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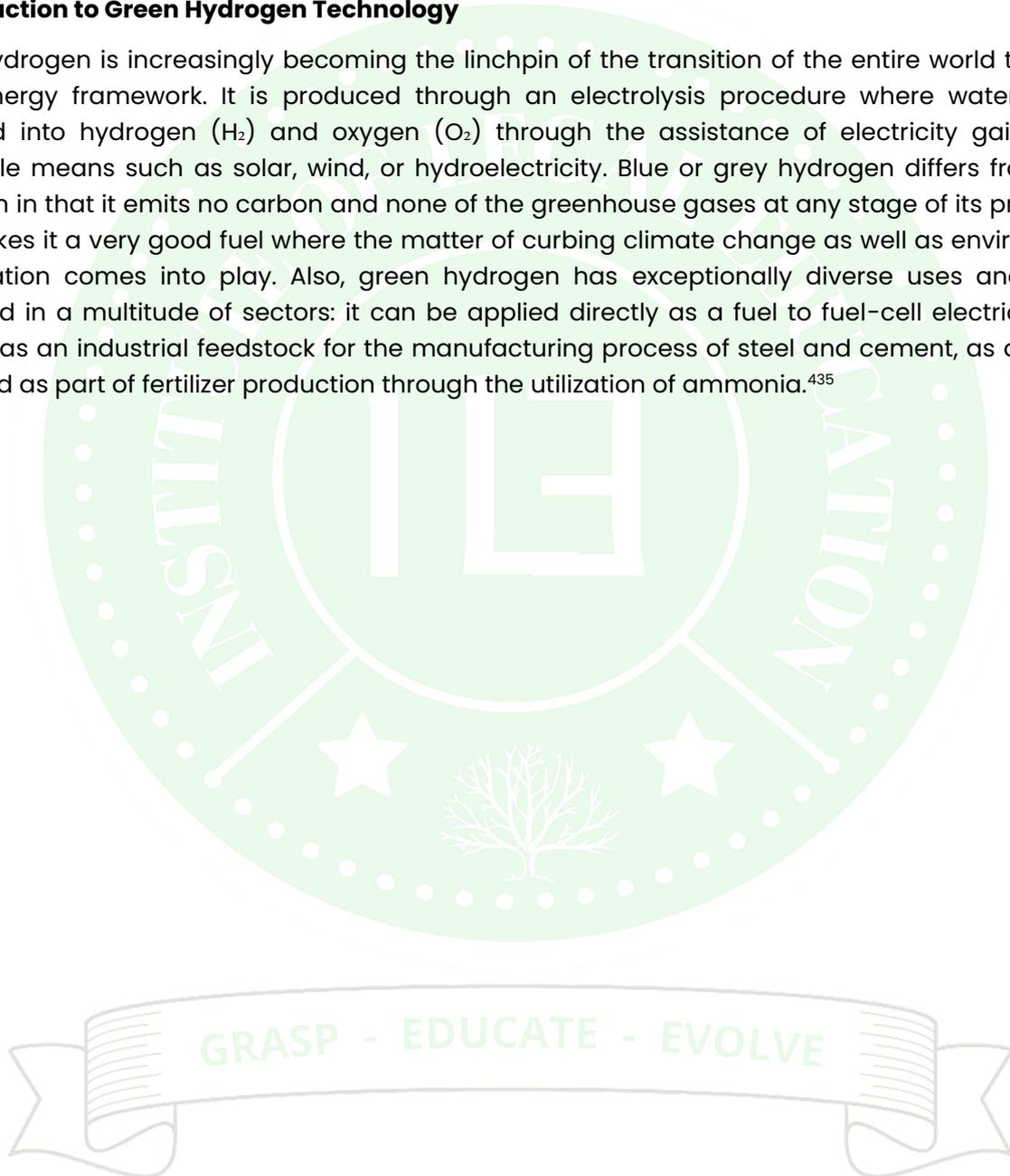
LEGAL AND REGULATORY FRAMEWORK FOR GREEN HYDROGEN IN INDIA

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1. Introduction to Green Hydrogen Technology

