Green Hydrogen and Green Ammonia

Summary Report on The Policy Narrative in India and Deployment Status

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National missions and their trajectory

A "national mission" in India refers to a large-scale, government-led initiative focused on achieving a specific goal related to national development, often addressing critical issues like healthcare, education, climate change, or infrastructure, with various programs and strategies implemented to reach that objective.

1. NITI Aayog has established the Energy Vertical that strives to provide top-quality policy support to all stakeholders to make India energy-secure. It aims to boost investment to achieve an efficient, sustainable, and clean energy system. The Vertical makes concerted efforts towards reducing energy import, ensuring an alternative supply of energy and enhancing domestic supply. It seeks to strengthen the energy infrastructure and resolve cross-sectoral issues. The policy framework is geared such that energy is supplied through efficient markets to improve India's competitiveness and spur economic growth.

2. Vision Document 2035: NITI Aayog kickstarted the exercise for drafting Vision Document 2035 for India, with the base year of 2020. The vision intends to provide a broad roadmap for addressing the concerns of energy access, affordability, reliability rational pricing and energy security. The document is under finalisation after due consultations with the relevant stakeholders and the Ministries/Departments.

3. State Energy and Climate Index: NITI Aayog is working on a State Energy and Climate Index to assess the performance of States based on a number of indicators. These include discoms' viability and competition, access, affordability and reliability of energy, clean energy initiatives and energy efficiency. The work is in progress and the tool will be designed to assess States' performance on various energy parameters, which will help them to efficiently manage their energy resources and provide better access to citizens

4. Geospatial Energy Map of India: NITI Aayog collaborated with Indian Space Research Organisation (ISRO) to develop a comprehensive Geospatial Energy Map of India, which provides a holistic picture of India's energy sector. This includes the visualisation of spatial and non-spatial data on renewable and non-renewable power plants, oil and gas downstream sector, renewable energy potential, fossil fuel resources, and other energy assets.

5. NITI Aayog, in collaboration with International Energy Agency (IEA) , has taken up the following activities:

    5.1. NITI Aayog and IEA organised workshops on 'Power System Transformation' in Maharashtra, Gujarat and Karnataka. The objective of these workshops was to bring together the international, national, and state-level stakeholders to address the issues of increasing shares of solar and wind in the grid. The workshops also explored opportunities for flexibility solutions to overcome issues faced by the States with regard to forecasting of solar and wind, transmission challenges, technical

challenges, such as inertia, system strength, frequency and voltage issues, demand forecast, etc.

5.2. Launch of Renewables Integration in India 2021: The analysis in this report is based on the outcomes of national and regional workshops focused on India's low-carbon transition strategy for renewable energy integration held in 2018 and a series of power system transformation workshops in Maharashtra, Gujarat and Karnataka in 2020 and 2021. The report not only includes outcomes of the workshops but also presents analysis to address future grid integration challenges due to a high penetration of renewables in India by 2030. The report provides an international framework for renewables integration and highlights a full repertoire of power system flexibility solutions. Power system transformation pathways and renewables integration challenges, solutions and priorities are vastly different in States and Union Territories.

5.3. Capacity building exercise: IEA and NITI Aayog has jointly worked with the States for capacity building and training program better energy data management.

6. National Hydrogen Mission on India's 75th Independence Day (i.e. 15th August, 2021). The Mission aims to aid the government in meeting its climate targets and making India a green hydrogen hub. This will help in meeting the target of production of 5 million tonnes of Green hydrogen by 2030 and the related development of renewable energy capacity

7. NATIONAL MISSION ON TRANSFORMATIVE MOBILITY AND BATTERY STORAGE

8. The National Electric Mobility Mission Plan (NEMMP) 2020 is a National Mission document providing the vision and the roadmap for the faster adoption of electric vehicles and their manufacturing in the country. This plan has been designed to enhance national fuel security, to provide affordable and environmentally friendly transportation and to enable the Indian automotive industry to achieve global manufacturing leadership.

Fiscal outlays and planned long term support for new technologies

The Strategic Interventions for Green Hydrogen Transition (SIGHT) program is a major financial part of the National Green Hydrogen Mission in India with an fiscal outlay of INR 17,490 our of the total of 19,744 Crores up between FY22-23 to FY29-30. In addition, INR 1,466 Cr. have been earmarked for Pilots and INR 400 Cr. For R&D. The program proposes two distinct financial incentive mechanisms to support the domestic manufacturing of electrolysers and the production of green hydrogen.

In the recently published guidelines for the SIGHT program dated June 2023, a total outlay of INR 13,050 crores have been sanctioned from FY 2025-26 to FY 2029-30 as an incentive scheme for Green Hydrogen Production. The Mission is expected to also support pilot

projects in emerging end-use sectors and production pathways. Regions capable of supporting large scale production and/or utilization of Hydrogen are to be identified and developed as Green Hydrogen Hubs. For the same period the Incentive Scheme for Electrolyser Manufacturing is a substantial financial outlay of INR 4,440 Cr.

Specifically for green ammonia, direct incentives of INR 8.82/kg in the first year, INR 7.06/kg in the second year, and INR 5.30/kg in the third year are expected to be provided from the commencement of green ammonia production and supply. These incentives are aimed to enable rapid scale-up, technology development, and cost reduction of green hydrogen by 2030.

Evolving policies and regulations

1. The Energy Conservation (Amendment) Bill, 2022 was introduced in Lok Sabha on August 3, 2022. The Bill seeks to amend the Energy Conservation Act, 2001. The Act promotes energy efficiency and conservation. It provides for the regulation of energy consumption by equipment, appliances, buildings, and industries. Key proposals under the Bill are: Obligation to use non-fossil sources of energy, Carbon Trading, Energy conservation code for buildings, Applicability to residential buildings, Standards for vehicles and vessels, Regulatory powers of State Electricity Regulatory Commissions.
2. Energy Conservation Act, 2001: An Act to provide for efficient use of energy and its conservation and for matters connected therewith or incidental thereto
3. Green Building Code: In India, the Green Building Code is a medley of codes and standards contained in the State by-laws, the National Building Code, the Energy Conservation Building Code (ECBC) and in the norms set by the ratings programmes, such as Leadership in Energy and Environmental Design-India (LEED-India), the standards and guidelines put down for the Residential Sector by the Indian Green Building Council (IGBC), TERI-GRIHA and other such certifications.
4. Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India (FAME India) Scheme in the year 2015 to promote manufacturing of electric and hybrid vehicle technology and to ensure sustainable growth of the same. The Phase-I of this Scheme was initially launched for a period of 2 years, commencing from 1st April 2015, which was subsequently extended from time to time and the last extension was allowed up to 31st March 2019. The 1st Phase of FAME India Scheme was implemented through four focus areas namely (i) Demand Creation, (ii) Technology Platform, (iii) Pilot Project and (iv) Charging Infrastructure. Market creation through demand incentives was aimed at incentivizing all vehicle segments i.e. 2-Wheelers, 3-Wheelers Auto, Passenger 4-Wheeler vehicles, Light Commercial Vehicles and Buses.
5. Production Linked Incentive (PLI) scheme for Advanced Chemistry Cell (ACC) Battery Storage

