WRI INDIA

CONFERENCE PROCEEDING

Green hydrogen growth: Subnational dialogue on catalyzing change for addressing growth hurdles

A SUMMARY OF EXPERT PERSPECTIVES ON ACCELERATING GREEN HYDROGEN ECOSYSTEM DEVELOPMENT IN INDIA, WITH A FOCUS ON INSIGHTS FROM STATE AND INDUSTRY STAKEHOLDERS

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BACKGROUND

WRI India hosted a roundtable discussion, "Green Hydrogen Growth: Sub-National Dialogue on Catalysing Change for Addressing Growth Hurdles," at the 10th India Energy Storage Week (IESW). Following the approval of the National Green Hydrogen Mission (NGHM) by the Government of India in January 2023, several states have intensified their efforts to develop and implement their hydrogen policies (MNRE 2023). Furthermore, states have complemented the central government's initiatives to reduce green hydrogen production costs and boost domestic manufacturing by offering incentives that lower the cost of renewable energy (RE). They also offer manufacturing incentives and subsidies to encourage the adoption of green hydrogen. Project developers are eager to capitalize on this opportunity through local projects and investments, which will help the NGHM achieve its goals.

The roundtable aimed to facilitate a dialogue between the participating government institutions (from the states of Kerala, Punjab, and Rajasthan) and industry stakeholders, to highlight the key challenges in implementing green hydrogen projects in the country. It also sought to explore how state-level policies can address these challenges and expedite the establishment of green hydrogen projects.`

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These conference proceedings reflect the presentations and discussions of participants and do not necessarily represent the views of WRI India or other participating institutions.

The topics of discussion included the following:

- Policy incentives to ease costs and support green hydrogen projects in India
- Exploring alternate pathways other than electrolysis for green hydrogen production
- Green hydrogen trade dynamics in global markets
- Navigating risks in green hydrogen projects
- Challenges faced by project developers in implementing green hydrogen projects in India

INTRODUCTION

The NGHM has set the ambitious goal of producing 5 million tonnes (Mt) of green hydrogen annually by 2030. Under the NGHM, the Government of India has introduced several key mission components aimed at advancing the green hydrogen ecosystem. A major focus of the NGHM is providing financial incentives for pilot projects in sectors such as green steel, transport, and shipping. These incentives aim to demonstrate the practical use of hydrogen in these industries. Additionally, the NGHM includes targeted initiatives to encourage green hydrogen production and electrolyzer manufacturing in India. The NGHM also offers schemes to establish hydrogen hubs, promote research and development (R&D) activities, and develop testing facilities and infrastructure. Furthermore, it emphasizes skill development, raises public awareness, and fosters international cooperation to build a robust foundation for the hydrogen economy in the country.