Green hydrogen is increasingly becoming the linchpin of the transition of the entire world towards a clean energy framework. It is produced through an electrolysis procedure where water (H₂O) is dissolved into hydrogen (H₂) and oxygen (O₂) through the assistance of electricity gained from renewable means such as solar, wind, or hydroelectricity. Blue or grey hydrogen differs from green hydrogen in that it emits no carbon and none of the greenhouse gases at any stage of its production. That makes it a very good fuel where the matter of curbing climate change as well as environmental conservation comes into play. Also, green hydrogen has exceptionally diverse uses and can be employed in a multitude of sectors: it can be applied directly as a fuel to fuel-cell electric vehicles (FCEVs), as an industrial feedstock for the manufacturing process of steel and cement, as an energy store, and as part of fertilizer production through the utilization of ammonia.⁴³⁵



⁴³⁵ International Renewable Energy Agency, Green Hydrogen: A Guide to Policy Making, (IRENA 2020) p. 12.

Technologically, the most significant benefit of green hydrogen is that it can decarbonize hard-to-abate sectors where electrification is technologically or economically not feasible. These sectors are air transport, sea transport, heavy industry, and long-distance road transport. Secondly, if reserved and reconverted into electricity, it can act as a storage of renewable energy and thus end the wind and solar intermittency issue.

From an Indian perspective, the adoption of green hydrogen is completely under India's 2070 Net Zero goal and Paris Agreement ambition. As India is blessed with vast solar and wind energy sources, India is inherently suited to produce green hydrogen at economic rates. Keeping this in perspective, the Government of India has launched the National Hydrogen Mission in a vision to transform India into a world-class green hydrogen producer and exporter. Pilot to commercial scale is no cakewalk, however. High upfront costs, absence of hydrogen fueling stations and pipelines for hydrogen only, absence of regulation in regulatory regimes, and low levels of standardization in safety protocols are some of the largest challenges.⁴³⁶

Besides this, India will also need to close the institutional and legal divide in regulation of hydrogen. Heterogeneity of policies with a dearth of a general legislative framework for guiding research, development, commercialization, and cross-border co-operation in the field of hydrogen is the status quo. As such, the green hydrogen must be facilitated in its uptake through a multi-sectoral legal architecture combining regulation of the environment, industrial policy-making, land use law, and regulation of the energy sector.⁴³⁷

Green hydrogen, without it, is not just a technological leap, but India's game-changer for energy independence, sustainability, and

economic transformation. So that this potential is harnessed, an enabling regulatory framework has to be established, one which will facilitate up-scaling of green hydrogen projects across the country.

2. National Hydrogen Mission and Policies Thereunto

1. Introduction to the National Hydrogen Mission (NHM)

To meet the world's shift towards decarbonization and the necessity to offset fossil fuel dependence, India launched the National Hydrogen Mission (NHM) in 2021 by the Ministry of New and Renewable Energy (MNRE). The mission was officially declared by the Prime Minister on India's 75th Independence Day, as a strategic move towards self-reliance in clean energy and in line with India's commitment to reach Net Zero carbon emissions by 2070⁴³⁸

The NHM is designed to increase production, storage, transportation, and utilization of hydrogen—mostly green hydrogen, produced from renewable sources. The initiative is considered a game-changer for the twin goals of energy security as well as climate resilience. It places India in a position of strength along with other world leaders like the EU, Japan, South Korea, and Australia, which have already laid out national hydrogen strategies⁴³⁹

2. National Hydrogen Mission Objectives

The main objectives of NHM are:

- To make India a global leader in green hydrogen production and export.
- To reduce reliance on imported fossil fuels and enhance domestic energy resources.
- To catalyze industrial decarbonization, particularly in industries like steel, fertilizer, oil refining, and heavy transport.
- To create a robust domestic value chain on the back of electrolyzer manufacturing.

⁴³⁶ A. B. Patil, "Green Hydrogen: Fuel of the Future," (2021) 63(4) Energy Policy Journal 245, p. 246.

⁴³⁷ R. K. Singh, "Hydrogen Storage as a Means to Support Renewable Energy Systems in India," (2020) 48(3) Renewable Energy Law and Policy Review 199.

⁴³⁸ Prime Minister's Independence Day Speech, August 15, 2021

⁴³⁹ Council on Energy, Environment and Water (CEEW), Green Hydrogen: Pathways to a Clean Energy Future (2022), p. 8

- To enable research, development, and demonstration (RD&D) of future hydrogen technologies.