Policies: National level interventions (Central Government)

Provisions notified by the Ministry of Power under the Green Hydrogen / Green Ammonia Policy (No. 23/02/2022-R&R) are as below:

1. Green Hydrogen / Ammonia producers may purchase renewable power from the power exchange or set up RE capacities themselves or through any other, developer, anywhere
2. Open access will be granted within 15 days of receipt of application.
3. The Green Hydrogen / Ammonia manufacturer can bank their unconsumed renewable power, up to 30 days, with distribution company and take it back when required within this period.
4. Distribution licensees can also procure and supply renewable energy to the manufacturers of Green Hydrogen / Green Ammonia in their States at concessional prices which will only include the cost of procurement, wheeling charges, and a small margin as determined by the State Commission.
5. Waiver of inter-state transmission charges for a period of 25 years will be allowed to the manufacturers of Green Hydrogen and Green Ammonia for the projects commissioned before 31st December 2030.
6. The manufacturers of Green Hydrogen / Ammonia and the renewable energy plant shall be given connectivity to the grid on priority basis to avoid any procedural delays.
7. Renewable Purchase Obligation (RPO) mandates that all electricity distribution licenses should produce or purchase a minimum specified quantity of their needs from RE sources. The benefit of RPO will be granted incentive to the hydrogen/Ammonia manufacturer and the Distribution licensee for consumption of renewable power.
8. To ensure ease of doing business a single portal for carrying out all the activities including statutory clearances in a time bound manner shall be set up by MNRE.
9. Connectivity, at the generation end and the Green Hydrogen / Green Ammonia manufacturing end, to the ISTS for Renewable Energy capacity set up for the purpose of manufacturing Green Hydrogen / Green Ammonia shall be granted on priority.
10. Manufacturers of Green Hydrogen / Green Ammonia shall be allowed to set up bunkers near Ports for storage of Green Ammonia for export / use by shipping. The land for the storage for this purpose shall be provided by the respective Port Authorities at applicable charges.

Policies: State level interventions

1. Tamil Nadu has categorized hydrogen as a sunrise sector and is eligible for the associated sunrise sector incentives. Also, among other incentives, the sector is eligible for land

subsidies and interest subvention of 5% (as a rebate in the rate of interest). Companies that secure land for renewable energy generation will have a competitive advantage in obtaining government land for hydrogen production. The state plans to offer a "structural package of incentives" to selected projects, which may include exemptions from electricity taxes and stamp duties, as well as flexible capital subsidies or turnover-based subsidies. These incentives will be customized for individual projects and disbursed upon the commencement of commercial production.

2. In Uttar Pradesh currently 10% blending of Green Urea has been mandated in the state's Urea production. Also, the state intends to promote the blending of green hydrogen with grey hydrogen in existing N-fertilizers and refineries, achieving at least 20% of green hydrogen in the consumption mix by 2028 and 100% by 2035. Exemptions from wheeling charges, cross subsidy surcharges, and distribution charges have been announced, along with other incentives. Furthermore, an additional subsidy of INR 3,500 per tonne of urea has been announced for every extra tonne of green urea produced in the state beyond the announced 10% blending mandate. The state offers various exemptions to enhance the financial viability of green urea production: 100% exemption from cross-subsidy surcharges, 100% exemption from distribution charges, 50% exemption from wheeling charges, and 50% exemption from intra-state transmission charges. Producers of green hydrogen and ammonia will benefit from a 100% reimbursement of the State's Goods and Services Tax (SGST) for their production activities. The policy includes provisions for capital subsidies, which can be up to 30%, with the first five projects receiving up to 40% capital subsidy, capped at a maximum of INR 225 crore. Other fiscal incentives may include: Exemptions from stamp duty and tax reimbursements and Interest subsidies on capital investments.
3. Green Hydrogen Policy 2023 in Maharashtra encourages investments in green hydrogen projects by offering: 100% discount on electricity for renewable energy projects and 30% subsidy on capital costs for the first 20 green hydrogen refuelling stations, with each station eligible for up to ₹4.50 crore.
4. Green Hydrogen Policy in Punjab includes A capital subsidy of up to ₹15 crores per project and Waivers on inter-state transmission charges for projects commissioned before December 31, 2030.
5. Andra Pradesh launched Green Hydrogen and Green Ammonia Policy in June, this policy targets the production of up to 2 million tonnes of ammonia per year using renewable energy. It includes various incentives to attract project developers.

Green Hydrogen and Green Ammonia

GH2 projects stanchioned under SIGHT

The Honourable Government of India inaugurated the National Green Hydrogen Mission in the beginning of 2023, to establish India's Green Hydrogen ecosystem. It made the emergence of many developers and electrolyser manufacturers towards green hydrogen production. The Ministry of New and Renewable Energy is carrying out the National Green Hydrogen Mission, which seeks to make India the global hub for the production, use, and export of green hydrogen and its derivatives. SECI has granted 412,000 metric tons of green hydrogen production capacity and 1.5 GW of electrolyser manufacturing capacity through the Strategic Interventions for Green Hydrogen Transition SIGHT initiative.

The current status of green hydrogen adoption in the country is as follows:

1. GAIL Limited launched India's first initiative to blend hydrogen into the city gas distribution grid. At Avantika Gas Limited (AGL)'s City Gas Station in Indore, Madhya Pradesh, two percent by volume of hydrogen is blended into the CNG network and five percent into the PNG network.

2. Beginning January 2023, NTPC Limited would blend up to 8% Green Hydrogen (vol/vol) in its PNG Network at NTPC Kawas Township in Surat, Gujarat.

3. Other PSUs have undertaken other projects, including:

I. NTPC launches hydrogen-powered fuel-cell electric vehicle (FCEV) buses in Leh.

II. NTPC launches hydrogen-powered fuel cell electric vehicle (FCEV) buses in Greater Noida.

III. Oil India Limited has created a 60 kW hydrogen fuel cell bus that combines an electric powertrain and a fuel cell.

IV. Indian Oil will employ demonstration pilot plants to produce Green Hydrogen using water electrolysis using solar power, biomass oxy steam gasification, and CBG reforming to fuel 15 hydrogen fuel cell buses.

In addition, numerous businesses have stated ambitions to establish green hydrogen/green ammonia manufacturing facilities in India. Because green hydrogen adoption in the country is still in its early stages, primarily through demonstration projects, its impact on job creation, dependence on oil, and exports has been limited thus far.
While the economic viability of various hydrogen uses is still being examined, the Mission's SIGHT program incentives have provided an initial boost to production cost reductions. This was accomplished through PLI tenders that focused on green hydrogen production and electrolyser manufacturing. Here is an overview of the first two tranches of these tenders. The following companies have received SIGHT incentives: Greenko Group, Reliance Industries Limited, Waaree Group, ACME Group, HYGENCO - The Hydrogen Company, Jindal India

Renewable Energy, Adani Green Energy Ltd., Larsen & Toubro, Matrix Gas and Renewables Limited, ADVAIT INFRATECH PRIVATE LIMITED, Ohmium and others.

