practices and growth potential. Designated as thrust sectors, they are entitled to additional benefits under the incentive scheme, further enhancing their prominence in the state's industrial landscape.

Table 13: Benefits in Aatmanirbhar Gujarat Scheme for Industry Assistance

Incentives	• 80-100% of net SGST reimbursement eligible for 10 years subject to a cap of 5.5%-8% of eFCI per annum. • Assistance of interest subsidy at 7% on Term Loan up to 1%-1.2% of eFCI per annum for 8-10 years. • 100% reimbursement of employer's statutory contribution to EPF subject to INR 1,800 per month per employee (whichever is lower) for a period of 10 years.

2.6.4 Upcoming Industrial Clusters and Investment Regions

It is estimated that around 54,000 acres of developed industrial land shall be required to cater to demand from new manufacturing investments till FY 26-27. Around 35,000 acre is already available in the state offered by the government and private industrial parks. It is estimated that there is a deficit of ~19,000 acres. The districts Vadodara, Surat, Jamnagar, Mehsana, Valsad and Rajkot currently have less land supply than demand and can be prioritized by GIDC/GoG for the development of new industrial estates. The following interventions are highlighted in the strategy for Government of Gujarat to enable India to become a USD 5 trillion economy[Error! Bookmark not defined.]:

- Development of new industrial estates in the following districts on priority under Phase-I: Vadodara, Surat, Jamnagar, Mehsana, Valsad, Rajkot.
- Development of new industrial estates in remaining districts under Phase II: Bharuch, Kheda, Banaskantha, Gandhinagar, Panchmahal and Surendranagar.
- Development of export infrastructure such as SEZs, testing & certification facilities, etc.
- Expedite development of sectoral parks in Gujarat: - PM MITRA Park, Bulk Drug Park, Ceramics Park, Toy Park, Biotech Park, Dholera SIR and Mandal-Becharaji SIR
- Consider/ evaluate development of new sectoral industrial parks: Special Economic Zones (Export oriented), Future of mobility parks (Auto, EV, Batteries), High tech engineering park (Machinery, Electrical machinery, other equipment's), Chemical clusters, **Green Hydrogen Park**, Metal clusters, etc.

Petroleum, Chemicals and Petrochemicals Investment Region (PCPIR): PCPIR in Dahej (South Gujarat) is India's first specially delineated investment region of 453 sq. km. for manufacturing of petroleum products, chemicals and petrochemicals. With the coming of Dedicated Freight Corridor (DFC), Delhi Mumbai Industrial Corridor (DMIC), Bullet Train and the Express Highway linking Baroda

to Mumbai, the prospect in PCPIR is further expected to boost. Three new LNG terminals and a greenfield airport have also been planned in/ around the PCPIR.

Dholera Special Investment Region (D-SIR): Dholera SIR in Gujarat is India's largest greenfield industrial investment region, spread over 920 sq. km. DSIR will have smart & sustainable infrastructure spanning transportation, water, power, waste-water, drainage and urban design. Its focus sectors include Heavy Engineering, Automobiles & Auto ancillary, Defense, Electronics, Hi-tech technologies, Agri & Food processing and Infrastructure. The world's largest solar park of 5 GW is also being developed at Dholera SIR.

2.7 Areas of interventions for Government of Gujarat

Gujarat has few policies and initiatives in place to help and kickstart GH Ecosystem development in Gujarat including Land Lease Policy for GH Projects 2023 announced by GoG recently, RE Policy 2023, GH Ecosystem for Gujarat's Thrust Sectors (Aatmanirbhar Gujarat Scheme for Industry Assistance), multiple existing and upcoming industrial clusters, investment regions, special economic zones (SEZs) and public transport initiatives as discussed in the above sections which may be leveraged to develop GH Ecosystem in Gujarat.

The readiness of Gujarat for GH Ecosystem development and initiatives covered in relevant state level policies is discussed in the table below.