3. Policy Instruments and Strategic Intervention

NHM is not a standalone document but has layers of policy and enablers such as:

a) Strategic Interventions for Green Hydrogen Transition (SIGHT):

- A flagship initiative of the NHM, falling under two categories:
- Component I: Financial incentives to locally produce green hydrogen.
- Component II: Financial incentives to locally produce electrolyzers⁴⁴⁰

b) Renewable Energy and Hydrogen Synergy:

The Government insists that green hydrogen should be produced from renewable energy sources. The establishment of solar parks, wind farms, and hybrid energy corridors is therefore part of the launch of NHM.

c) Green Hydrogen Hubs:

The target includes the development of hydrogen hubs in coastal and industrial centers like Gujarat, Maharashtra, and Tamil Nadu. The hubs will be hydrogen production, storage, and consumption integrated clusters.

d) Mandatory Purchase Obligations (MPO):

A device that has been proposed where refineries and fertilizers are forced to mandatorily purchase a share of their hydrogen requirements from green sources, thereby creating a market guarantee⁴⁴¹

4. Federal and Inter-Ministerial Coordination

The biggest strength of the NHM is that it depends on a cross-sectoral system of governance involving:

- Ministry of Power – for power supply and grid connectivity.

- Ministry of Petroleum and Natural Gas – for fuel utilization and refining.
- Department of Science & Technology – for R&D support.
- NITI Aayog – for policy integration and international collaboration⁴⁴²

Additionally, the mission also seeks to concentrate on federal cooperation with the objective to encourage state governments to create their hydrogen roadmaps. Gujarat and Kerala are some of the states that have provided state hydrogen policies according to NHM.

5. Current Policy and Regulatory Challenges

While NHM might have an ambitious nature vision, it is still a baby and has numerous legal and policy challenges:

a) No Single Legislative Framework

Though Germany and Japan have a Hydrogen Law focused on production, safety, transportation, and industrial application, there is no stand-alone Hydrogen Law for India regulating the three matters. Ad hoc laws such as the Electricity Act, 2003, the Environmental Protection Act, 1986, and the Factories Act, 1948 are used.

b) Infrastructure and Safety Regulations

There is no legislative code governing the safety of hydrogen fueling stations, pipelines, or storage. This is defined by regulatory uncertainty, particularly for investors and foreign investors⁴⁴³

c) Uncertainty of Clear Definitions and Certifications

These terms like "blue hydrogen," "green hydrogen," and "grey hydrogen" have not been formally established under Indian law, and it is leading to uncertainty in the realm of fiscal and trade policy. Furthermore, there exists no certificate mechanism for green hydrogen, and

⁴⁴⁰ MNRE Notification No. 13/03/2022-H2, SIGHT Scheme Guidelines, (2022).

⁴⁴¹ International Energy Agency, Hydrogen Projects Database – India Section, (2023)

⁴⁴² NITI Aayog, Hydrogen Roadmap for India (2023), p. 12.

⁴⁴³ Bureau of Indian Standards (BIS), Draft Safety Code for Hydrogen Storage and Distribution, (2022).

it is impacting domestic adoption as well as export potential to other nations.

d) Financing and Subsidy Mechanisms

Today, NHM finances through schemes and tenders such as SIGHT, but there is no legislative assurance of long-term subsidy security, tax benefits, or viability gap funding for large hydrogen infrastructure⁴⁴⁴.

6. Synergies with International Frameworks and Collaborations

The NHM has been outlined to leverage India's strategic alliances with countries such as the UAE, Germany, Australia, and Japan, who are making investments in hydrogen initiatives and offering technology transfer, investment, and collaborative research opportunities.

- India is also actively participating on platforms such as:
- International Partnership for Hydrogen and Fuel Cells in the Economy (IPHE)
- Clean Energy Ministerial Hydrogen Initiative
- International Solar Alliance (ISA) – enabling hydrogen from solar energy.

7. Complementary National Policies

Some of the other national policies overlap and supplement the NHM:

- Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME-II) – includes hydrogen fuel-cell vehicle supply.
- National Electric Mobility Mission Plan (NEMMP) – promotes zero-emission transport.
- Green Energy Corridors Scheme – promotes transmission infrastructure for renewable projects.⁴⁴⁵
- These policies coexist together in developing the green hydrogen ecosystem

and laying the ground for future legal harmonization.