The figures below summarise the winners of Green Hydrogen Producers for Setting up Production Facilities for Green Hydrogen in India under the Strategic Interventions for Green Hydrogen Transition (SIGHT) Scheme. Figure 1 shows the annual production capacity of green Hydrogen quoted by the bidders in both tranche I and II (Bucket 1 & 2) and the awarded annual production capacity (MT) under Tranche I (Bucket 1 & 2). The year-wise incentives demanded by the successful bidders of tranches I and II are shown in the figure 2. Figure 3 summarizes the manufacturing capacity and the incentive awarded towards the green hydrogen production under the tranche 1(Bucket 1 & 2). Since the awarded Incentives and production capacities for the winners of Tranche II are not released yet by the authorities, it was not discussed here. Figure 4 depicts the winners of Electrolysers production facility, the demanded electrolyser capacity, Awarded electrolyser capacity, and the awarded incentives under the tranches I and II. The awardees under the SIGHT PLI, are expected to commission the projects under 36 months from the date of announcement, failing that will impose significant fine.

In the first quarter of 2024, the Solar Energy Corporation of India (SECI) made significant progress in improving India's green hydrogen capacity through ambitious tenders, competitive auctions, and aggressive regulatory actions. SECI issued a substantial tender to develop an astounding 1,500 MW of electrolyzer manufacturing capacity through the Strategic Interventions for Green Hydrogen Transition (SIGHT) project (Tranche-II). This project is a critical step toward increasing green hydrogen generation in India, establishing the country as a leader in the shift to better energy options.

SECI successfully performed two important auctions under the SIGHT program in the first quarter of 2024. The first auction sought to construct 1,500 MW of electrolyzer manufacturing plants in India (Tranche I, Component I). Electrolyzers are essential for manufacturing green hydrogen because they efficiently convert water into hydrogen and oxygen using renewable energy. Increasing domestic production capacity for these electrolysers is an important step toward advancing India's green hydrogen sector. The second auction, held under Mode-1-Tranche-I, Component II, chose green hydrogen producers to establish production facilities with a combined annual capacity of 412,000 metric tons.

Green Energy Projects Commissioned in India: In Q1 2024, two pioneering green hydrogen projects were commissioned in India.
- Larsen & Toubro (L&T) has triumphantly commissioned its first domestically constructed electrolyser with a 1 MW capacity at its cutting-edge green hydrogen plant in Hazira, Gujarat, at the AM Naik Heavy Engineering Complex.
- Jindal Stainless Steel (JSL) took a huge stride ahead by inaugurating its first green hydrogen plant in Hisar, Haryana, cementing its status as India's first stainless steel company to establish such a facility commercially.

The Mission's initial budget is Rs. 19,744 crore, which includes Rs. 17,490 crores for the Strategic Interventions for Green Hydrogen Transition (SIGHT) program, Rs. 1,466 crore for pilot projects, Rs. 400 crores for R&D, and Rs. 388 crores for other Mission components.

Providing incentives to increase domestic electrolyser manufacturing capacity and reduce reliance on imports. Proposed outlay: Rs. 4440 crores Scheme Notification: Scheme Guidelines for Electrolyser Manufacturing Tranche I was notified on June 28, 2023, while Tranche II was notified on March 16, 2024. Request For Selection (RFS): Request for Selection (RfS) for the selection of Electrolyser Manufacturers (EM) for the establishment of 1.5 GW annual electrolyser manufacturing capacity under the SIGHT Scheme Tranche-I was released on July 7, 2023, while Tranche-II was issued on March 16, 2024. Receipt of bids under Tranche-I: 21 companies made bids for the installation of 3.4 gigawatts (GW) of annual electrolyzer manufacturing capacity. There were 14 offers for 2942 MW production capacity under Bucket-1 and 7 bids for 486 MW manufacturing capacity under Bucket-2, awarded under Tranche-I. The tender for the selection of Electrolyser Manufacturers (EM) for setting up manufacturing capacities for Electrolysers in India under SIGHT Scheme (Tranche-I) was granted on January 12, 2024, to 8 businesses for a total capacity of 1,500 MW per year.

Green Hydrogen Production: Providing incentives to green hydrogen producers to make it competitive with fossil-fuel-derived hydrogen. Proposed outlay: Rs. 13050 crores Scheme Notification: The Scheme Guidelines for Green Hydrogen Production Mode-I have been notified on June 28, 2023. Invitation for Bid (RFS): On July 10, 2023, the state-owned SECI invited proposals from Green Hydrogen producers to establish production facilities for 4,50,000 tons of Green Hydrogen under the SIGHT Scheme (Mode-1-Tranche-I). Receipt of bid: 14 enterprises expressed interest in incentives for Green Hydrogen generation, totaling 553,730 metric tons per year. Nine businesses were awarded 13 proposals under Bucket I (Technology Agnostic Pathways) for a production capacity of 551,730 metric tonnes annually. One bid is for a production capacity of 2,000 metric tons per year under Bucket II (Biomass-based Pathways).

Award (Tranche-1, Mode-1): The tender for the selection of Green Hydrogen Producers for setting up Green Hydrogen production facilities in India under the Strategic Interventions for Green Hydrogen Transition (SIGHT) Scheme (Mode-1-Tranche-I) was awarded on January 9, 2024, to ten companies with a total capacity of 4,12,000 tons per year.

Several significant investments were boldly announced by notable parties in the first quarter of 2024:
- ReNew demonstrated its commitment by investing INR 26,400 crore in a green hydrogen facility in Karnataka, with a production capacity of 0.22 million metric tons per annum (MMTPA).
- Acme Cleantech announced an amazing investment of INR 27,000 crore to build a green hydrogen production facility in India with a capacity of 1.10 MMTPA.