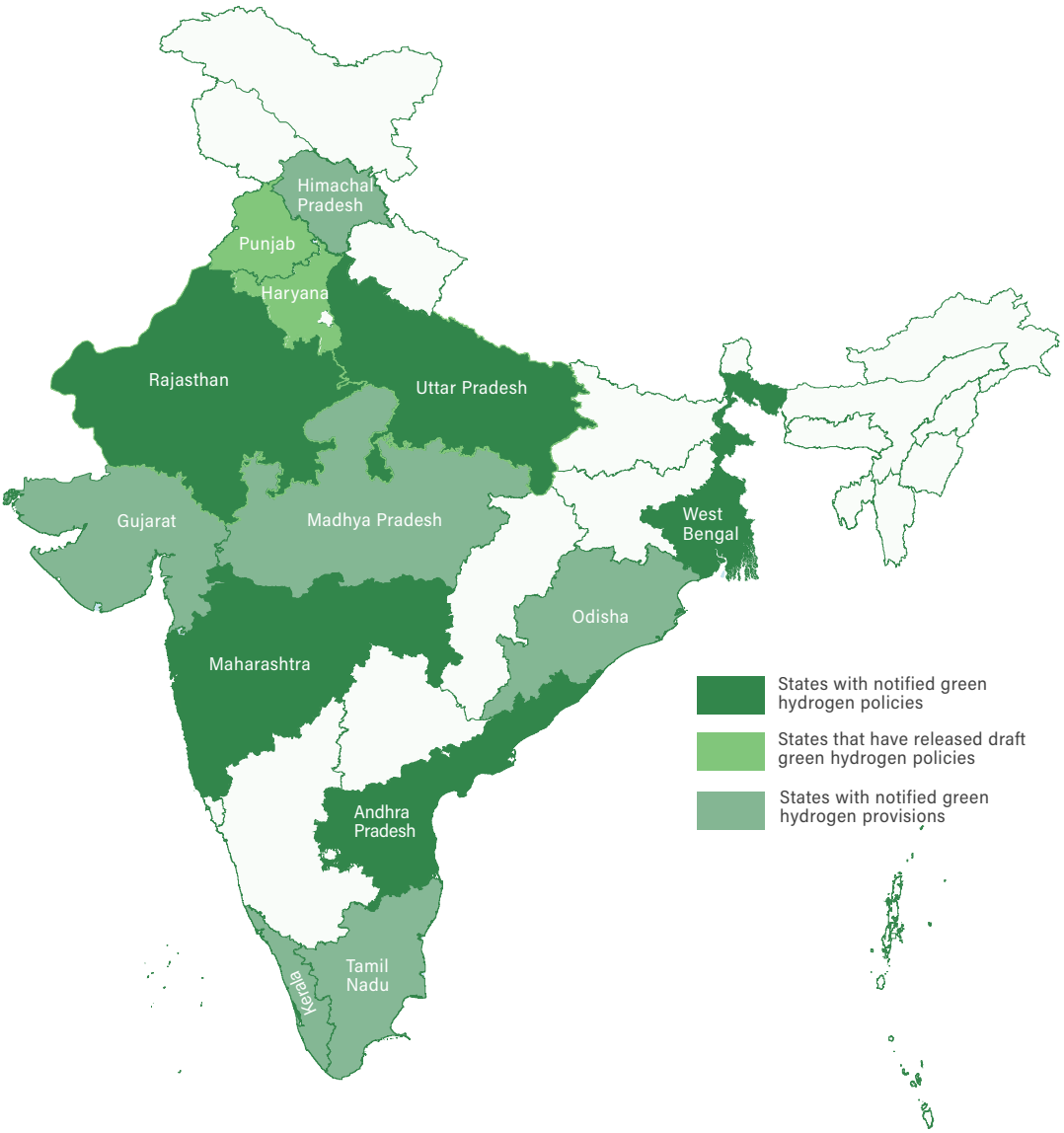
The NGHM is expected to attract investments of approximately INR 8 lakh crore and avoid 50 MMT per annum of expected carbon dioxide emissions by 2030. Also, it is projected to generate over 6 lakh direct and indirect jobs in sectors such as manufacturing, construction, research, and the overall hydrogen value chain.

Of the total allocated budget of INR 19,744 crores for the NGHM, a significant portion—INR 17,490 crores—is dedicated to the Strategic Interventions for Green Hydrogen Transition (SIGHT) program. This program proposes to support domestic electrolyzer manufacturing and green hydrogen production, offering financial incentives and capital support to drive these initiatives. In addition to fostering the growth of the domestic industry, the NGHM encourages international collaborations to bring advanced technologies and expertise to India (NGHM 2023).

Following the central government's announcement regarding the approval of the NGHM, many states have also introduced, or are in the process of introducing, subnational green hydrogen policies and incentives. These state-level subsidies or incentives complement the central government's schemes, providing additional support for green hydrogen project development.

States' approaches to providing green-hydrogen-related assistance vary. Several states have introduced dedicated hydrogen policies, and a few have issued draft hydrogen policies that include incentives to support the development of a green hydrogen ecosystem. In addition to issuing dedicated hydrogen policies, several states have introduced provisions to develop a green hydrogen ecosystem through other aligned policies. Some states have incorporated green hydrogen and green ammonia as thrust or sunrise sectors into their broader industrial policies to provide manufacturing-related incentives. A few states have incorporated green hydrogen into their RE or energy policies, offering incentives for the utilization of RE to produce green hydrogen. Apart from these states, Gujarat has established land policies designed to facilitate green hydrogen initiatives by providing suitable land parcels with the necessary infrastructure and regulatory clearances, while Kerala has allocated budgetary provisions aimed at fostering the green hydrogen ecosystem, ensuring financial support for project development (Koundal 2023). Figure 1 illustrates the provisions introduced by various states to expand the green hydrogen economy.

FIGURE 1 | Green hydrogen initiatives across India



DISCLAIMER: This map is for illustrative purposes and does not imply the expression of any opinion on the part of WRI India concerning the legal status of any country or territory or concerning the delimitation of frontiers or boundaries.