8. Proposal to Strengthen Legal Framework of NHM

i. Hydrogen Energy Law, i.e., definitions, safety, taxation, and investment – codification.

- Establishment of a National Hydrogen Regulatory Authority for inter-ministerial cooperation and inter-state government coordination.
- Establishment of a Hydrogen Purchase Obligation mechanism to assure market stability.
- Harmonization of hydrogen safety standards with the National Building Code and disaster management Acts.
- Harmonization with international certification schemes to facilitate cross-border trade.

3. Current Legal Framework and Institutional Structure

India's current legal and institutional structure regarding green hydrogen is emerging and dispersed, comprising sectoral legislation, policy guidelines, and institutional coordination mechanisms. While the National Hydrogen Mission has set out a strategic roadmap, the concurrent legal framework remains to be molded into an integrated and harmonious structure. The legislation is cutting across environmental law, electricity law, security law, and institutional law, each having a distinct regulator. The country needs to make use of recycling provisions of existing law in order to regulate the various stages of production, storage, and supply of green hydrogen because there isn't a consolidating hydrogen law. This section discusses the existing legal traditions and institutional framework determining the development of green hydrogen in India.

2.1 Environmental and Energy Regulatory Legislation

⁴⁴⁴ Department of Economic Affairs, Public-Private Partnership Appraisal Committee Report on Hydrogen Infrastructure, (2022).

⁴⁴⁵ Ministry of Power, Green Energy Corridor Implementation Report, (2023).

Green hydrogen manufacture is, linearly, connected with renewable energy as well as environmental sustainability. It comes under Indian environmental law as well as energy legislations to an immensely great degree. The Environment (Protection) Act, 1986, is the general legislation that provides jurisdiction to the Central Government to prescribe environmental quality standards and impose compliance by industries, including hydrogen manufacturing ones⁴⁴⁶ Large hydrogen-producing ventures, i.e., water-consuming electrolysis, need to be critically examined on the environmental side under the Environmental Impact Assessment (EIA) Notification, 2006. The Electricity Act, 2003, also regulates the generation and supply of electricity, which is the foundation of green hydrogen since it operates on the basis of renewable electricity for electrolysis. Open access, renewable purchase obligations (RPOs), and tariff fixation for renewable energy under this Act are central to the economic viability of hydrogen producers.

2.2 Industrial Safety Regulation and Hazardous Substances

Hydrogen, being a highly flammable gas with high pressure storage needs, is regulated under various safety and industrial operation regulations. The Factories Act, 1948, regulates industrial operations, including workers' safety and hazardous processes, directly applicable to hydrogen plants. Further, the Gas Cylinder Rules, 2016, notified under the Explosives Act, 1884, govern the compression, storage, and transport of hydrogen gases. The Petroleum and Explosives Safety Organisation (PESO) is the primary regulator of compliance with the above standards. Nevertheless, while these rules set a floor level of industrial safety, there is very little hydrogen-specific law for emerging technologies such as LOHCs or cryogenic hydrogen. Apart from this, the Bureau of Indian Standards (BIS) is also aiming to create hydrogen-specific technical standards for

electrolysers, pipelines, and storage facilities⁴⁴⁷ with a view to ensuring industrial and environmental safety.

2.3 Institutional Mechanisms and Regulatory Agencies

Housing of hydrogen projects does not mean having one ministry and multiple institutions sharing some combined responsibilities. The nodal ministry tasked with the responsibility of taking care of green hydrogen policy implementation is the Ministry of New and Renewable Energy (MNRE). They oversee the administration of the Strategic Interventions for Green Hydrogen Transition (SIGHT) scheme and other schemes of financial and technical support. The Ministry of Power plays a central role in enabling access to renewable power through power purchase agreements (PPAs), grid connectivity, and renewable energy transmission infrastructure. Environmental clearances of hydrogen projects fall under the Ministry of Environment, Forest and Climate Change (MoEFCC), while administration of the EIA process and environmental monitoring are also under State Electricity Regulatory Commissions (SERCs) and the Central Electricity Regulatory Commission (CERC) regulate the grid access directly, interstate transmission regulation, and green tariffs for the renewable affecting green hydrogen projects. Such coordination is most essential but is largely fractured, indicating administrative inefficiencies and delays at the regulatory agencies.⁴⁴⁸

3.4 Legislative and Regulatory Gaps

Despite all of those laws there, there are some lacunas in the legal system regarding green hydrogen. To begin with, no law exists for hydrogen identifying the different colors of hydrogen (green, grey, blue) or offering a categorical framework of legal production,

⁴⁴⁶ The Environment (Protection) Act, No. 29 of 1986, Acts of Parliament, 1986 (India).

