THE ENERGY CONSORTIUM
IIT MADRAS

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ACCELERATING GREEN HYDROGEN : UNLOCKING INDIA'S TECHNOLOGICAL PROWESS

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Workshop Insights Report

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Energy Leap WITH xynteo

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1. EXECUTIVE SUMMARY

Green Hydrogen Workshop Overview: From Potential to Deployment

India is at a critical inflection point in the global green hydrogen transition. With abundant renewable energy resources and a rapidly growing innovation ecosystem, the country is well-positioned to become a global leader in green hydrogen. Over 50 startups have emerged in the sector innovating across the value chain. However, despite steady progress in scaling hydrogen production technologies, one core challenge remains: the commercialisation of indigenous deep-tech, hardware-intensive solutions such as electrolysers, fuel cells and hydrogen storage systems.

A workshop at IIT Madras conducted by **Energy Leap team at Xynteo in collaboration with IITM Energy Consortium with exclusive sponsorship from Technip Energies and Rely, on June 25th 2025,** brought together subject matter experts and leaders from the government, industry, finance, and academia to assess systemic gaps and co-create solutions to accelerate deployment. This report distils insights from the discussion that ensued and provides a thesis around key enablers for this ecosystem.

Key Insights

To unlock green hydrogen innovation at scale, India must undertake a comprehensive ecosystem transformation. This requires action across five key areas:

Capital and Commercialisation Gaps: Indian green hydrogen start-ups face a financing "valley of death" between pilot validation and commercial scale (TRL 6–9). Venture capital models are ill-suited for long-gestation, high-CAPEX hardware, leading to stalled first deployments due to absent viability-gap funding, conditional offtake guarantees, and risk-sharing instruments. A demand-side pull with blended, milestone-linked capital are essential to break the investor–buyer deadlock.

Infrastructure and Validation Gaps: There is a shortage of certified hydrogen labs, modular testbeds, and safe demonstration zones in India. Start-ups often must rely on costly overseas validation, delaying market readiness. Without domestic, risk-mitigated testing and piloting facilities (similar to European Hydrogen Valleys), innovators struggle to prove compliance, benchmark performance, and gain customer trust.

Regulatory Gaps and Standards Inertia: India's regulatory frameworks for green hydrogen are fragmented and lack responsive amendment pathways, and regulatory sandboxes. This creates uncertainty, slows approvals, and pushes procurers toward safer, established technologies, limiting opportunities for early-stage innovations.