Table 14: Readiness of Gujarat in GH Ecosystem and support offered by other relevant states

Initiatives	State Level Readiness of Gujarat	Other States Readiness for GH Ecosystem
Renewable Energy (RE) for GH Projects	• Gujarat RE Policy 2023 exists, however, does not mention about GH/GA and benefits for GH/GA projects	• Madhya Pradesh Renewable Energy Policy 2022 mentions the benefits for the production of GH and Electrolyser manufacturing • Odisha Renewable Energy Policy 2022 also covers GH/GA projects • Promotion of RE for GH/GA projects mentioned in Uttar Pradesh GH Policy 2022 (Draft), Andhra Pradesh GH & GA Policy 2023 and Punjab GH Policy 2023 (Draft)
Electricity Charges Exemption for GH Projects	• Only Cross-Subsidy and Additional Surcharges not applicable if green energy is utilized for production of GH and GA[24]	• Multiple exemptions in Uttar Pradesh GH Policy 2022 (Draft), Andhra Pradesh GH & GA Policy 2023, Maharashtra GH Policy 2023, Rajasthan GH Policy 2023 (Draft) and Punjab GH Policy 2023 (Draft)
Electricity Transmission Infrastructure for GH Projects	-	• Expansion of transmission infrastructure for development of GH/GA production units mentioned in Uttar Pradesh GH Policy 2022 (Draft) and Punjab GH Policy 2023 (Draft)
GH Hub/Valley/Cluster	• Gujarat may consider GH Park/Valley in locations like Jamnagar and Kutch for improving manufacturing competitiveness of focus sectors mentioned (as mentioned in its 5 trillion strategy document)	• Development of GH/GA industrial clusters /hubs/ valleys mentioned in Uttar Pradesh GH Policy 2022 (Draft), Andhra Pradesh GH & GA Policy 2023, Maharashtra GH Policy 2023 and Punjab GH Policy 2023 (Draft)

[24] Draft Gujarat Electricity Regulatory Commission (Terms and Conditions for Green Energy Open Access) Regulations, 2023: https://gercin.org/wp-content/uploads/2023/06/Final-Draft-regulationsGEOA-Regulations-2023-dated-23.06.pdf

Initiatives	State Level Readiness of Gujarat	Other States Readiness for GH Ecosystem
Land for GH Projects	Gujarat Land lease Policy for GH Projects 2023	Provision for land allotment and exemptions for GH Projects in Uttar Pradesh GH Policy 2022 (Draft), Andhra Pradesh GH & GA Policy 2023, Maharashtra GH Policy 2023 and Rajasthan GH Policy 2023 (Draft)
Water for GH Projects	-	Provision for water allocation in Uttar Pradesh GH Policy 2022 (Draft), Andhra Pradesh GH & GA Policy 2023, Maharashtra GH Policy 2023 and Punjab GH Policy 2023 (Draft)
Storage & Transportation for GH Projects	-	• Storage mentioned in Andhra Pradesh GH & GA Policy 2023 • Development of GH ready pipelines for transportation mentioned in Uttar Pradesh GH Policy 2022 (Draft) and Punjab GH Policy 2023 (Draft)
Benefits/ Incentives for GH Projects	Aatmanirbhar Gujarat Scheme for assistance to large industries and thrust sectors – GH Ecosystem thrust sector (GH/GA, Electrolyser, RE Equipment, Battery Storage and Fuel Cells)[25]	• Financial support, capital subsidy, PLI benefits in Uttar Pradesh GH Policy 2022 (Draft), Maharashtra GH Policy 2023 and Punjab GH Policy 2023 (Draft) • SGST reimbursement for GH/GA production in Uttar Pradesh GH Policy 2022 (Draft) and Andhra Pradesh GH & GA Policy 2023
Funding for GH Projects	Big-ticket investments by key corporates in Gujarat in GH sector may gain lending from New Development Bank (NDB)[26]	• GH Ecosystem Fund in Uttar Pradesh GH Policy 2022 (Draft) and Punjab GH Policy 2023 (Draft). • INR 8,562 crore for Maharashtra GH Policy 2023
Ease of doing business for GH Projects	-	Initiatives in Uttar Pradesh GH Policy 2022 (Draft), Andhra Pradesh GH & GA Policy 2023 and Punjab GH Policy 2023 (Draft)
Skill Development in GH	Hydrogen valley innovation cluster in Gujarat – To promote research on novel hydrogen technologies while building capacity and capability for its production, distribution, and use cases[27]	Initiatives in Uttar Pradesh GH Policy 2022 (Draft) and Andhra Pradesh GH & GA Policy 2023
R&D in GH Ecosystem		Initiatives in Uttar Pradesh GH Policy 2022 (Draft), Rajasthan GH Policy 2023 (Draft) and Punjab GH Policy 2023 (Draft)