⁴⁴⁷ Bureau of Indian Standards, "Draft Standards for Hydrogen Storage and Transmission," BIS Technical Committee TC 28, 2023.

⁴⁴⁸ Ministry of Environment, Forest and Climate Change, "Compendium on EIA for Emerging Technologies," 2023.

consumption, and exchange of its type⁴⁴⁹. Secondly, existing environmental and energy law is deficient in providing for technology-specific hydrogen production and storage hazards such as explosion risks or aquifer depletion from the excessive use of water in the electrolysis process. Thirdly, there exists dual jurisdiction and no single-window clearance mechanism to render it difficult to issue project clearances. Second, there is suspicion about the use of water and water rights, especially in arid environments, and this will most likely cause conflict between hydrogen producers and irrigation or domestic water users. Finally, uncertainty over direct regulations for green hydrogen certification, carbon intensity labels, and grid responsibility requirements prevents transparency and investor trust.

2.5 Hydrogen-Specific Legislation and Harmonized Regulation Requirement

To circumvent such impediments, what is required is a harmonized and coordinated legal regime for green hydrogen. This can be done in the shape of a National Hydrogen Energy Law that can define the meaning of green hydrogen, lay down certification procedures, make provisions for safety measures, and issue clearances. An institution of a National Hydrogen Regulatory Authority or an efficient inter-ministerial coordination committee would facilitate centralization of decisions and de-congestion of regulatory bottlenecks. There must be an international standard, a public-private partnership model, sustainable water usage, and early adopter incentives in a hydrogen-specific law. Regulatory risk and business confidence will be moderated until the law comes into force by transitional action in the shape of model rules, technical guidance, and state-level hydrogen policy.⁴⁵⁰

4. Green Hydrogen Deployment Regulatory Issues

Green hydrogen deployment is gaining momentum in India due to its potential to decarbonize the major sectors such as mobility, power, and industry. Although its future appears promising, there are certain regulatory issues which need to be addressed with highest priority. The existing legal framework and policies are predominantly in operation for traditional sources of energy and are not adequately in operation enough to address the special requirements of this sunrise industry. Licensing problems, infrastructural shortfalls, and absence of uniformity in environment clearances are the key issues that stand out. While these do not solely result in project delays, these also create uncertainty issues among the developers and the investors. They capture them and are critical to India's success in realizing its green hydrogen ambitions and becoming a global leader in the green energy transition.⁴⁵¹

4.1 Licenses and Clearances

The existing framework of granting licenses and clearances for Indian green hydrogen projects is marked by fragmentation, non-coordination, and procedural lag. Many clearances of multiple central and state governments are necessary for land procurement, environment studies, safety standards, construction permission, water use, and integration. The multi-level and multi-stage process has the potential to generate bureaucratic obstacles that discourage timely implementation. Even a single-window clearance does not exist today for green hydrogen projects. So, the project developers are not sure of the open chain of approvals, adherence to the regime of regulations, and timeframe to obtain necessary permits. Ineffective standard operating procedures and centralized administration create high compliance costs and investor confidence issues. This is also supported by the

⁴⁴⁹ R. Mehta, "India's Missing Hydrogen Law: Regulatory Gaps and Investor Risk," (2023) 8 *Journal of Energy Policy and Law* 49.

⁴⁵⁰ Bhattacharya, Debajit and Singh, Aparna, *Green Technologies and Indian Energy Policy*, 2nd edn (Eastern Book Company 2022) p. 129.

⁴⁵¹ Malhotra, Rajeev, *Sustainable Energy Development in India: Legal and Policy Challenges*, 1st edn (Oxford University Press 2021) p. 86.

fact that green hydrogen doesn't easily fall into any existing industry or energy category, and therefore is subject to various interpretations by regulatory agencies.