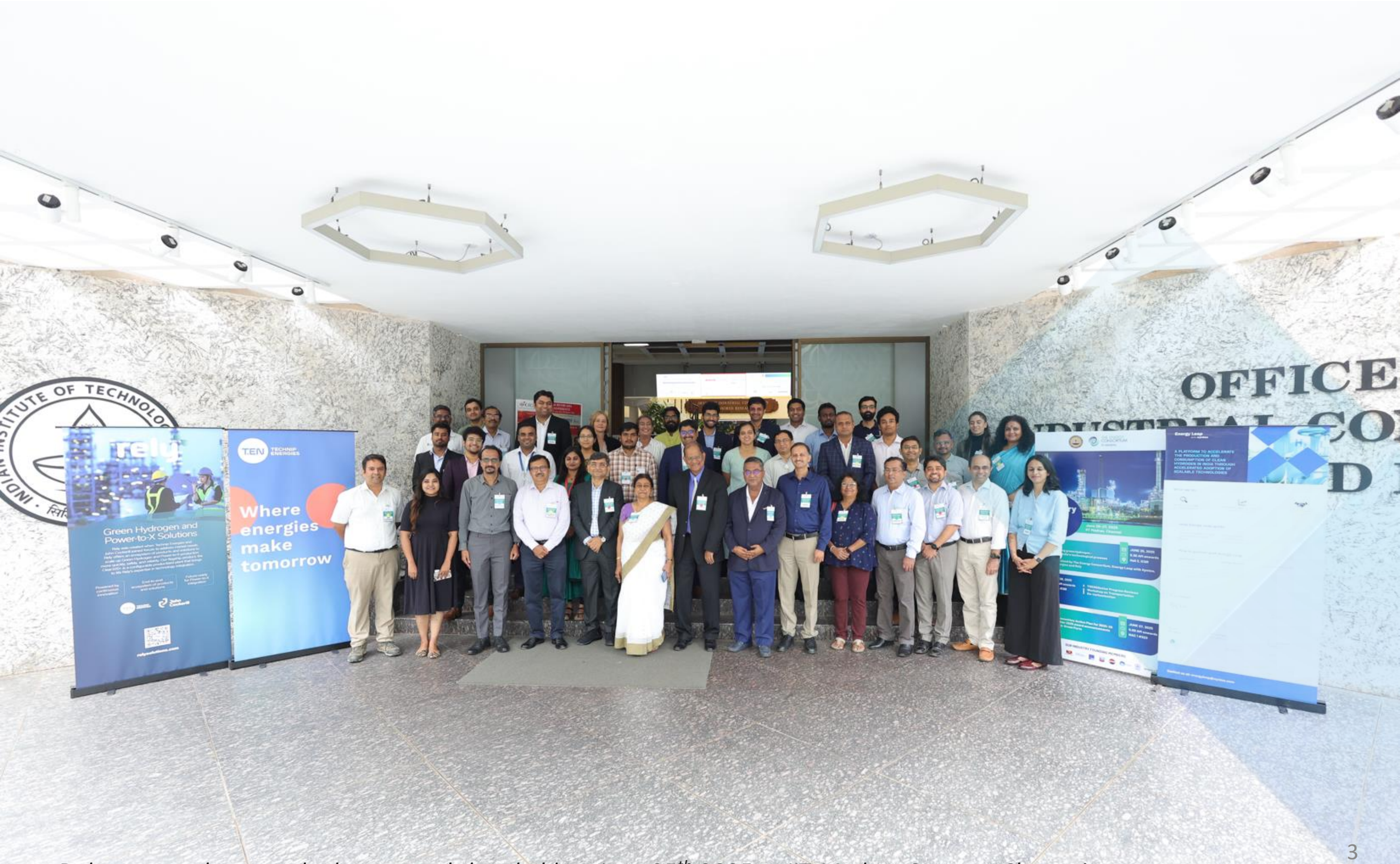
Evolving Institutional Anchors and Ecosystem Coordination: Strengthening the hydrogen value chain will benefit from a central coordinating platform that can aggregate demand, align stakeholders, and support public procurement mandates. As the ecosystem grows, bringing together start-ups, academia, MSMEs, and industrial players, raising awareness and visibility of use-cases will help accelerate investor confidence.

Industrial Competitiveness Constraints: Indian manufacturers face rising input costs (steel price volatility) and aggressive competition from subsidised Chinese imports priced 20–30% lower. Without localisation targets, manufacturing incentives, and protective measures, India risks dependence on imports and losing a foothold in global hydrogen supply chains.

Call to Action

Green hydrogen is no longer a distant ambition. It is central to India's strategy for industrial decarbonisation, energy security, and global competitiveness. The opportunity is immense, but the time for building competitive differentiation and value creation is limited. India must accelerate the shift from demonstration to deployment by closing infrastructure gaps, scaling domestic manufacturing, and securing global offtake agreements.

The workshop identified a common need for an integrated national pathway to support early-stage commercial deployment of hydrogen technologies. From the discussions emerged a need for a government-anchored, multi-stakeholder platform that aggregates demand, enables structured financing, fast-tracks regulatory support, and provides shared demonstration infrastructure. The platform would secure public and industrial offtake commitments, offer milestone-based and hybrid financing tailored for deep-tech hardware, fast-track safety standards and pilot waivers, and give start-ups access to certified real-world testbeds. Housed within the IIT Madras Energy Consortium and supported by the Energy Leap platform, it would bridge the gap between innovation and adoption, enabling India to scale indigenous hydrogen technologies competitively and at speed.



Delegates at the green hydrogen workshop held on June 25th 2025 at IIT-Madras Campus, Chennai

2. CONTEXT: ACCELERATING GREEN HYDROGEN TECHNOLOGIES

Green hydrogen has emerged as a cornerstone of India's strategy to achieve its net-zero emissions target by 2070, offering a critical pathway to decarbonise hard-to-abate sectors such as fertilisers, refining, steel, and heavy transport. It is also poised to serve as a long-term industrial feedstock and a clean energy carrier for power storage and export. With the global green hydrogen market projected to reach $410 billion by 2030, India has the opportunity to become a cost-competitive global hub.