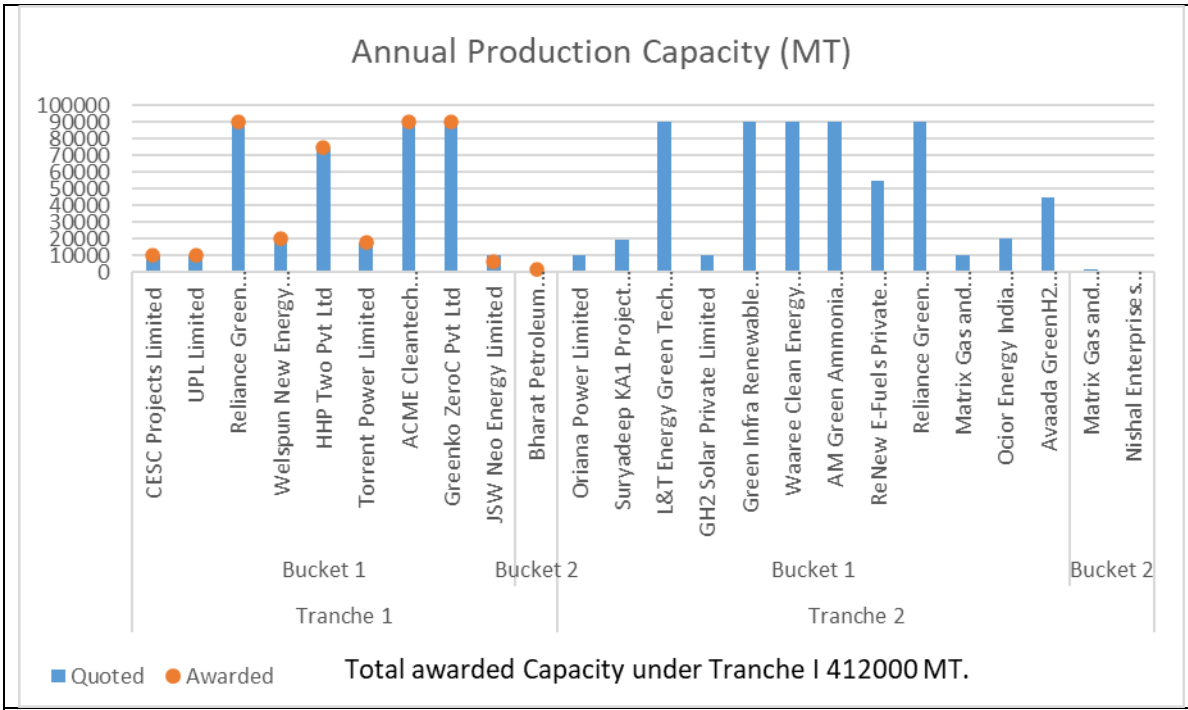

Figure 1: Awardees of Green Hydrogen Producers for Setting up Production Facilities for Green Hydrogen in India under the Strategic Interventions for Green Hydrogen Transition (SIGHT) Scheme.

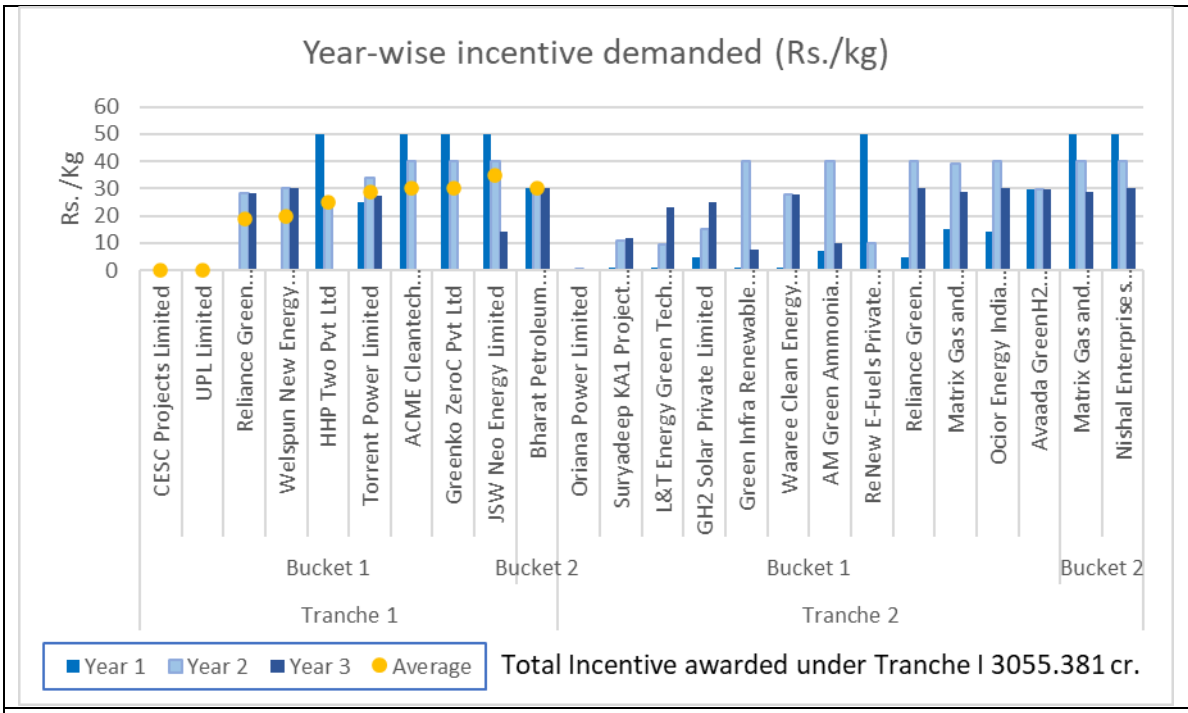

Figure 2: Year wise production incentives demanded for GH2 production under the Tranches I and II.

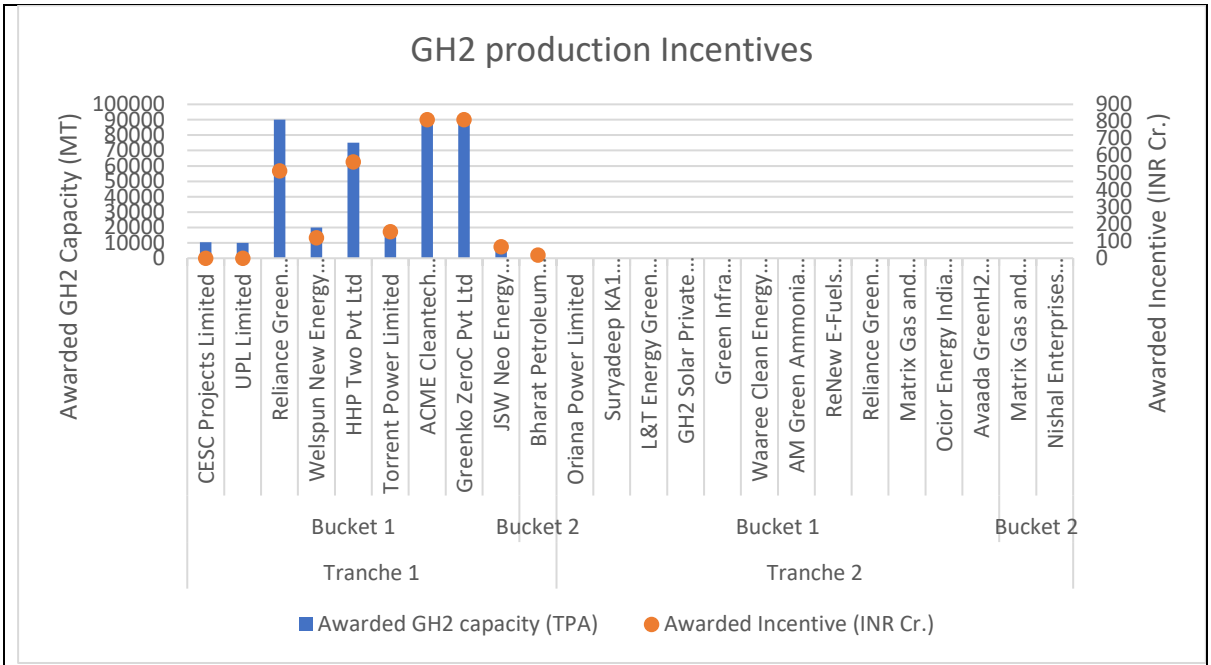

Figure 3: Awarded production incentives and the green Hydrogen manufacturing capacity for the successful bidders under the tranche 1 (Bucket 1 & 2).