4.2 Infrastructure Development Barriers

Proper deployment of green hydrogen is highly dependent on having robust infrastructure. Compared to solar or wind energy, green hydrogen is a totally new value chain with production plants (e.g., electrolyzers), storage hubs, pipes, and refueling stations. Most of this infrastructure is currently non-existent in India, so mass deployment would be a logistical nightmare. In addition, as an element, hydrogen is highly reactive and requires special materials and equipment for handling in order to be safe and efficient. Shortage of independent hydrogen pipelines, shortage of renewable-hydrogen dominant regions' water resources, and shortage of storage facilities with large-capacity operation restrict the expansion of producers in their scales. Aside from that, the majority of current energy infrastructure is incompatible with hydrogen and needs to be replaced or upgraded. The construction of such infrastructure is very capital-intensive and may never, in theory, depend on private finance unless supplemented with adequate incentives or support from the public side. The issue is even worsened by the fact that there are no standard codes and standards for hydrogen equipment, hence creating interoperability and safety concerns.⁴⁵²

4.3 Environmental Impact Assessment Issues

Green hydrogen has been labeled as a green and clean fuel, but its production—more so through electrolysis—is highly energy-intensive and requires high inputs such as electricity and water. This has been raising some environmental concerns, most notably in regions where there is low availability of water, which is already a delicate issue. While existing environmental laws do not place hydrogen projects on the same evaluation tiers as

equivalent, states employ different criteria in determining whether or not to require an Environmental Impact Assessment (EIA). This does not create a singular degree of uncertainty for developers and regulators. Moreover, the existing EIA process does not take into account the specific environmental issues of hydrogen production, such as water efficiency, brine disposal, or renewable electricity generation emissions. Lacking hydrogen-specific EIA guidelines, most projects proceed without appropriate assessment or get caught up in unnecessary delays by misinterpretation of rules. There is a greater need for a balanced, hydrogen-focused EIA strategy that achieves the perfect balance between sustainability and the necessity for speeding up the transition to clean energy.

5. Comparative Legal Approaches – EU, Japan, and Australia

Green hydrogen has become a strategic priority in most nations vying for energy security and decarbonisation. Domestic needs, readiness of technology, and national strategy ambitions have conditioned legal frameworks used to guide hydrogen development in each nation. Herein, comparative policy and legal approaches in the European Union, Japan, and Australia are considered, which are all at the forefront of developing the hydrogen economy. The report offers insights to India in creating strong regulation systems that foster innovation, environmental sustainability, and infrastructure scalability.

European Union

The European Union has taken a position as a global leader on green hydrogen policy through its Hydrogen Strategy for a Climate-Neutral Europe (2020), within the broader European Green Deal. The EU has embraced the gradual regulatory solution beginning with hydrogen generated through electrolysis using renewable energy (green hydrogen), supported by state aid, carbon price mechanisms, and market-based mechanisms such as the EU Emissions Trading System (ETS). The EU has also

⁴⁵² Sharma, Anjali, Environmental Governance in India: Challenges and Opportunities, 1st edn (LexisNexis 2020) p. 142.

suggested certification schemes under the Renewable Energy Directive (RED II and RED III) to distinguish among green, blue, and grey hydrogen based on lifecycle emissions, and this distinction affects incentives eligibility.⁴⁵³

Legally, the EU is also heading towards standardization of hydrogen infrastructure with steps like TEN-E Regulation amendments, which cover hydrogen infrastructure in Projects of Common Interest (PCIs). Besides, the EU Hydrogen Backbone Project has as its target by 2040 a transnational hydrogen pipeline network that necessitates strong cross-border harmonization of legislation. The EU model places emphasis on harmonized legal systems, legally binding emission cuts, and technology-neutral subsidies to develop a hydrogen economy in a fair and sustainable manner.