India holds structural advantages in this transition. The country's levelised cost of renewable electricity is among the lowest in the world, with recent solar bids as low as ₹2.20 per kWh. Additionally, India benefits from low-cost construction and engineering capabilities, which can reduce the capital expenditure of green hydrogen plants compared to Western markets. According to the IEA, India has the potential to produce green hydrogen at $1.50–2.00/kg by 2030, making it highly competitive on a global scale.

However, realising this potential requires India to build domestic capacity across the hydrogen value chain— particularly in the manufacturing of electrolysers, fuel cells, compressors, and hydrogen storage systems. Currently, the sector remains import-dependent, especially for critical components like membranes, stacks, and high-efficiency power electronics. China dominates over 70 percent of the global electrolyser manufacturing market, exposing India to supply chain risks, price volatility, and strategic vulnerabilities.

> **"While the production of critical minerals is relatively diverse, processing is strongly limited to only a few geographies, especially for REEs, where more than 80 per cent of total processing is concentrated in one country (China). Further, only two countries (China and Indonesia) together constitute about 50 per cent of the total nickel processing capacity. Therefore, scaling up electrolyser manufacturing capabilities in India requires us to develop resilient supply chains for these critical minerals."**
>
> ***- How can Hydrogen Electrolysers be Made in India? A Bottom-up Cost Assessment to Quantify the Indigenisation Potential, CEEW (Sept 2024)***

The Government of India launched the National Green Hydrogen Mission (NGHM) in 2023, with the aim of producing at least 5 MMT of green hydrogen annually by 2030. Yet, policy support alone is insufficient to catalyse innovation at scale. Critical gaps persist in the commercialisation of technologies across TRL 6 to TRL 9. Many Indian start-ups and technology developers face the "valley of death", a phase where pilot-tested innovations struggle to transition into commercially viable products. Challenges include:

- Limited access to blended finance instruments tailored to high-risk hardware ventures
- Absence of independent testbeds and demonstration infrastructure
- Market uncertainty and lack of long-term offtake guarantee
- Fragmented and evolving regulatory frameworks

First-of-a-kind (FOAK) deployments in particular face high capital intensity, long payback periods, and low risk tolerance among financiers. Without dedicated mechanisms to de-risk early deployments, such as viability gap funding, sovereign-backed demonstration grants, entrepreneurial and investor interest remains constrained. This stalls India's push for technology indigenisation and reduces its ability to compete globally.

Accelerating green hydrogen in India will require a multi-pronged strategy:

- Scaling up innovation support through grand challenge funds and blended finance
- Establishing regional green hydrogen clusters with shared demonstration infrastructure
- Creating regulatory sandboxes for faster clearances and safety validation
- Unlocking demand through mandates and incentives in refineries, fertilisers, and steel
- Deepening international partnerships for technology transfer and export market access

India's success in green hydrogen will depend not just on how cheaply it can generate renewable power, but on how quickly it can build an integrated and resilient green hydrogen ecosystem that supports innovation, manufacturing, and deployment at scale.

The innovation valleys such as Kerala Hydrogen Valley Innovation Cluster, Pune Hydrogen Valley Innovation Cluster address some parts of the strategy in terms of providing demonstration infrastructures and funding.

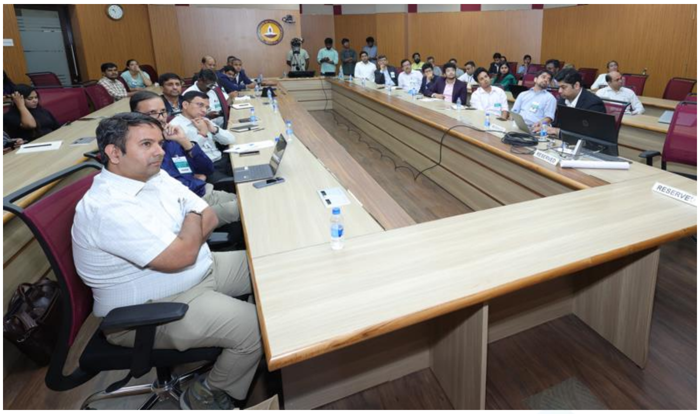
3. ABOUT THE WORKSHOP

To move the needle on India’s green hydrogen ambition, Xynteo, in partnership with the IIT Madras Energy Consortium, with exclusive sponsorship from Technip Energies and Rely, convened a focused workshop to unpack what it will really take to scale green hydrogen technologies in India. The session brought together a mix of players— government (MNRE), OEMs (Adani, Jakson Green Infinity), off-takers (Shell, Chevron), energy technology integrators (Baker Hughes, Technip Energies, Rely), Innovation valleys (Pune Innovation Cluster), start-ups (Hydrovert, H2C0, Saarthi Greentech, Hylan Power One, Hycell Engage) and researchers (IIT Madras)