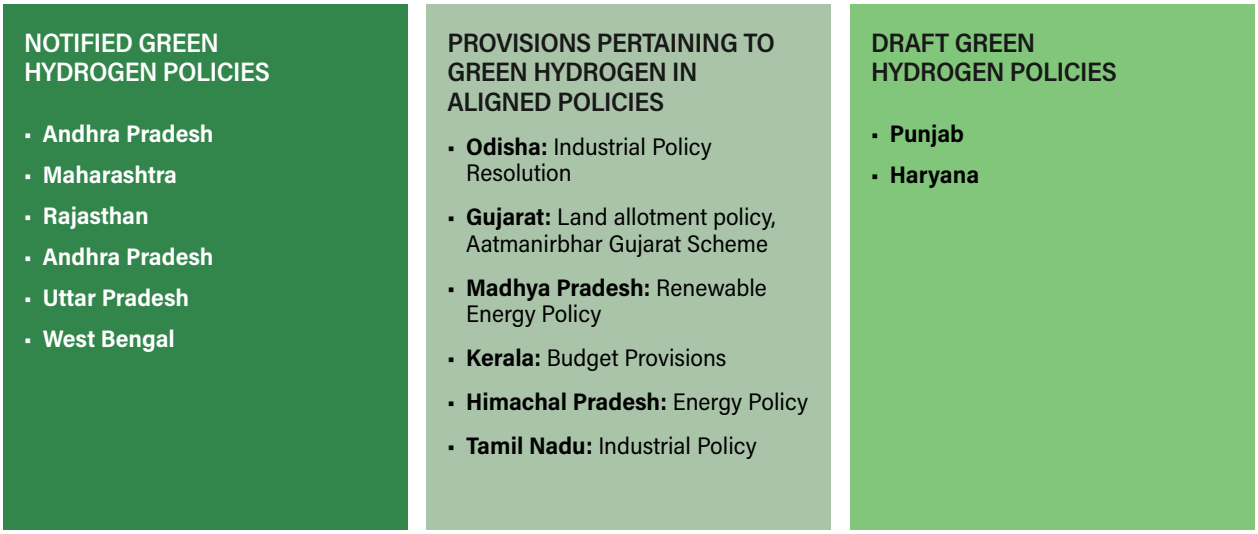
Sources: Respective state websites. Complied by WRI India

OVERVIEW OF HYDROGEN STATES STRATEGIES

This section provides an overview of key state policies and initiatives aimed at building a robust green hydrogen ecosystem, highlighting the strategies and progress as of May 2024. Each state has adopted a distinct approach to developing its green hydrogen ecosystem. States have analyzed their unique strengths and tailored their incentive mechanisms for developing green hydrogen ecosystems that align with their specific goals and ambitions by leveraging local resources.

Figure 2 illustrates the status of green hydrogen initiatives in various states (Himachal Pradesh in 2021, Tamil Nadu in 2021, Gujarat in 2022, Odisha in 2022, Madhya Pradesh in 2022, Andhra Pradesh in 2023, Gujarat in 2023, Kerala in 2023, Maharashtra in 2023, Rajasthan in 2023, Punjab in 2023, West Bengal in 2023, Haryana in 2024, and Uttar Pradesh in 2024).

FIGURE 2 | Status of green hydrogen initiatives in the states



Source: GoAP 2023; GoH 2023; GoHP 2021; GoG 2023; GoMP 2022; GoM 2023; GoO 2023; GoP 2023; GoR 2022; GoR 2023; GoUP 2024; GoTN 2021; GoWB 2023; MSME Gujarat 2022.

Each state has approached its green hydrogen policy with a combination of common goals and unique strategies tailored to its specific resources and priorities. This diversity reflects various aspects of state-level planning, with one key approach being the establishment of production targets that clearly articulate each state's green hydrogen development goals. Table 1 highlights the states that established production and/or demand targets for hydrogen ecosystem development within the operative period.

TABLE 1 | State-wise targets and operative period

State	Production target	Demand target	Operative period
Andhra Pradesh	500 ktpa of GH_2 or 2,000 KTPA of GA		Until 2028
Haryana	250 ktpa of GH_2 and 2 GW of electrolyzer manufacturing capacity		Until 2030
Maharashtra	500 ktpa of GH_2		Until 2030
Punjab	100 ktpa of GH_2	8% blending of GH_2 with gray hydrogen	Until 2030
Rajasthan	2,000 ktpa of GH_2, 1 gigafactory for electrolyzer manufacturing capacity, cater to 20% of GH_2 exports from India	10% blending of GH_2 in natural gas pipelines	Until 2030
Uttar Pradesh	1 Mtpa of GH_2		Until 2028

Note: GA = green ammonia. GH_2 = green hydrogen. ktpa = kilotonnes per annum. Mtpa = million tonnes per annum.
Source: GoAP 2023; GoH 2023; GoM 2023; GoP 2023; GoR 2023; GoUP 2023.

WATER AVAILABILITY

Water availability is a critical component of the success of green hydrogen projects, and several states in India have deployed mechanisms to allocate water for green hydrogen production plants. Uttar Pradesh has stated that it will collect comprehensive data on water availability. Haryana encourages the establishment of shared water treatment plants, with a special preference for projects utilizing gray water. Punjab prioritizes plants that use treated sewage water for electrolysis over those that use fresh water. Similarly, Rajasthan prioritizes plants utilizing brine water or treated wastewater, offering a special incentives and priority allocation of government land for such plants incorporating co-located RE sources.