Based on the comparison done in the table above, it is found that there are following gaps in the GH policy ecosystem in the state:

- While Gujarat has a comprehensive RE policy in place, which came out in 2023, ***there is currently no mention of any specific provisions for RE required for production of GH in***

[25] Aatmanirbhar Gujarat Schemes 2022: https://cmogujarat.gov.in/wp-content/uploads/2022/10/AatmaNirbhar-Gujarat_Industrial-Policy.pdf
[26] https://timesofindia.indiatimes.com/city/ahmedabad/push-to-gujs-green-hydrogen-projects/articleshow/101792432.cms
[27] https://energy.economictimes.indiatimes.com/news/renewable/gujarat-launches-design-for-hydrogen-valley-project/99849152

the state. Also, only Cross-Subsidy Surcharge and Additional Surcharges are not applicable if green energy is utilized for production of GH and GA, while other states provide multiple exemptions in additional charges for RE procurement by developers in the state.

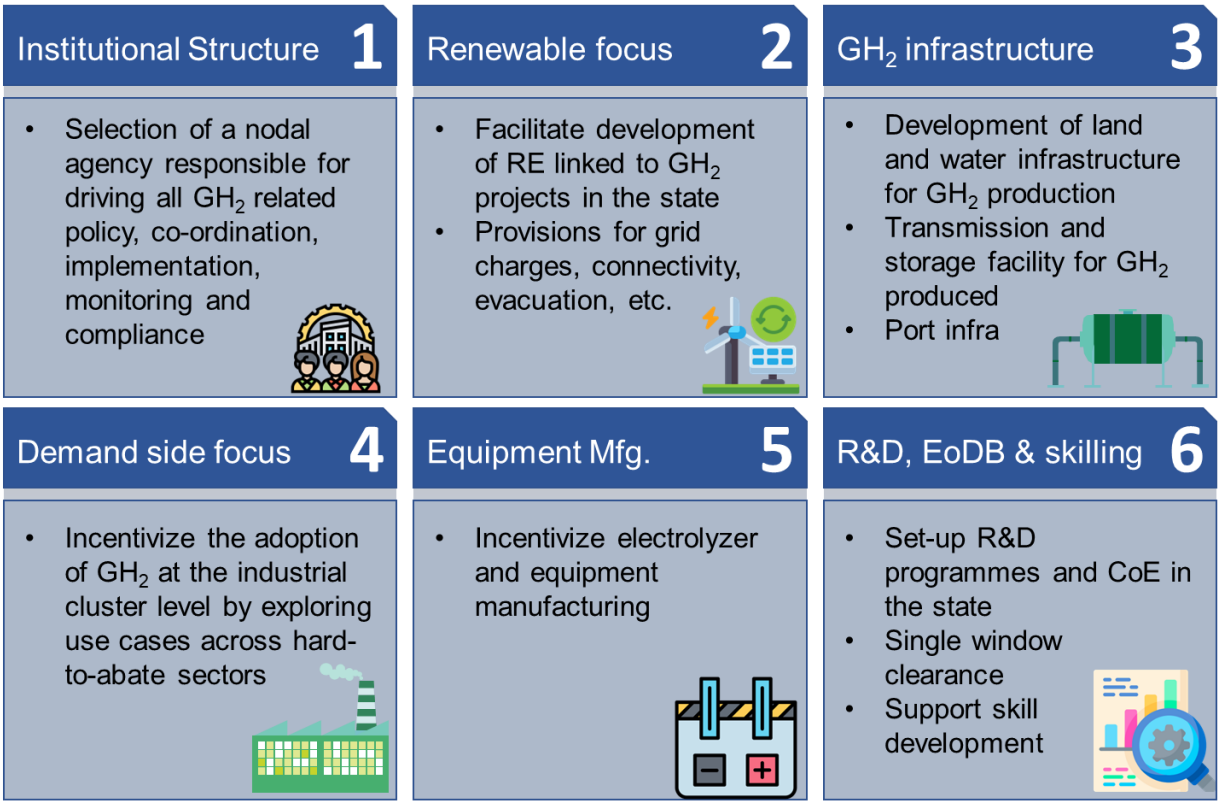
- Along with RE installation, a key aspect would be its offtake and delivery, which would require a robust transmission network from RE production site to GH production site (unless co-located). ***There is currently no policy provision for expansion of transmission infrastructure for development of GH/GA production***
- Development of GH/GA industrial clusters can be key for ramping up its production within a state and take a first mover advantage in the ecosystem. While not explicitly mentioned in its current policies, ***Gujarat may consider GH Park/Valley in key locations for improving manufacturing competitiveness of focus sectors*** (as mentioned in its 5 trillion economy strategy document of 2022)
- Gujarat has issued a policy on leasing of government waste land for GH production (using non-conventional energy sources), but ***GH production requires large amounts of water and provision of water for such projects is key for sustainability in the long term. This is currently missing in the policy provisions of the state***, along with clarity on storage and transportation of the final product from production sites.
- As state level policies across India begin to get notified and start attracting GH developers in their respective states, a key differentiator would be the Ease of Doing Business (EoDB) in these states. ***Gujarat can replicate what it has done in the past to attract industries in its state by formulating a smooth application to clearance process for such projects***, which is currently not covered in its policies.