The focus of the workshop was two-fold – i) How do we bring more indigenous innovation into the ecosystem? ii) How do we help promising technologies—especially those in the TRL 6-9 range—move toward commercial scale?

The agenda kicked off with a keynote address by Dr. Sujit Pillai (Scientist-F, MNRE), who shared updates on the National Green Hydrogen Mission and the push for electrolyser indigenisation. This was followed by a presentation on the new IITM–Hyundai Hydrogen Centre, as well as an overview of the broader energy research portfolio at IIT Madras—from hydrogen and storage to CCUS and combustion systems.

The discussion throughout the day was grounded and forward-looking. We heard from both large companies and start-ups on practical challenges—cost, intermittency, modularity, system integration—and what it will take to scale green hydrogen projects in Indian conditions.



In the second half, participants broke into groups to work through specific scale-up challenges—mapping stakeholders, bottlenecks, and identifying actions that could be taken forward in the next 6-12 months. These conversations were not just theoretical—the intent was to synthesise them into a follow-on report to guide implementation and ecosystem coordination.

The workshop underscored what many already recognise: green hydrogen is a deep-tech sector. It needs time, capital, and serious alignment across industry, government, and R&D. But it also showed that momentum is building and with the right mechanisms, India is well-positioned to lead.

4. KEY INSIGHTS

The discussions from the workshop revealed a clear pattern: while technical progress is strong, India's green hydrogen ecosystem faces systemic barriers that prevent promising innovations from moving beyond prototypes and pilots. These challenges are interlinked — spanning financing, infrastructure, regulatory readiness, institutional coordination, and manufacturing competitiveness — and must be addressed in a coordinated way to unlock early-stage commercial deployment. The following key insights distil the most critical gaps identified during the workshop and form the foundation for the recommended national platform approach.

A. Capital and Commercialisation Gaps:

India's hydrogen start-up ecosystem is growing rapidly, with an increasing number of domestic technologies achieving successful lab validation and early pilot results. However, most **innovations struggle to transition from prototype to market-scale deployment.** The gap lies not in technology potential, but in the absence of tailored capital instruments and institutional demand signals that can support the unique risk and scale-up requirements of deep-tech hardware innovations.

Hydrogen technologies, whether electrolysers, storage systems, or fuel cell components, are capital-intensive, infrastructure-dependent, and regulated. They typically require multi-year investment horizons, access to demonstration environments, and predictable demand to reach commercial traction. Unfortunately, India's existing financing architecture and market structures are not designed for these conditions.

Key Issues:

1. **Capital misalignment**: Technologies at TRL 6-9, the phase between prototype validation and commercial rollout, require long-gestation, risk-tolerant capital. However, India's start-up financing landscape is dominated by venture capital models optimised for SaaS, consumer tech, or low-CAPEX ventures. As a result, hydrogen start-ups find themselves underfunded just when they need to invest in certifications, pilot manufacturing, safety compliance, and early offtake engagement.
2. **First deployment deadlock:** Early commercial deployments, often called first-of-a-kind or market-scale pilots, are repeatedly stalled due to the absence of:
    - Viability gap funding mechanisms to bridge the cost premiums associated with the first few deployments
    - Conditional offtake guarantees that signal long-term demand
    - Insurance or risk-sharing products that would enable lenders or investors to underwrite project risk. This results in validated technologies sitting idle, unable to secure customers or capital for the next step
3. **Offtake–funding loop**: A classic chicken-and-egg dynamic persists. Investors and banks want long-term buyer commitments before investing. Buyers, in turn, are reluctant to commit until prices come down with scale, which won't happen until the technology is deployed and financed.