HYDROGEN HUBS

There is also a shared emphasis on developing hydrogen hubs to facilitate the production, storage, transportation, and utilization of green hydrogen within a concentrated area. States such as Rajasthan, Maharashtra, Haryana, Kerala, and Uttar Pradesh are prioritizing the development of hydrogen hubs to centralize resources and infrastructure, streamline green hydrogen production, and support its derivatives. These hubs aim to integrate land, water, and other critical infrastructure to foster a green hydrogen ecosystem.

R&D

Another key focus area in the states is R&D to drive innovation and advance green hydrogen technologies. Rajasthan is promoting the establishment of R&D centers equipped with testing, skilling, and incubation facilities. Punjab is allocating budgetary support for R&D activities and collaborating with academic and research institutions to establish centers of excellence (CoEs). Similarly, Maharashtra is supporting the establishment of a dedicated CoE and encouraging central universities, state universities, and government-recognized organizations to support entrepreneurship and research in hydrogen and its derivatives. Haryana is facilitating funding through appropriate state authorities to support the establishment of R&D units on a case-by-case basis. Uttar Pradesh is taking proactive steps by establishing two CoEs dedicated to green hydrogen innovation. Additionally, some states have introduced special incentives to further bolster R&D efforts, as outlined in Table 2.

TABLE 2 | R&D incentives in the states

State	R&D incentive
Rajasthan	One-time grant of up to 30% of the cost incurred in the establishment of R&D centers subject to a maximum of INR 5 crores
Uttar Pradesh	100% financial incentive (maximum up to INR 50 crores) for establishing CoEs
Odisha	50% assistance on investments subject to a maximum of INR 10 crores

Note: CoE = center of excellence. INR = Indian rupee. R&D = research and development.
Source: GoR 2023; GoUP 2023; GoO 2023.

SKILL AND BUSINESS DEVELOPMENT

Skill development is another focus area of the subnational hydrogen policies for fostering the green hydrogen transition. States are launching dedicated skill development programs to train their workforce for the green hydrogen or green ammonia transition, collaborating with Industrial Training Institutes (ITIs), polytechnics, international educational institutions, RE developers, hydrogen producers, and scientific organizations to cultivate skilled talent for the sector and integrate specialized courses in state engineering and technical institutes. Another approach is promoting ease of doing business to stimulate growth in the green hydrogen sector. Many states have introduced streamlined processes and single-window clearances to expedite approvals, permits, and clearances, facilitating smoother project development for green hydrogen.

Alongside the abovementioned common goals, each state has tailored its green hydrogen policies to capitalize on its unique local strengths and priorities:

- **Feedstocks for production:** Rajasthan is actively encouraging the use of brine water for green hydrogen production to optimize resource utilization.
- **Green hydrogen production:** Punjab, being an agrarian state, is promoting and providing capital subsidies for green hydrogen and ammonia production from agricultural residues and biomass waste, and incentives for the machinery required for bailing collection and transportation of biomass.
- **Green hydrogen production infrastructure:** Drawing from its experience with solar parks, Rajasthan is developing green hydrogen parks with or without co-located RE plants. These parks provide civil and power infrastructure that reduces project risks and streamlines development.
- **Transportation:** Maharashtra, which is strategically positioned near major hydrogen-consuming industries such as refineries, fertilizer, and steel plants, is prioritizing and providing subsidies on capital as well as on subvention of interest rates for hydrogen transport via pipelines.
- **Energy storage:** Himachal Pradesh is prioritizing hydrogen-based energy storage solutions. Himachal Pradesh has a surplus of energy during the summer and monsoon months, and it aims to use this surplus energy to produce green hydrogen.
- **Demand incentives:** Uttar Pradesh aims to address local demand in refineries and fertilizer industries through domestic green hydrogen and ammonia production.
- **Job creation:** Haryana is ensuring gender and social inclusion by supporting the participation of women and socially marginalized communities in the development of projects related to green hydrogen and its derivatives. The state is reskilling workers from fossil-fuel-based industries to bridge the skill gap and create a more employable workforce.

To further attract investments and build a green hydrogen ecosystem, states have introduced comprehensive fiscal and nonfiscal incentives. These include various incentives to lower the cost of RE used to produce green hydrogen and green ammonia, as well as measures to develop a robust manufacturing ecosystem for electrolyzers and make hydrogen more affordable across diverse applications.

The measures to lower the cost of RE include exemptions on electricity duty charges, cross-subsidy surcharges, additional subsidy surcharges, intrastate transmission charges, and wheeling charges. These incentives also extend to land allocation, provision of government land at subsidized rates, stamp duty exemptions, and exemptions from other local taxes.