3. Policy support options, recommendations, and economic rationale for the state of Gujarat

Historically, every part of the energy system has enjoyed some form of policy support. This has been and is still true for fossil fuels (which are supported with both direct and indirect subsidies) and for renewable energy sources, across all sectors – power, heating and cooling, and transport. The hydrogen sector has also received some attention from policy makers at the national and sub-national level in India with dedicated policies. But more dedicated policy support is needed at each stage of technology readiness, market penetration and market growth, especially at the state level where actual implementation and demand centres are present. As highlighted in the previous section, while Gujarat already has some policies in place that can facilitate the green hydrogen ecosystem in the state, there is a need for a systematic approach to positioning the state as a green hydrogen hub in the coming years. The following section covers the policy support options, the recommendations within these specific options and finally broad economic rationale for implementing these policy recommendations

3.1 Pillars for policy support options at the state level

Long-term signals are essential for private and institutional investors to take the risk of investing in a novel technology, and this is particularly true for green hydrogen. The large levels of investment that are required mean that, in general, public capital alone is not enough to move hydrogen from niche to mainstream. Long-term commitment from government is necessary to make available the private capital required for the transition to green hydrogen. Illustrated below are the key policy support options that the Government of Gujarat can roll-out.



3.2 Recommended actions across the policy support pillars

The table below covers the specific action points across the policy support options mentioned above. The actions have been categorized under 3 heads, immediate (0-1 years), short term (1-3 years) and medium term (3-5 years). Since green hydrogen landscape at the international, national, and sub-national level is at nascent stage, policy actions for long term (>5 years) haven't been considered here.