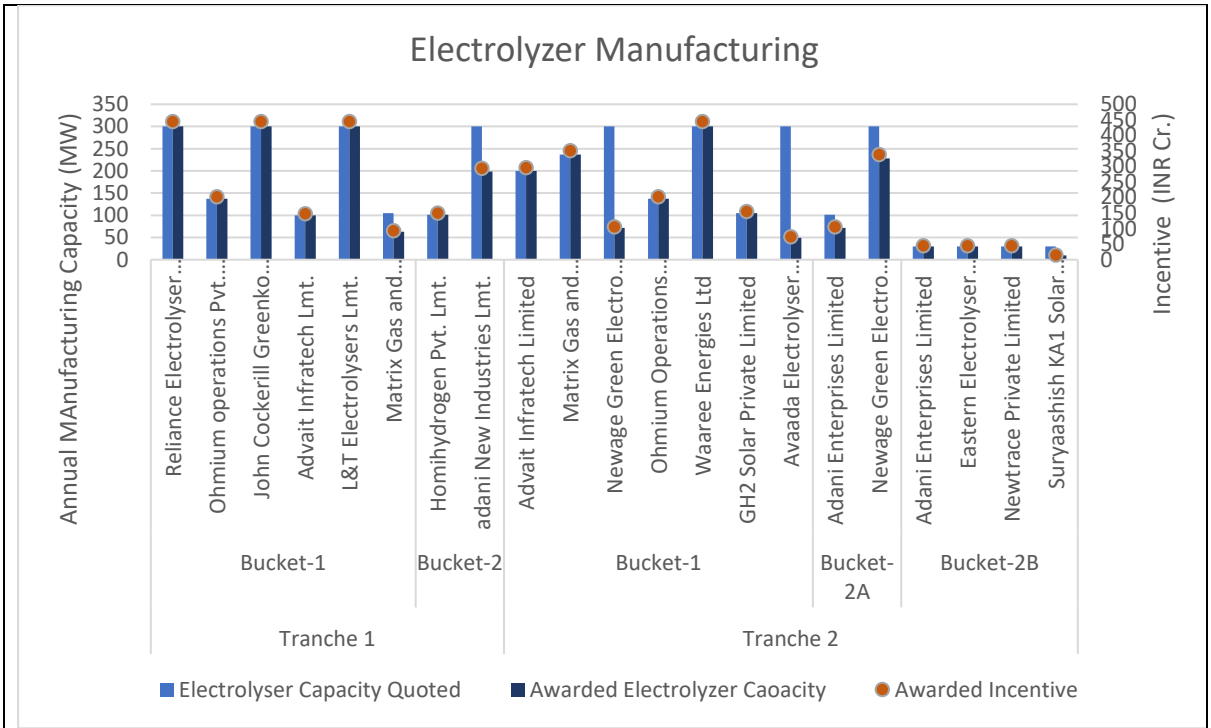

Figure 4: Selection of Electrolyser Manufacturers (EM) for Setting up Manufacturing Capacities for Electrolysers in India under the Strategic Interventions for Green Hydrogen Transition (SIGHT) Scheme.

	Awarded Incentive (Cr.)	Quoted Capacity (MW)	Awarded Capacity (MW)
GH2	3055.381	1038000	412000
Electrolyzer	4440	3744	3000

Apart from the projects discussed above under the SIGHT programs, there are several green hydrogen projects running across the country. These initiatives focus on harnessing renewable energy sources to produce hydrogen, which can play a crucial role in decarbonizing various industrial sectors, including ammonia production, transportation, and energy storage. Numerous outstanding Indian companies are actively engaged in developing innovative projects, which are not necessarily funded/ supported by the MNRE. The commissioned green hydrogen projects, such as those by Shell, L&T, and GAIL, have already begun producing hydrogen and contributing to the nation's clean energy goals. These projects not only support India's green energy transition but also set a foundation for scaling up green hydrogen production. Figure 1 illustrates the various GH2 production facilities commissioned in India that focus on the GH2 production, the ammonia generation for various applications. The following summarizes the commissioned green hydrogen projects in India:

- **OIL India - Jorhat Pump Station AEM Electrolyser**: Located in Assam, this is a pioneering project in green hydrogen production, focusing on ammonia as its end use. The project features an electrolyser capacity of **0.1 MW**, enabling a hydrogen production capacity of **3.6 tonnes per annum**. It employs advanced alkaline electrolyser membrane (AEM) technology.
- **NTPC - City Gas at NTPC Kawas**: Situated in Surat, Gujarat, this commissioned project supports ammonia production by integrating green hydrogen into city gas systems. It operates with an electrolyser capacity of **0.05 MW**, producing **0.7 tonnes of hydrogen annually**. The project contributes to NTPC's broader vision of transitioning to renewable energy sources.
- **ACME - Green Hydrogen and Green Ammonia Plant**: This large-scale project in Bikaner, Rajasthan, is a flagship initiative for green hydrogen and ammonia production in India. With an impressive electrolyser capacity of **2.1 MW**, the plant is capable of producing **314 tonnes of hydrogen annually**, making it one of the largest operational facilities in the country. It aligns with global efforts to decarbonize the ammonia supply chain.
- **NTPC - Green Hydrogen for Ladakh Fuelling Station**: Located in Ladakh, Jammu and Kashmir, this project is tailored for hydrogen-based mobility and supports ammonia production. It features an electrolyser capacity of **0.206 MW**, yielding **29.2 tonnes of hydrogen annually**. The facility plays a key role in demonstrating hydrogen's feasibility for fuel-cell vehicles in high-altitude areas.
- **Hygenco Heartland Ujjain Hydrogen Plant**: This commissioned plant in Ujjain, Madhya Pradesh, marks an innovative step towards green hydrogen integration in

industrial processes. Although it currently reports **no operational capacity**, it is likely in the pilot or early development phase, focusing on hydrogen production technology validation and optimization.