Japan

Japan has been at the forefront in adopting hydrogen technologies and has put in place a holistic legal framework that encompasses hydrogen in transport, power, and industrial applications. Japan's approach is supported by its Basic Hydrogen Strategy (2017), which outlines Japan's vision to become a "hydrogen society." Japan's legal framework is conducive to domestic hydrogen production and international supply chain collaborations, particularly with nations such as Australia and Brunei. Its legislation facilitates demonstration projects, R&D subsidies, and regulatory sandboxes to enable innovation unencumbered by excessive compliance limits.⁴⁵⁴

Japan's High Pressure Gas Safety Act and legislation governing its production, storage, and transportation of hydrogen make sure that safety issues are legislatively enshrined. Moreover, hydrogen is incorporated into the nation's Strategic Energy Plan, providing legislative support for national utilization. In comparison to the EU, Japan is not making a

strong distinction between green and blue hydrogen on the legal front but is focusing on hydrogen as an inter-mediate fuel, with gradual transition towards lower-carbon fuels. Its policy involves direct state investment, public-private partnerships, and incentives for infrastructure development.

Australia

Australia's hydrogen strategy is rooted in its vast renewable energy potential and global export ambitions. The National Hydrogen Strategy (2019) provides the legal and policy basis for hydrogen production and export readiness. Unlike the EU or Japan, Australia emphasizes technology neutrality and focuses on building an export-oriented hydrogen supply chain. The strategy is implemented in a decentralized manner, with states and territories playing a key role through regional legal instruments such as Queensland's Hydrogen Industry Development Strategy and Western Australia's Renewable Hydrogen Roadmap.

Australia's legal approach is characterized by fast-tracked project approvals, land-use planning integration, and environmental regulation alignment. The federal government has also introduced clean hydrogen certification trials through the Guarantee of Origin scheme, which measures emissions intensity across hydrogen production processes. Regulatory clarity is further supported by pilot hydrogen hubs funded through the Hydrogen Energy Supply Chain (HESC) project, aimed at creating export terminals and integrated supply infrastructure.

The Australian approach stands out for balancing economic development with regulatory flexibility. While it still faces environmental and social license challenges, it offers a model for India on how to decentralize hydrogen policy within a national framework and promote private sector innovation.⁴⁵⁵

⁴⁵³ European Commission, A Hydrogen Strategy for a Climate-Neutral Europe, COM(2020) 301 final, p. 5.

⁴⁵⁴ Bhattacharya, Debajit, Green Technologies and Indian Energy Policy, 2nd edn (Eastern Book Company 2022) p. 157.

⁴⁵⁵ Australian Government, National Hydrogen Strategy, Department of Industry, Science, Energy and Resources, 2019, p. 11.

The EU, Japan, and Australia offer diverse legal models that cater to their unique energy goals and economic structures. The EU focuses on emissions reductions and legal harmonization, Japan leads with safety regulations and public investment, and Australia emphasizes export-oriented growth and regional autonomy. India can learn from these frameworks by incorporating a mix of legal standardization, economic incentives, safety protocols, and environmental safeguards into its green hydrogen laws. Developing a well-coordinated, transparent, and scalable legal infrastructure is crucial for India to emerge as a competitive player in the global hydrogen market.

6. Legal and Regulatory Reform Recommendations

To build a strong green hydrogen economy, India requires a uniform legal and regulatory system that connects innovation, safety, investment, and environmental objectives. Existing policies, while being ambitious in purpose, are not supported by legislation, lack regulatory transparency, and suffer from poor institutional coordination. Drawing on comparative models and domestic Indian challenges, the following legal and regulatory reforms are suggested:

6.1 Enactment of a Special Green Hydrogen Law

There must be a centralized Green Hydrogen Act to ensure certainty of the law, define hydrogen types (green, blue, grey), set national ambitions, and impose production, distribution, storage, and usage standards. This legislation also must define the roles of central and state agencies so as not to duplicate in governance.⁴⁵⁶

6.2 Streamlining Licensing and Environmental Clearance

Green hydrogen projects can be initiated under one-window clearance system with local, energy, safety, and environmental authorities' clearance. Environmental Impact Assessment

(EIA) process must be made streamlined with hydrogen-specific parameters and provision of low-carbon technology on fast-track.

6.3 Legal Requirements for Infrastructure Development

India must compulsorily establish a legal framework for the establishment of hydrogen infrastructure like electrolyser plants, pipelines, fuel stations, and storage facilities. This may be achieved by using public-private partnership models of government investment against legally binding project milestones. Electricity Act and PNGRB Act would need to be amended to include regulation of hydrogen infrastructure.