Table 15: Recommended actions across policy support options

Policy support options	Recommended action points		
	Immediate Term (0-1 years)	**Short Term (1-3 years)**	**Medium Term (3-5 years)**
Institutional structure	• Setting up of a state level modal agency which will be responsible for: ○ Policy implementation, monitoring and measurement activity ○ Co-ordination with central government ministries on regulations, mandates, certifications, production, storage, delivery and usage of green hydrogen	• Nodal agency to facilitate mapping of resources such as land, water, Renewable Energy, transmission infrastructure etc. at identified potential sites/clusters for the development of Green Hydrogen hubs through relevant State authorities. • Nodal agency to facilitate the planning and allotment of government land/water/transmission infrastructure through relevant State authorities for Green Hydrogen Projects	
Renewable energy focus	• Exemption from intra state transmission charges and wheeling charges for a defined period from the date of commissioning of green hydrogen project • Exemption from cross-subsidy surcharge and additional charges • Unrestricted banking to be allowed on a monthly basis for RE projects linked to green hydrogen projects • Banking charges not to be levied for a defined period from the date of commissioning of green hydrogen project	• Support in establishment of appropriate evacuation facility for RE power for green hydrogen projects • Identification of high potential sites for the development of offshore wind energy projects and formulate guidelines for the allocation of such sites to the prospective green hydrogen and green hydrogen project developers	• Capex subsidy for offshore wind projects linked with green hydrogen projects • Exemption from intra state transmission charges and wheeling charges for a defined period from the date of commissioning of green hydrogen project • Exemption from cross-subsidy surcharge and additional charges • Support in establishment of appropriate evacuation facility for offshore wind for green hydrogen projects
GH_2 infrastructure	• Allocation of land as per waste land policy 2023 (already notified) • Exemption on local body land taxes, stamp duty and registration charges for land acquisition and or leasing of land for eligible green hydrogen projects • Identification and facilitation of the development of water	• Exemption on conversion charges payable for change of land use and conversion of land for eligible green hydrogen projects • Development of large-scale water	• Facilitate the development of hydrogen refuelling stations • Upgrading the port infrastructure for handling green hydrogen and its derivatives shipments (bunkers, pipelines, etc.)

Policy support options	Recommended action points		
	Immediate Term (0-1 years)	**Short Term (1-3 years)**	**Medium Term (3-5 years)**
	infrastructure for Green Hydrogen Projects. • Guidelines for the allocation of water resources to the prospective Green Hydrogen Project developers • Identify potential regions and clusters near the existing use-case locations for the development of green hydrogen hubs to support large scale production and utilisation of green hydrogen and its derivatives • Facilitate the formulation and implementation of rules, regulations, certifications, and safety standards for the storage and transportation of green hydrogen and its derivatives • Facilitate the approvals and clearances for setting up common infrastructure such as bulk storage and pipeline for transportation of green hydrogen	desalination plants located near the coastline • Development of demineralization plants and water softening/processing plants near the desalination plants as well as existing and future industrial water sources • Facilitate the development of green hydrogen hubs in the coastal areas near the ports for exports Of green hydrogen and its derivatives • Facilitate approvals and clearances for the distribution of green hydrogen and derivatives products through the local network of pipelines, high-pressure tube trailers, and liquified hydrogen tankers	
Demand side focus	• Undertake pre-feasibility studies for sectors where green hydrogen can replace grey/blue hydrogen in the short-medium term • Identify key industries within those sectors where initial pilot cases can be run for this fuel switch • Based on learnings from case studies (within state, other sub-national pilots and international experience) define subsidy levels for usage of green hydrogen in the industry	• Per tonne usage subsidy for pre-defined set of years from the date of commissioning of green hydrogen projects linked to hard to abate sectors where grey/blue hydrogen is already in use and shift to green hydrogen	• Subsidies for a pre-defined number of re-fuelling stations to be set up within the state. The subsidy would be applicable for the set of components for the refuelling station such as hydrogen storage tank, hydrogen compressor, refrigeration unit, dispenser, hose and nozzle unit, etc. •