- **Shell - Bengaluru Green Hydrogen Project**: This project in Bangalore blends green and grey hydrogen, with an electrolyser capacity of 1 MW, producing 142 tonnes of hydrogen annually. It aims to contribute to cleaner energy solutions for industrial applications, leveraging renewable energy sources like solar or wind for hydrogen production. The project demonstrates Shell's commitment to India's green hydrogen transition and has the potential for expansion to support urban and industrial hydrogen needs.
- **L&T - Green Hydrogen Plant**: Located in Hazira, Gujarat, L&T's demonstration plant has a 1 MW electrolyser capacity, producing 157.4 tonnes of hydrogen annually. This plant is designed to showcase L&T's ability to scale green hydrogen production and support decarbonization in industries such as steel and cement. It plays a crucial role in establishing the green hydrogen infrastructure in India and can supply hydrogen to local refineries and fertilizer plants.
- **GAIL - GH2 Project**: Situated in the Vijaipur Complex, Madhya Pradesh, GAIL's GH2 project boasts a 10 MW electrolyser capacity and produces 1,570.542 tonnes of hydrogen annually. The project focuses on supplying green hydrogen for industrial purposes, especially in refineries and fertilizers. As one of India's largest gas transmission companies, GAIL aims to create a green hydrogen hub and expand this project to meet increasing industrial demand for clean hydrogen.
- **SJVN Limited - NJHPS Multi-purpose GH2 Pilot Project**: This pilot project in Jhakri, Himachal Pradesh, explores green hydrogen production using local renewable energy resources. With a 0.1 MW electrolyser capacity, it produces 4.34 tonnes of hydrogen annually. The project aims to demonstrate the viability of decentralized hydrogen production, utilizing hydroelectric and solar energy, and serves as a key test for scaling similar projects in remote regions.
- **Ohmium (Bangalore, Karnataka)**: Ohmium's green hydrogen project in Bangalore is one of the largest in India, with an electrolyser capacity of 500 MW. While specific hydrogen production details are unspecified, the project holds significant potential for large-scale hydrogen production. It aims to leverage India's renewable energy resources to produce green hydrogen at competitive prices, positioning Ohmium as a major player in both the domestic and international green hydrogen markets.

In addition to the commissioned projects, there are several under-commissioned green hydrogen projects underway, including those by BPCL, HPCL, NTPC, and JSW. Figure 6 shows the under commissioned projects in terms of their GH2 production and electrolyser capacity. These projects have different end use applications in the generation of ammonia, green ammonia and green hydrogen. The details of the given below.

1. **BPCL - Green Hydrogen Pilot (Bina, Madhya Pradesh)**: BPCL's Green Hydrogen Pilot project, currently under construction in Bina, Madhya Pradesh, focuses on ammonia production using green hydrogen. With a substantial electrolyser capacity of 20 MW, the project aims to produce 3102.5 tonnes of hydrogen annually. This initiative

will be India's largest green hydrogen unit and plays a crucial role in reducing carbon emissions from ammonia production, which is essential for fertilizers. Powered by renewable energy sources, BPCL's project showcases the potential of green hydrogen in large-scale industrial applications, contributing significantly to India's clean energy goals and demonstrating a shift towards more sustainable and eco-friendly practices in the ammonia sector.

2. **HPCL - Green Hydrogen Plant (Visakhapatnam, Andhra Pradesh)**: HPCL is developing a green hydrogen plant in Visakhapatnam, Andhra Pradesh, with a 2.4 MW electrolyser capacity that will produce 370 tonnes of hydrogen annually. The hydrogen generated will be primarily used for ammonia production, further supporting the fertilizer industry. This under-construction plant is part of HPCL's strategy to reduce its carbon footprint by utilizing clean, renewable energy to produce green hydrogen. The project contributes to India's green energy transition by addressing the need for a sustainable and decarbonized ammonia production process. The plant is expected to play a key role in setting a precedent for integrating green hydrogen into industrial operations

3. **GAIL - Vijaipur PEM Electrolyser Project (Guna, Madhya Pradesh)**: GAIL's Vijaipur PEM Electrolyser Project, under construction in Guna, Madhya Pradesh, features a 10 MW electrolyser capacity, producing 1569.5 tonnes of hydrogen annually for ammonia production. This project utilizes proton exchange membrane (PEM) electrolysis, powered by renewable energy, to produce green hydrogen on a large scale. As part of GAIL's efforts to decarbonize its industrial operations, the project will help meet the growing demand for green hydrogen while reducing carbon emissions in key sectors like fertilizers and chemicals. This project reinforces GAIL's commitment to advancing India's green hydrogen infrastructure and contributes significantly to the country's shift towards a sustainable energy future.

4. **NTPC - Green Hydrogen for Green Methanol from CC Vindhyachal (Vindhyachal, Madhya Pradesh)**: NTPC's Green Hydrogen for Green Methanol project, located in Vindhyachal, Madhya Pradesh, is designed to produce 730 tonnes of hydrogen annually through a 5 MW electrolyser. This hydrogen will be utilized to produce green methanol, a sustainable alternative fuel that can help decarbonize sectors like shipping and heavy industry. The project integrates renewable hydrogen with carbon capture technologies, supporting India's energy transition goals. The production of green methanol is a key step toward creating a circular economy, where renewable energy is used to produce sustainable fuels, thereby reducing dependence on fossil fuels. NTPC's initiative marks an important milestone in India's pursuit of a greener, more sustainable energy landscape.

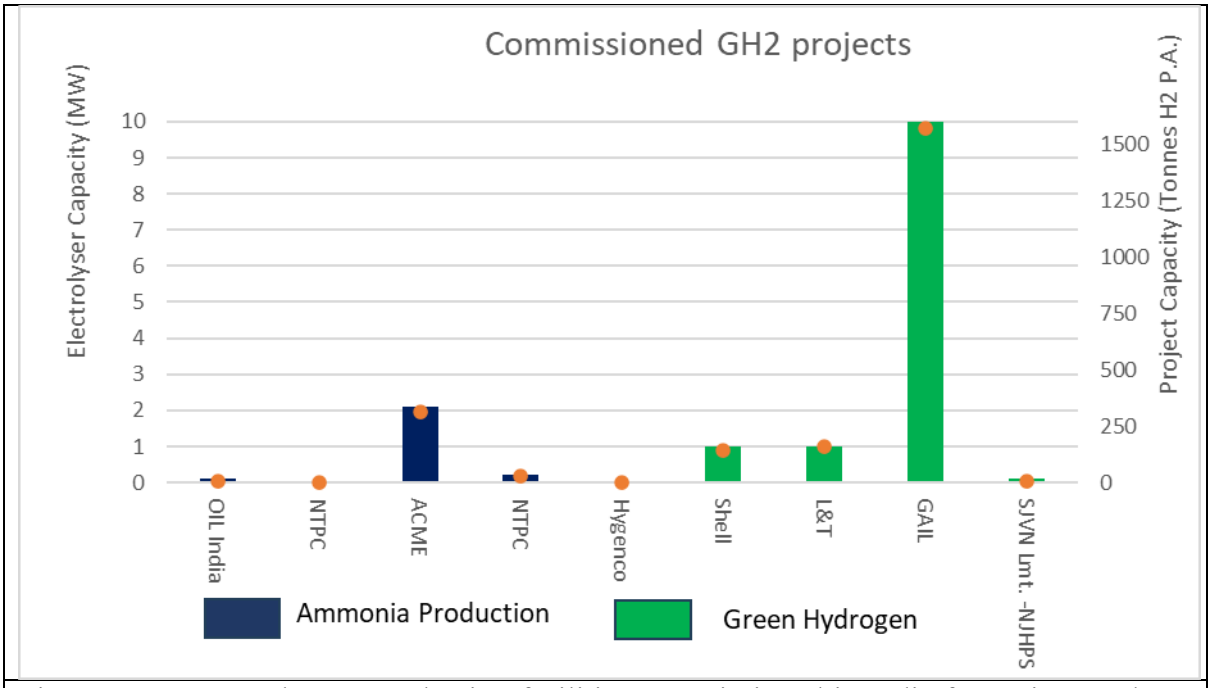

Figure 5: Green Hydrogen production facilities commissioned in India for various end use applications.