Strategic Implication: Without structured demand-side pull mechanisms (e.g., PSU offtake, procurement mandates that pay premium for initial deployments) and blended, milestone-based capital instruments, even high-potential hydrogen innovations may fail to reach the market. The result is a chronic underutilisation of India's R&D pipeline, loss of IP to foreign players, and missed opportunity to build domestic manufacturing and supply chains. Breaking this logjam requires a coordinated platform that de-risks both the demand and financing side of early-stage commercialisation.

B. Infrastructure and Validation Gaps

Commercial readiness in this domain demands not only technical functionality but also rigorous performance validation, safety testing, third-party certification, and real-world demonstration under industrial conditions. However, India's hydrogen shared infrastructure and independent validation capacity are still in the nascent stage, particularly for start-ups and early-stage innovators.

While a growing number of Indian hydrogen companies are reaching TRL 5-7, they face significant structural barriers when trying to conduct real-world pilots or achieve third-party certification. Unlike software or service-based innovations, these technologies cannot go to market without access to certified labs, industrial-grade testbeds, and safe, regulatory-compliant demonstration zones.

Key Issues:

1. **Lack of certified hydrogen labs**: India lacks nationally accredited labs for certification and testing of key hydrogen components such as electrolysers, storage systems, and fuel cells. Start-ups then seek international testing partners (e.g., TÜV, DNV), which is costly, time-consuming, and inaccessible for many. The limited accessibility to domestic certification facilities delays product development cycles, undermining trust among potential customers, regulators, and financiers.
2. **Lack of modular testbeds across technologies**: There are currently **no modular, technology-agnostic testing facilities** that can simulate field conditions for different hydrogen pathways, including alkaline, PEM, and solid oxide electrolysis cells (SOECs). This makes it difficult for start-ups to benchmark performance, conduct durability and efficiency testing, or iterate on real-use feedback in a controlled environment.
3. **No demonstration zones with integrated safety protocols**: Hydrogen start-ups face extreme difficulty in finding locations to deploy their systems for real-world piloting. Industrial partners are often reluctant to host untested systems due to concerns around safety, regulatory risk, and operational disruptions. Moreover, India lacks dedicated "hydrogen-safe" demonstration zones – integrated spaces where start-ups can test technologies within an ecosystem equipped with fire safety, ventilation, compliance monitoring, and emergency response protocols.

Global Example: The European Hydrogen Valleys Programme provides a strong model. It offers co-located infrastructure for hydrogen production, storage, and use, allowing start-ups and corporates to pilot technologies at scale with shared permitting, safety systems, and access to validation partners This integrated approach significantly reduces time-to-market and increases investor and customer confidence.

Strategic Implication: Without accessible, certified, and risk-mitigated infrastructure, Indian hydrogen start-ups are left with few viable pathways to demonstrate performance, prove compliance, and de-risk their offerings for customers. To enable a thriving hydrogen innovation ecosystem, India needs a network of certified labs and demonstration zones embedded within national R&D institutions and hydrogen valleys, operated through clear access protocols, performance benchmarking systems, and safety oversight.

C. Regulatory Gaps and Standards Inertia

As hydrogen technologies evolve rapidly, the regulatory frameworks in India have not kept pace. Many start-ups operating at the frontier of hydrogen innovation find themselves constrained not by technical feasibility, but by regulatory ambiguity, sometimes outdated standards, and the absence of structured mechanisms for adaptive compliance.

Hydrogen technologies inherently involve high-pressure gases, flammable materials, and system-level integration, requiring clear, well-defined, and credible safety and performance standards. However, India's regulatory environment is fragmented and reactive, often relying on legacy standards not designed for next-generation systems like solid-state storage or advanced electrolysis stacks.

This creates a risk-averse environment for both start-ups and buyers. Public procurers hesitate to issue pilot orders without certification clarity. Industrial offtakers avoid collaboration due to liability concerns. As a result, otherwise promising innovations are unable to cross the critical demonstration threshold.