Policy support options	Recommended action points		
	Immediate Term (0-1 years)	Short Term (1-3 years)	Medium Term (3-5 years)
		can be envisaged	
Equipment manufacturing	• Electrolyser manufacturing facilities, green hydrogen Project related other plant & equipment manufacturing facilities, manufacturing facilities for plant & equipment related to green hydrogen derivatives, and renewable energy plant & equipment manufacturing facilities shall be treated as eligible industries under the Gujarat Industrial Policy 2020 and incentives available to industrial units under Gujarat Industrial Policy 2020 Shall be made available to such facilities • Identification of land for dedicated manufacturing hubs for electrolyser, green hydrogen projects related to other plants & equipment, plant & equipment related to green hydrogen derivatives and other associated components	• Guidelines for the allocation of land in such manufacturing hubs as identified in the immediate term • Guidelines for statutory clearances for setting up of manufacturing hubs as identified in the immediate term • Development of dedicated manufacturing hubs for electrolyser, green hydrogen projects related to other plants & equipment, plant & equipment related to green hydrogen derivatives and other associated components	• NA
R&D, Ease of Doing Business (EoDB) and Skilling	• Assist in identification and pre-feasibility studies for green hydrogen pilot projects as highlighted in the previous policy support options. This is to be taken up by government research institutes, educational institutes and private sector and provide fiscal incentives for such programmes on a case-to-case basis • Set-up a single window clearance facility for approvals of green hydrogen and RE linked to green hydrogen projects. The single window clearance facility will take care of: ○ Facilitate all statutory clearances and permissions from the concerned agencies/state authorities for green	• Co-ordinate with ITIs/diploma institutes/engineering colleges to design courses and impart training on the green hydrogen ecosystem in partnership with the industries • Support women participation in educational courses and trainings for the green hydrogen ecosystem through IT Is/diploma institutes/engineering colleges/skill	• Facilitate the development Of dedicated skill development centres, focusing on the green hydrogen value chain including renewable energy plant & equipment manufacturing, electrolyser manufacturing, ancillary component manufacturing, project installation and operations & maintenance activities, safety & handling of green hydrogen for consumption etc. through partnership between relevant State authorities, academia, and industries.

Policy support options	Recommended action points		
	Immediate Term (0-1 years)	**Short Term (1-3 years)**	**Medium Term (3-5 years)**
	hydrogen projects and all associated project ○ Define the mechanisms for raising and resolving grievances ○ Single point of contact for all approvals/processes established under the single window clearance ○ Facilitate environmental clearance on priority • Facilitate the capacity building of State authorities through international cooperation and coordination between various public and private sector entities	development centres	

3.3 Economic rationale for green hydrogen adoption in Gujarat

India is prioritising green hydrogen as a potential solution to decarbonise hard-to-abate sectors such as refinery, ammonia, methanol, iron and steel and heavy-duty trucking. Prime Minister Modi announced the National Hydrogen Mission with the aim of making India the world's largest hydrogen hub.

India's distinct advantage in terms of low-cost renewable electricity, complemented by rapidly falling electrolyser prices, can enable green hydrogen to be not just economical compared to fossil-fuel based hydrogen but also compared to the green hydrogen being produced around the globe. India is at a crucial juncture in terms of its energy landscape and green hydrogen has a critical role to play to make the nation self-reliant and energy independent. Hydrogen can be an energy molecule that is truly 'made-in-India' and that can contribute to the country's energy security and long-term economic competitiveness. India has the unique opportunity to capitalise on this new technology and become a world leader in green hydrogen production and its applications.