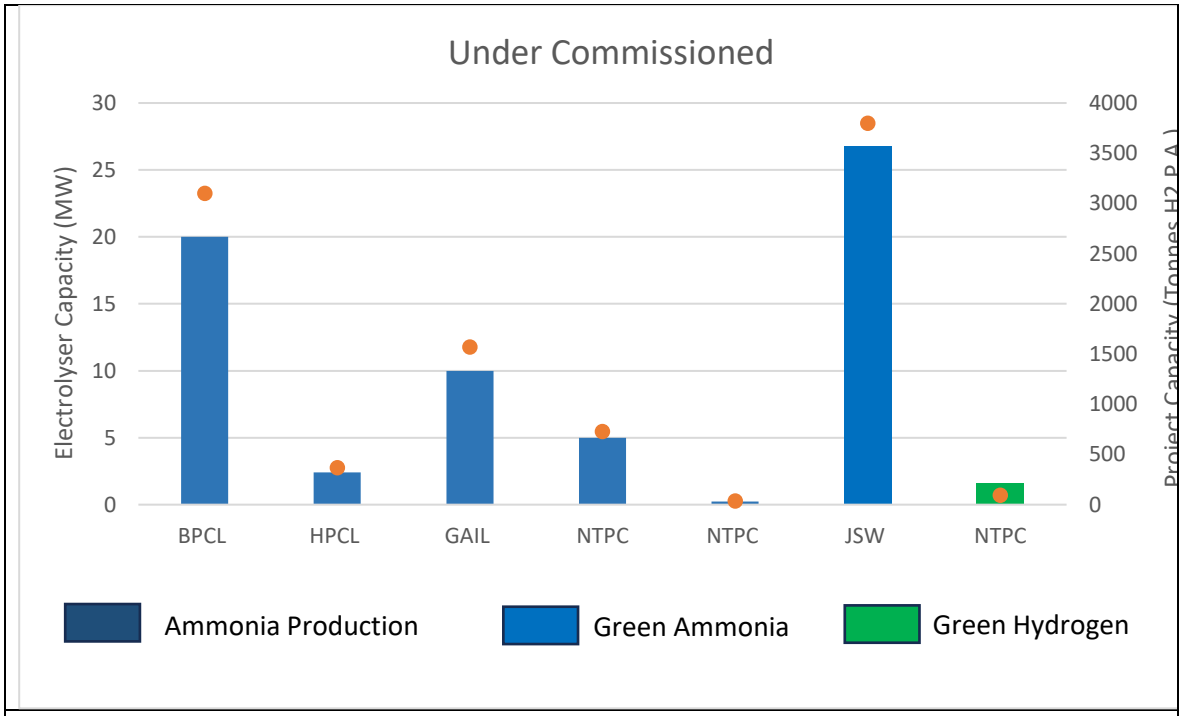

Figure 6: Green Hydrogen production facilities that are under construction in India for various end use applications.

5. **NTPC - Green Hydrogen for Fuel Cell Microgrid Simhadri (Visakhapatnam, Andhra Pradesh)**: NTPC's project at Simhadri, Visakhapatnam, focuses on using green hydrogen to power a fuel cell microgrid, providing clean and reliable energy.With a 0.24 MW electrolyser capacity, the project will produce 37.6 tonnes of hydrogen annually, supporting a microgrid that utilizes hydrogen for energy storage and supply. This project exemplifies the potential of hydrogen to be integrated with renewable energy systems, offering a sustainable and efficient solution for energy storage. By leveraging hydrogen fuel cells, the project demonstrates how renewable hydrogen can enhance energy resilience and contribute to a low-carbon energy transition.
6. **JSW Green Hydrogen - Green Hydrogen/Ammonia (Mangaluru, Karnataka)**: JSW's Green Hydrogen project in Mangaluru, Karnataka, is a major step towards scaling green hydrogen production in India. The project, under construction with an electrolyser capacity of 26.761 MW, will produce 3800 tonnes of hydrogen annually for green ammonia production. This large-scale initiative is designed to reduce carbon emissions from ammonia production, a critical component in fertilizers. JSW's green hydrogen plant highlights the company's commitment to sustainability and clean energy, contributing to India's efforts to achieve energy independence and decarbonize key industries. With significant investments, this project is set to become a cornerstone of India's green hydrogen ecosystem and demonstrates the economic potential of clean hydrogen for industrial applications.
7. **NTPC Green Hydrogen Mobility (Greater Noida, Uttar Pradesh)**: NTPC's Green Hydrogen Mobility project in Greater Noida, Uttar Pradesh, focuses on using green hydrogen to power fuel cell electric vehicles (FCEVs). This under-construction project features a 1.6 MW electrolyser capacity and will produce 94.9 tonnes of hydrogen annually. By supporting the use of hydrogen in the transportation sector, the project aligns with India's goals to reduce emissions from vehicles and shift towards a cleaner, hydrogen-powered mobility future. The project sets an important precedent for green hydrogen adoption in India's transportation sector, contributing to the national agenda of achieving net-zero emissions in the coming decades.

These upcoming initiatives are expected to further advance India's green hydrogen infrastructure, with significant electrolyser capacities and ambitious production targets. Once completed, these projects will contribute to reducing carbon emissions, supporting green ammonia production, and powering fuel cell electric vehicles. Collectively, both commissioned and under-commissioned projects represent a vital step in India's commitment to achieving net-zero emissions and driving the global transition to clean energy.

Figure 7 shows the mapping of green hydrogen production facilities available currently and yet to be commissioned in India. This gives us the overall idea on each facility's current status,

their end product and their location. Figure 8 shows the other green hydrogen projects in terms of electrolyser production, use of electricity from grid and fuel cells. The current status of them is also shown. Figure 9 shows the total number projects in India working under the green hydrogen, Ammonia, Green Ammonia, Methanol and Green Methanol production. Also, the current status of those projects in terms of announced, under construction, commissioned and decommissioned.