Key Issues:

1. **Absence of TRL-specific standards**: There is no clear regulatory or safety framework aligned with different stages of technology maturity (e.g., TRL 6 vs. TRL 9). This means early-stage pilots are often held to the same standards as fully commercial systems, making approvals prohibitively difficult. For example, start-ups developing new storage configurations or high-efficiency stacks often face blanket disqualification due to non-alignment with existing codes meant for mature technologies.
2. **Lack of responsive amendment pathway**: There is currently limited formal mechanism through which innovators can propose regulatory exemptions, fast-track code updates, or request safe-use waivers for pilot deployments. This lack of procedural transparency and responsiveness creates a rigid environment that delays or prevents demonstrations, particularly in newer segments like solid-state storage or integrated hydrogen-electric mobility systems.
3. **Lack of regulatory sandboxes**: Unlike sectors such as fintech and health tech, India's hydrogen ecosystem does not yet offer regulatory sandboxes that allow early-stage technologies to be tested under flexible, controlled conditions. Such frameworks could help balance risk and innovation, enabling start-ups to validate safety, collect field data, and engage regulators iteratively rather than being blocked outright.

Strategic Implication: This regulatory inertia drives conservative behaviour across the ecosystem – from public sector procurement agencies to industrial buyers and financiers. In the absence of flexible standards, procurement teams default to safe, known technologies, or simply defer decisions. This restricts the deployment of homegrown innovations, delays progress toward decarbonisation goals. To unlock innovation and adoption at scale, India must establish a structured, multi-stakeholder regulatory interface for hydrogen — one that enables code reform, introduces TRL-based standards, and provides sandbox pathways for safe experimentation and iterative learning. This will be critical to accelerating both market access and trust in India's emerging hydrogen technology base.

D. Evolving Institutional Anchors and Ecosystem Coordination

India's green hydrogen ecosystem is gaining momentum, with innovation activity and diverse stakeholders entering the space. To move towards greater maturity, the sector will benefit from greater institutional coordination and more cohesive integration across the value chain. At present, start-ups, academia, MSMEs, public sector buyers, and large industrial players often pursue parallel efforts, which highlights the opportunity to achieve alignment, shared priorities, and collective platforms that can scale promising solutions.

In contrast to more mature clean energy ecosystems (like solar or wind), hydrogen still requires a unified platform that integrates both supply and demand. While MNRE anchors the National Green Hydrogen Mission, and several centres of excellence (e.g., IIT Madras, CSIR labs) are active in research, there remains scope for a mechanism that aggregates demand, tracks deployment progress, or coordinates technical, financial, and regulatory enablers in a systematic way to enable technology commercialisation. For instance, the Fraunhofer Institute and organisations such as Indo-German Energy Forum (IGEF) support the technology commercialisation of key German technologies and strategically support global market access to these technology companies.

Key Issues:

1. **Ecosystem integration**: Coordination can be strengthened across the green hydrogen value chain. Start-ups often operate independently of the business needs of larger firms; MSMEs developing components (e.g., BOPs, valves, membranes) face limited visibility into demand pipelines; and translating R&D into industrial scale-up remains a critical step to duplication and accelerate maturity.
2. **Lack of mandated institutional procurement**: Unlike other strategic sectors (e.g., defence, renewable energy), there are no public procurement mandates or incentives encouraging PSUs or public departments to provide anchor demand for indigenous and proven hydrogen solutions. As a result, start-ups face high barriers in securing anchor customers. Early procurement frameworks through PSUs or state utilities could help bridge this gap.
3. **Awareness and visibility of use-cases:** Hydrogen applications remain less visible outside central ministries. For instance, state and municipal departments often have limited familiarity with potential applications in mobility (e.g., fuel cell buses), backup power (e.g., telecom towers), or decentralised energy systems. Successful pilots underway also need greater visibility to enable replication, cross-learning, and trust-building

Strategic Implication: Strengthening institutional anchors and improving ecosystem coordination will be central to accelerating India's green hydrogen market development. A central platform or mission hub could play this role by:

- **Aggregate and communicate deployment progress**
- **Facilitate collaboration across stakeholder groups**
- **Advocate for public-sector procurement mandates**
- **Institutionalise demand creation and matchmaking**

Such a platform would not only streamline access for innovators, but also reduce duplication, build market trust, and accelerate the maturation of India's green hydrogen economy.

E. Industrial Competitiveness Constraints

As India seeks to build a competitive and self-reliant green hydrogen industry, domestic manufacturers face mounting pressure on two fronts: rising input costs and intensifying international competition, particularly from China. While India has made significant strides in building local capabilities for components like balance-of-plant (BoP) systems, electrolyser stacks, and storage tanks, its manufacturing ecosystem remains young, cost-sensitive, and under-incentivised compared to global peers.