Further support is provided through assistance and incentives for innovation and R&D, Goods and Services Tax (GST) reimbursement, employment subsidies, capital expenditure (CAPEX) subsidies for electrolyzer and equipment manufacturing facilities, subsidies for green hydrogen utilization in diverse applications, facilitation of water infrastructure development, single-window clearance, and facilitation of transmission connectivity. For end-use applications, capital subsidies are offered for hydrogen use in the transportation sector, such as for refueling stations and passenger vehicles. A targeted subsidy is also provided to lower the cost of green hydrogen in specific applications, reducing the price by a designated amount to encourage wider adoption. A detailed breakdown and analysis of the incentives are provided in the following section.

STATE-WISE INCENTIVES

Overview of state-level incentives for reducing the cost of RE

By incorporating RE incentives into their policies, many states are promoting green hydrogen production, addressing a significant cost component in the process. Table 3 depicts the incentives offered by states, which vary widely.

FIGURE 3 | Categorization of state-wise incentives

Note: CAPEX = capital expenditure. RE = renewable energy.

Source: WRI India authors

TABLE 3 | State-level renewable energy incentives

State	Intrastate transmission charges exemption	Wheeling charges exemption	CSS exemption	As exemption	Electricity duty exemption	Banking provisions	Contract demand
Andhra Pradesh	25% for 5 years, maximum INR 10 lakhs/MW/yr of electrolyzer	NA	100% Reimbursed for 5 years	NA	100% for 5 years	NA	NA
Haryana	100% for 10 years	100% for 10 years	100%	NA	100% for 10 years	NA	100% for procuring renewable energy from open access
Himachal Pradesh	100% for 5 years for power used from hydro projects	NA	NA	NA	100% for 5 years	NA	NA
Madhya Pradesh	NA	50% for 5 years	NA	NA	100% for 10 years	NA	NA

Note: AS = additional surcharge. CSS = cross-subsidy surcharge. MW = megawatt. NA = not applicable. ToD = Time of Day.

Source: GoAP 2023; GoH 2023; GoHP 2021; GoMP 2022; GoM 2023; GoO 2023; GoP 2023; GoR 2023; GoUP 2024; GoTN 2021; GoWB 2023.

*Banked energy during a particular time block can be used only during that block.

TABLE 3 | State-level renewable energy incentives (cont'd)

State	Intrastate transmission charges exemption	Wheeling charges exemption	CSS exemption	As exemption	Electricity duty exemption	Banking provisions	Contract demand
Maharashtra	50% for 10 years	50% for 10 years	100%	100%	100% for 10 years for standalone plants, 15 years exemption for hybrid plants	NA	NA
Odisha	100% for 20 years	NA	100% for 20 years	100% for 20 years	100% for 20 years	NA	NA
Punjab	50% for 5 years	50%	100%	100%	100%	NA	Concession in contract demand charges
Rajasthan	50% for 10 years	50% for 10 years	100% for 10 years	100% for 10 years	50% for 10 years	30 days banking with a cap of one-third of energy injection	NA
Tamil Nadu	NA	NA	NA	NA	100% for 5 years	NA	NA
Uttar Pradesh	100% for 10 years	100% for 10 years	100% for 10 years	100% for 10 years	100% for 10 years	Monthly banking with no carry forward.*	NA
West Bengal	NA	NA	NA	NA	100% for 5 years	NA	NA

Note: AS = additional surcharge. CSS = cross-subsidy surcharge. MW = megawatt. NA = not applicable. ToD = Time of Day.

Source: GoAP 2023; GoH 2023; GoHP 2021; GoMP 2022; GoM 2023; GoO 2023; GoP 2023; GoR 2023; GoUP 2024; GoTN 2021; GoWB 2023.

*Banked energy during a particular time block can be used only during that block.

State-level incentives (land incentives)

Several states have introduced specific incentives specifically for resource usage aimed at reducing operational costs (see Table 4).

TABLE 4 | State-level incentives for land

State	SGST exemption	Stamp duty exemption (%)	Land conversion charges exemption	Land tax exemption	Land lease rate (INR/acre/year)
Andhra Pradesh	100% reimbursement for 5 years	100%	100%	0%	31,000 (5% increase every 2 years)
Haryana	NA	100%	100%	100%	NA
Gujarat	100%	100%	NA	100%	Lease to be provided for 40 years at INR 15,000 per hectare
Madhya Pradesh	NA	50%	NA	NA	NA
Maharashtra	NA	100%	100%	100%	NA
Odisha	100% of net SGST up to 200% of GH2/ GA plant CAPEX	100%	100%	100%	50% of published zonal rates
Punjab	NA	100%	100%	NA	NA
Rajasthan	75% for 7 years	100%	100%	100% (for 7 years)	NA
Tamil Nadu	100%	100%	NA	NA	Between 10% and 50% concessional rate, depending on the district
Uttar Pradesh	100%	100%	NA	NA	INR 1/acre/year (PSUs), INR 15,000/ acre/year (private, 30 years)
West Bengal	100% until December 2028	100% until December 2028	100% until December 2028	NA	NA

Note: CAPEX = capital expenditure. GA = green ammonia. GH2 = green hydrogen. NA = not applicable. PSUs = public sector units. SGST = State Goods and Service Tax.