6.4 Standardization and Certification Framework

There is a pressing requirement for a National Hydrogen Certification System, rooted in legislation, that specifies the carbon intensity of hydrogen according to lifecycle emissions. This will not only satisfy international trading standards but also inform eligibility for domestic subsidies and carbon credits under a future Hydrogen Carbon Credit Trading Mechanism.

6.5 Fiscal and Regulatory Incentives through Legal Instruments

The government needs to implement legally binding incentives of tax relief, production-linked incentives (PLI), and carbon credits for green hydrogen projects. The incentives need to be tied with the levels of sustainability and implemented through legislation and not through a series of short-term policy statements to offer legal certainty for long-term investments.

6.6 Linkage with Climate Change and Renewable Energy Legislation

Green hydrogen should be officially incorporated into India's climate action law and energy transition policy, e.g., the Energy Conservation Act and National Action Plan on Climate Change (NAPCC). This would provide a binding policy mandate for hydrogen development and enable legal liability in

⁴⁵⁶ Rajeev Malhotra, Sustainable Energy Development in India: Legal and Policy Challenges (Oxford University Press 2021) 164.

achievement of emission reduction targets under the Paris Agreement.⁴⁵⁷

6.7 State-Level Hydrogen Policy Harmonisation

As some Indian states are initiating their own hydrogen missions, a legal framework for central and state policies harmonisation must exist. Model laws or guidelines by the Ministry of New and Renewable Energy (MNRE) can bring uniformity to standards, eliminate legal conflicts, and enable ease of inter-state trade of hydrogen-based energy.

6.8 Legal Framework for Public Participation and Safety Regulations

Legal provisions would have to be enacted to facilitate community involvement, openness, and access to information on hydrogen projects. Additionally, the special safety regulations applicable to hydrogen would have to be enacted under the guise of handling, leakage response, storage, and disaster relief measures—perhaps under the Factories Act or the amendments to the Environment Protection Act.⁴⁵⁸

To facilitate a successful green hydrogen economy, legal reform must move beyond patchwork policy measures and establish a solid statutory basis. In following the footsteps of the EU, Japan, and Australia, India needs to enact targeted legislation, streamline procedures, encourage innovation, and promote safety and environmental responsibility. These law and regulation reforms will be the driving force in making India a green hydrogen hub globally and achieving its energy transition ambitions.

7. Conclusion

Green hydrogen and plastic-to-oil (PTO) conversion technologies are not merely innovative energy solutions; they represent a pivotal opportunity for India to align economic growth with environmental stewardship. Both sectors promise to reduce dependence on fossil fuels, enhance energy security, and tackle the mounting crisis of plastic waste, all while advancing India's international climate commitments.

Yet, as this paper has shown, their progress is hampered by fragmented laws, overlapping institutional jurisdictions, and a lack of standardization in safety, certification, and fiscal incentives. The absence of a dedicated Hydrogen Law and the failure to formally recognize PTO as a renewable energy source reflect a larger gap in India's energy governance architecture. Without comprehensive reform, India risks regulatory stagnation and investor hesitation, undermining the very technologies it seeks to promote.

Comparative lessons from the European Union, Japan, and Australia illustrate the importance of harmonized legislation, robust safety regimes, certification frameworks, and integrated infrastructure development. These models show that legal clarity and long-term policy stability are essential to unlock private investment and international collaboration.

India's pathway forward must be anchored in the enactment of a **National Clean Technology Act**, the creation of a **single-window clearance system**, and the establishment of **BIS-led certification and safety standards**. Fiscal incentives such as carbon credits and production-linked schemes must be legislatively guaranteed, not left to ad hoc policy announcements. Finally, public-private partnerships and the inclusion of informal waste sector workers can ensure that the clean energy transition is socially equitable.

In conclusion, green hydrogen and PTO conversion offer India a dual opportunity: to

⁴⁵⁷ Neelam Deshpande, *Energy Law and Policy in India* (Universal Law Publishing 2023) 192.

⁴⁵⁸ Rakesh Iyer, *Hydrogen Economy: Global Prospects and Indian Readiness* (Bloomsbury India 2021) 127.



emerge as a global leader in sustainable energy and to transform its waste management crisis into a driver of innovation. By moving from fragmented policies to a coherent, legally binding framework, India can ensure that these technologies fulfill their promise of a just, resilient, and sustainable energy future.