Projects related to the generation of green methanol are at the stanched stage. These upcoming initiatives are expected to further advance India's green hydrogen infrastructure, with significant electrolyser capacities and ambitious production targets. Once completed, these projects will contribute to reducing carbon emissions, supporting green ammonia production, and powering fuel cell electric vehicles. Collectively, both commissioned and under-commissioned projects represent a vital step in India's commitment to achieving net-zero emissions and driving the global transition to clean energy.

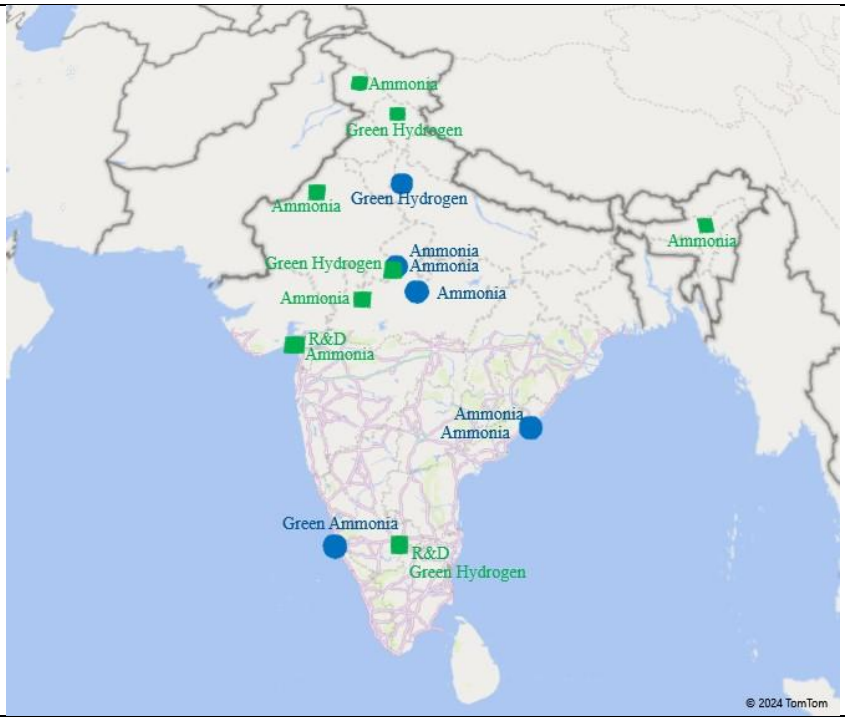

Figure 7: Mapping of Green Hydrogen production facilities that are commissioned and under construction for different end use.

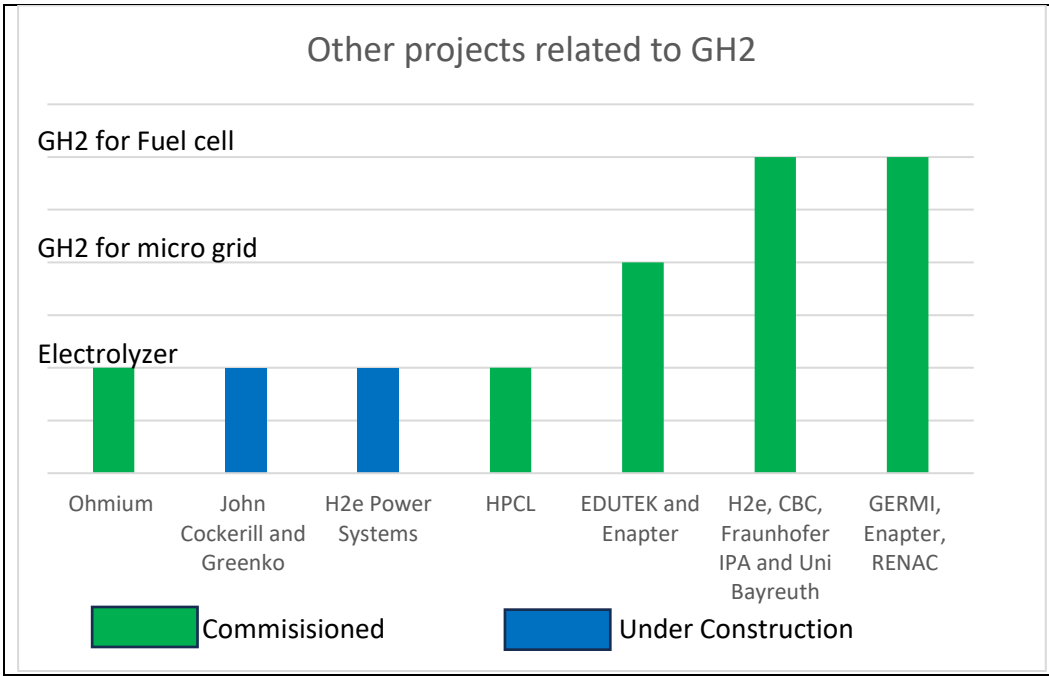

Figure 8: Other GH2 related projects commissioned and under construction in India.

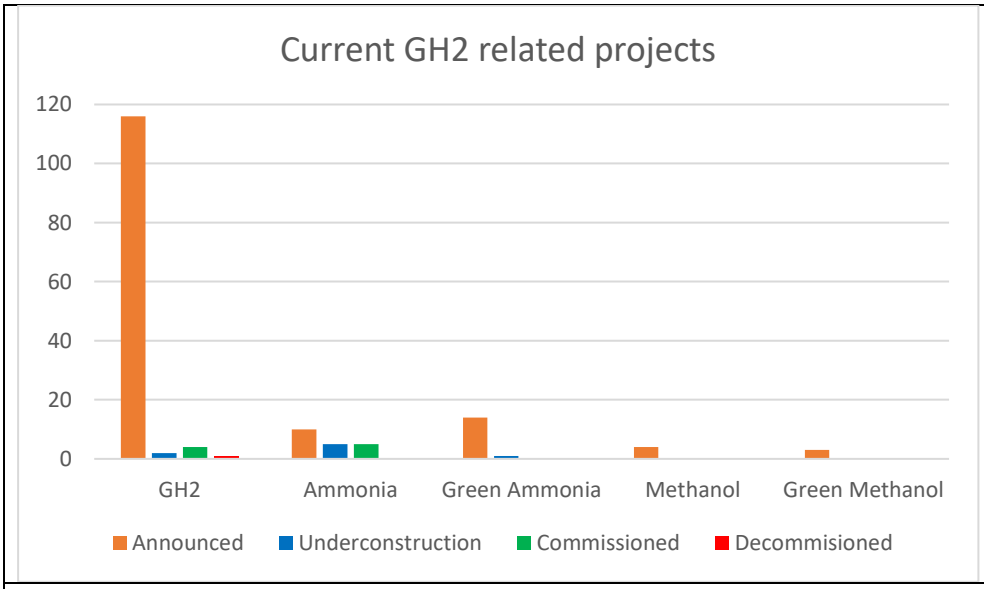

Figure 9: Current status of green hydrogen related projects in India.