Source: GoAP 2023; GoH 2023; GoHP 2021; GoG 2023; GoMP 2022; GoM 2023; GoO 2023; GoP 2023; GoR 2022; GoR 2023; GoUP 2024; GoTN 2021; GoWB 2023; MSME Gujarat 2022.

Capital incentives

Several states have introduced capital subsidies and manufacturing-side incentives to attract investments (see Table 5).

TABLE 5 | State-level incentives for capital subsidy

State	Investment incentives	CAPEX incentives
Gujarat	• Assistance of interest subsidy @ 7% on term loan subject to a maximum of 1.2% of eligible fixed capital investment (eFCI) per annum for 10 years • Reimbursement of net SGST at 100% of the net SGST, subject to a maximum of 0.9% of the eFCI per annum, for 20 years • Up to 100% reimbursement of input SGST paid on capital goods	NA
Maharashtra	Anchor units refer to three green hydrogen plants of 50 ktpa capacity: • A subsidy of 30% on rent shall be admissible • 50% concession in transmission charges and wheeling charges for 20 years • A rebate of 1% in power tariff for 15 years • Benefit will be applicable for one anchor unit up to 100 ktpa capacity	• INR 2.5 crores per project for hydrogen transportation through pipeline with a maximum of 10 crores, limited to 30% capital cost • 1% interest subsidy on a hydrogen transport project for 10 years. A total of INR 50 lakh will be given as a subsidy
Odisha	30% CAPEX subsidy for a captive renewable energy plant. A subsidy of 25% of the investment, up to a maximum of INR 10 crores per industrial unit • Green building • Wastewater treatment facilities • Effluent treatment plant • Deep sea discharge facility • 50% capital subsidy on up to a maximum of INR 10 crores per industrial unit for industries practicing at least 50% wastewater recovery through zero liquid discharge (ZLD)	30% CAPEX subsidy for a green hydrogen or green ammonia plant
Punjab	NA	Maximum INR 15 crores/project (INR 3 crores per tonnes per day, a maximum of 5 tonnes per day for biomass or green hydrogen projects, up to 10 projects)
Rajasthan	The first three units require a minimum investment of INR 50 crores each • A sunrise booster of 20% is available on the selected asset creation incentives, including capital subsidy, TLI, or SGST reimbursement • 100% banking, wheeling, and transmission charges waived off/ reimbursed for captive power plants set up by the first three units • Other incentives, exemptions, employment booster, special incentives	NA
Tamil Nadu	• Sunrise Booster, which implies an additional cap-ital subsidy of up to 7.5% of eligible fixed assets, depending upon the investment and employment • Interest subvention of 5% as a rebate up to INR 400 lakhs in the rate of interest on actual term loans for 6 years	NA
Uttar Pradesh	• Option 1: A capital subsidy, covering up to 30% of the total investment, with a maximum limit of INR 150 crores, which can be increased to INR 210 crores with a booster • Option 2: SGST reimbursement is available with an annual limit of up to 25% of the total investments and an overall limit of up to 300%, applicable for a maximum of 16 years • Option 3: Top-up of 30% on sanctioned incentives received under PLI scheme, limited to 100% of the total investments	NA

Note: CAPEX = capital expenditure. PLI = production linked incentive. SGST = State Goods and Service Tax. TLI = Turnover Linked Incentives.

Source: GoM 2023; GoO 2023; GoP 2023; GoR 2022; GoUP 2024; GoTN 2021; MSME Gujarat 2022.

Incentives for end use

States have also introduced incentives targeting the end-use applications of hydrogen(see Table 6).