Gujarat possesses a strategic advantage with its substantial local market for hydrogen, cost-effective RE available within its RE parks and abundant water resources owing to its extensive coastline. The hydrogen demand in India is currently estimated at approximately 6.9 MMTPA, with 53% utilized in petroleum refineries and 44% in fertilizer plants. Gujarat specifically contributes to this demand, consuming an estimated 2.03 MMTPA of Hydrogen in the refineries and fertilizers sector. The NGHM is targeting to build capabilities to produce at least 5 million Metric Tonnes (MMT) of GH per annum by 2030 and envisages the addition of 125 GW of Renewable Energy (RE) generation capacity. Since the state's current share is of 30%, at least 1.5 Mn tonnes of green hydrogen production will be required in Gujarat by 2030. Given ESG/ Net Zero commitments/ and regulations in the export markets, several sectors including steel are transitioning to green steel production, which will further add to the state's demand for green hydrogen. All these will translate to at least 1 Mn tonnes of hydrogen production per year by FY27 in Gujarat, which will need around 13 GW of RE capacity. Large private sector users have earmarked investments for 7.5 GW for this.

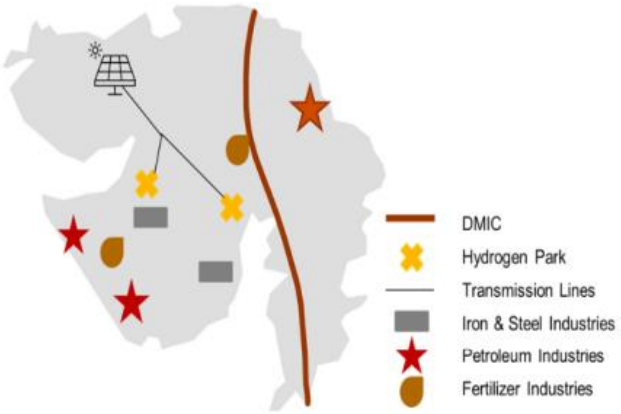


Figure 3: Potential green hydrogen demand in Gujarat

The cost of green hydrogen is expected to reduce to USD 2.13 per kg for an industrial cluster in Gujarat[28].. In the cost of green hydrogen, the cost of electrolyser and hydrogen storage contribute to 50% and 20% share respectively. Specific interventions by the Government of Gujarat on green hydrogen production ecosystem can significantly reduce this cost. Gujarat can become supplier of green hydrogen not only for its own demand, but also to fetch market from neighbouring states.

Market assessment for hydrogen consumption in Gujarat and implement novel concept of green hydrogen parks located near demand centres which will reduce the transportation and storage costs. Central grid connectivity should be provided to them to reduce transmission and variability challenges. RE capacity for green hydrogen should be situated in desert RE parks only to address challenges in land allocation. They should be connected with central grid to address stability challenge of state grid and take advantage of cost-free evacuation till 2025. Based on Gujarat's current share in hydrogen usage and using the envisaged numbers from the NGHM, i.e., 1.5 Mn tonnes of green hydrogen production per year by 2030 in Gujarat, the impact of green hydrogen adoption on Gujarat's economy is presented below[29]

Adoption of Green Hydrogen as a fuel source and manufacturing opportunities from electrolyser in Gujarat can result in ***2.4 lakh crore in total investments*** *and potential for* ***creation of 1.8 lakh jobs****. An expected* ***reduction of a cumulative 30 thousand crore worth of fossil fuel imports by 2030*** *can contribute to reduction in dependence on import of fossil fuels*

[28] TERI report on Potential of hydrogen in India, 2020

[29] Status of adoption of Green Hydrogen in the country, Source: https://pib.gov.in/PressReleasePage.aspx?PRID=1989809#:~:text=Achievement%20of%20Mission%20targets%20is,create%20over%206%20lakh%20jobs. , accessed on 6th Jan 2024