TABLE 6 | State-level incentives for end-use applications

State	Hydrogen use incentive	Hydrogen application incentive	Other monetary incentives
Gujarat			Reimbursement of EPF for 10 years
Haryana	INR 50 per kilogram (kg) subsidy for 5 years of green hydrogen blending in gas		
Maharashtra	INR 50 per kg subsidy for 5 years of green hydrogen blending in gas	30% capital cost subsidy for the first 500 hydrogen fuel cell passenger vehicles (heavy vehicles, or HVs) and 20 hydrogen refueling stations (HRSs) subject to INR 60 lakhs per HV and INR 4.50 crores per HRS	INR 4 crores per annum for 10 years for recruitment of skilled workers, their training, and skill development; single-window facility
Odisha			• 100% reimbursement of ESI and EPF for 7 years • Reimbursement of green tariff at INR 3 per unit for 20 years
Punjab	A subsidy of INR 50 per kg, for the first 10 industries consuming green hydrogen, applicable for a period of 5 years	• A capital cost subsidy of 20% for fuel cell trucks and buses, with a maximum limit of INR 50 lakhs per vehicle, applicable to the first 100 vehicles • A capital cost subsidy of 20% for HRSs, with a maximum limit of INR 3 crore per HRS, applicable to the first 10 stations	NA
Tamil Nadu	NA	NA	• 25% subsidy on the cost of setting up environmental protection infrastructure • Subsidy of 50% of the total cost of obtaining the quality certification • 50% reimbursement to a maximum of INR 1 crore for intellectual property creation
Uttar Pradesh	NA	NA	• A financial incentive of INR 25 lakhs per year for a duration of 5 years to each startup, with a maximum of 10 startups per incubator, and a total limit of three incubators • 20% incentive allocated to start-ups for activities such as capacity-building, hackathons, events, and administrative expenses.

Note: EPF = Employee Provident Fund. ESI = Employee State Insurance.

Source: GoH 2023; GoM 2023; GoO 2023; GoP 2023; GoUP 2024; GoTN 2021; MSME Gujarat 2022.

PERSPECTIVES OF KEY STAKEHOLDERS

Many states have signed memorandums of understanding (MoUs) with private companies intending to devote huge investments to develop green hydrogen projects in their states. However, as the industry moves toward developing projects, several challenges are anticipated. These challenges may vary by state or by region, thus requiring a tailored approach to address each project's specific needs. The following section highlights the discussion between state participants and industry participants focusing on state policy incentives, the progress achieved thus far, and suggestions for fostering the development of the green hydrogen ecosystem. The discussion regarding the proactive measures taken by Kerala, Punjab, and Rajasthan is summarized as follows:

- **Kerala** presented its draft hydrogen policy, highlighting its goal to become a leading producer and consumer of green hydrogen and green ammonia by 2040. Kerala highlighted its efforts to advance the Kochi green hydrogen hub by collaborating with the India Hydrogen Alliance (IH2A), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), and Kreditanstalt für Wiederaufbau (KfW). The state has identified key participants in the hub, including existing industrial consumers such as BPCL and fertilizer manufacturers, along with proposed offtakes for mobility and export purposes.

The state highlighted the following key initiatives:

  - It showcased the planned pilot projects of hydrogen valleys in Kochi and Thiruvananthapuram, with diverse end uses in land transport (buses), water transport (boats), hydrogen blending, and propulsion for houseboats.
  - A pilot for green-hydrogen-powered trucks, utilizing both internal combustion engines (ICEs) and fuel cells (FCs).
  - Cochin Shipyard's initiative to build hydrogen-powered ferry vessels.

- **Punjab** emphasized that its green hydrogen policy strongly focuses on biomass, leveraging the state's abundant resources. The state mentioned its plans to produce green hydrogen through biogas processing and shared details of upcoming biogas projects, including partnerships with Reliance and Adani. Also, Punjab has proposed the establishment of a National Center for Advanced Green Hydrogen Production with the Ministry of New and Renewable Energy (MNRE) and IIT Ropar, with a focus on biomass-based production methods. Additionally, the state is developing mechanisms to directly connect offtakers, such as refineries and fertilizer plants, with green hydrogen production facilities.
- **Rajasthan** outlined its policy incentives and targets for developing the green hydrogen ecosystem. The state emphasized its goal of establishing a green hydrogen valley to cater to the demands of fertilizer plants and refineries. Additionally, Rajasthan plans to develop a gigafactory for electrolyzer manufacturing to export domestically produced electrolyzers to global markets.

After the perspectives of individuals were shared, a group discussion was held. The outcomes of the group discussion are summarized as follows.

GROUP DISCUSSION OUTCOMES

Government policies for green hydrogen projects in India

- Land acquisition is a critical issue for the development of green hydrogen projects in India. Waiving up-front land value charges would reduce the financial burden on developers, lower initial project costs, and make land more accessible for green hydrogen project developers.
- Identifying strategic locations for green hydrogen applications rather than implementing broad country-wide incentives would optimize land use and project viability.
- Treating initial green hydrogen projects as strategic investments rather than focusing solely on low cost for green hydrogen production can help demonstrate and validate the technology.

Derisking the hydrogen ecosystem

- Financial incentives and access to affordable capital are needed to support first-mover green hydrogen projects, given the nascency of the green hydrogen ecosystem in India.
- It was emphasized that insufficient financial backing risks stalling the advancement of the green hydrogen industry. Exploring public-private partnerships (PPPs) to combine private-sector efficiency with public-sector resources could mitigate this risk.
- Industry participants are focusing on linking green hydrogen projects to monetize emissions reductions through carbon markets. This can facilitate access to international markets to sell carbon credits and secure additional financial support for green hydrogen projects.

Advancing hydrogen production through alternative pathways

- The participants emphasized the dual benefits of using biomass to produce hydrogen: reducing agricultural waste and contributing to the green hydrogen ecosystem.
- Partnerships between state governments, research institutions, and private companies are necessary to scale biomass-based hydrogen technologies.
- The participants suggested that R&D facilities and pilot projects should focus on states that can provide biomass feedstock, thus advancing hydrogen production through this pathway.

FIGURE 4 | Discussions on accelerating the Hydrogen ecosystem in India

Photo Credit: WRI India.

Other discussion points

- Harmonize green hydrogen standards to enable project developers to gain access to multiple international markets, facilitate global trade, and position India as a key supplier to regions such as Europe and Japan.
- Develop a concise and relevant document for government officials to enable them to build their internal capacity for advancing hydrogen projects.
- Provide detailed information to government officials, enabling them to support the identification and exploration of specific locations suitable for green hydrogen applications.
- Transform hydrogen project funding with tokenization to allow fractional ownership with increased financial liquidity and enable investors to buy tokens representing parts of hydrogen projects. This would reduce risks for large-scale investors.

THE WAY FORWARD

- Harmonize standards and certification processes for green hydrogen to ensure compliance and facilitate trade.
- Promote PPPs to support early-stage projects and attract private investment.
- Introduce streamlined and low-cost land acquisition processes and prioritize strategic locations for green hydrogen projects.
- Promote R&D, pilot projects, and decentralized green hydrogen production hubs to utilize agricultural waste for hydrogen production.
- Enable green hydrogen projects to participate in carbon markets to monetize emissions reductions and improve project viability through carbon credits.
- Foster partnerships between industry stakeholders, academia, and the government to align policy efforts, identify strategic actions, and resolve implementation challenges.
- Launch targeted programs to train a workforce capable of supporting the green hydrogen transition, focusing on emerging technologies, operational needs, and innovation.

APPENDIX A
List of experts

Prem Kumar, Agency for New and Renewable Energy Research and Technology (ANERT)

M.P. Singh, Punjab Energy Development Agency

Pawan Tanwar, Rajasthan Renewable Energy Corporation Ltd.

Surbhi Goyal, World Bank

Ramanna Reddy, KfW Development Bank

Mudit Jain, Tata Capital

Ravi Verma, Avaada

Aniruddha Kadvekar, Sopan

Kiran Kumar Alla, Plug Power

Pragya Gupta, FTI Consulting

Ranjit Gupta, Ocior

Ankur Malyan, RMI India

Satyasheel Bharadwaj, Larsen & Toubro Ltd.

Snehil Singh, FTI Consulting

Dipesh Pherwani, Ex-WRI India

Dr. Bhaskar Jha, Xynteo India Limited

Vipul Tuli, Sembcorp

Madhav Pai, WRI India

Pawan Mulukutla, WRI India

Anuraag Nallapaneni, WRI India

Utsav Shah, WRI India

Anindita Bhattacharjee, WRI India

Garima Jain, WRI India

LIST OF ABBREVIATIONS

AS: Additional Surcharge

BPCL: Bharat Petroleum Corporation Limited

CAPEX: Capital Expenditure

CoE: Center of Excellence

CSS: Cross-Subsidy Surcharge

EPF: Employees' Provident Fund

ESI: Employees' State Insurance

FC: Fuel Cell

GA: Green Ammonia

GH_2: Green Hydrogen

GIZ: Deutsche Gesellschaft Für Internationale Zusammenarbeit

GST: Goods and Services Tax

GW: Gigawatt

HRS: Hydrogen Refueling Station

ICE: Internal Combustion Engines

IESW: India Energy Storage Week

IH2A: India Hydrogen Alliance

IIT: Indian Institute of Technology

INR: Indian Rupees

ITI: Industrial Training Institutes

KfW: Kreditanstalt Für Wiederaufbau

Ktpa: Kilotonnes per Annum

MoU: Memorandum Of Understanding

MNRE: Ministry of New and Renewable Energy

MSME: Micro, Small, and Medium Enterprises

Mt: Million Tonne

Mtpa: Million Tonnes per Annum

MW: Megawatt

NA: Not Applicable

NGHM: National Green Hydrogen Mission

POC: Proof-Of-Concept

PPP: Public-Private Partnership

R&D: Research & Development

RIPS: Rajasthan Investment Promotion Scheme

RE: Renewable Energy

SGST: State Goods and Services Tax

SIGHT: Strategic Interventions for Green Hydrogen Transition

TLI: Turnover Linked Incentives

TPD: Tonnes Per Day

VGF: Viability Gap Funding

ZLD: Zero Liquid Discharge

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