Chinese players, in particular, pose a significant challenge. Backed by state subsidies, scale advantages, and export-driven industrial policy, Chinese electrolyser manufacturers are flooding global markets with low-cost products, in some cases, pricing systems 20–30% lower than Indian equivalents. At the same time, volatility in raw material prices, especially steel and specialty alloys continues to inflate the capital cost of building hydrogen infrastructure within India.

This dual pressure from external competition and internal cost instability threatens to undercut the viability of Indian manufacturers at precisely the moment when global hydrogen supply chains are taking shape.

Key Issues:

- **Chinese cost pressures:** Chinese electrolyser stacks and subcomponents are priced significantly lower due to subsidised electricity and material inputs, export-focused manufacturing incentives, and larger economies of scale. Without similar support, Indian manufacturers struggle to match these price points while maintaining quality and safety standards. This is particularly concerning for Indian firms aiming to serve both domestic and export markets.
- **Steel price volatility:** The cost of key materials like stainless steel and coated steel are critical for hydrogen storage vessels, pipelines, and BOP systems and has remained volatile. This unpredictability directly impacts the CAPEX of hydrogen projects in India, making local infrastructure costlier compared to imports.
- **Absence of localisation targets:** Unlike solar PV or defence electronics, the hydrogen sector currently lacks clear domestic content requirements, phased manufacturing roadmaps, or localisation-linked procurement incentives. As a result, Indian manufacturers have little visibility into future demand or policy support, which discourages long-term investment in supply chains, tooling, or R&D.

Strategic Implication: Without targeted support to level the playing field, Indian hydrogen manufacturers risk being squeezed out of both the domestic and global markets. This would undermine India's ambitions to become an exporter of green hydrogen technologies and components, while deepening reliance on imported systems, potentially recreating the vulnerabilities seen in solar module supply chains. To compete effectively, India will need to introduce a comprehensive manufacturing competitiveness framework, including:

- **Local content requirements for publicly funded hydrogen projects**
- **Incentives for localisation of core components (e.g., electrolyser stacks, membranes, BOP)**
- **Price preference or tariff-based protection against subsidised imports**
- **Dedicated PLI-type schemes aligned with export potential and global certification standards**

Such measures are essential to build scale, trust, and resilience in India's hydrogen manufacturing base and to position Indian firms as credible players in global supply chains.

Table 1. Key Insights Summary

Area	Barrier	Strategic Implication
1. Capital and Commercialisation Gaps	Lack of risk-tolerant capital for TRL 6–9; no offtake guarantees; funding–demand deadlock	Pilot-stage technologies remain stranded; innovations fail to progress to market scale
2. Infrastructure and Certification Gaps	No certified labs; absence of modular testbeds; lack of hydrogen-safe demonstration zones	Delays in certification; high cost of validation; reduced trust from investors and buyers
3. Regulatory Gaps and Standards Inertia	Outdated codes; no TRL-specific frameworks; absence of amendment or sandbox mechanisms	Start-ups face compliance uncertainty; public and industrial users hesitate to pilot new tech
4. Evolving Institutional Anchors and Ecosystem Coordination	No procurement mandates; low coordination across value chain; low awareness among state actors	Redundant efforts, high transaction costs, and limited demand aggregation
5. Cost Pressures and Global Competitiveness	Chinese imports undercut Indian firms; raw material volatility; no localisation incentives	Indian manufacturing scale-up remains unviable; risks import dependency

5. OUR RECOMMENDATION

Based on the key insights during the workshop across start-ups, government, industry, and finance, a common thread emerged: **the need for an integrated national pathway to support the early-stage commercial deployment of hydrogen technologies.** This would require a coordinated platform that can aggregate demand, enable structured financing, fast-track regulatory support, and provide shared infrastructure, creating the conditions for Indian hydrogen innovation to scale credibly and competitively.

5.1 Proposed Solution: Platform to Accelerate Commercialisation of indigenous Green Hydrogen Technologies

To address the systemic barriers identified, the workshop recommended establishing a government-anchored, multi-stakeholder platform focused on enabling early-stage commercial deployment of Indian hydrogen technologies. This platform would bring together public sector demand aggregators, regulators, financiers, and research institutions to unlock the transition from pilot to market.

It would focus on six core functions, each directly linked to MNRE-led actions:

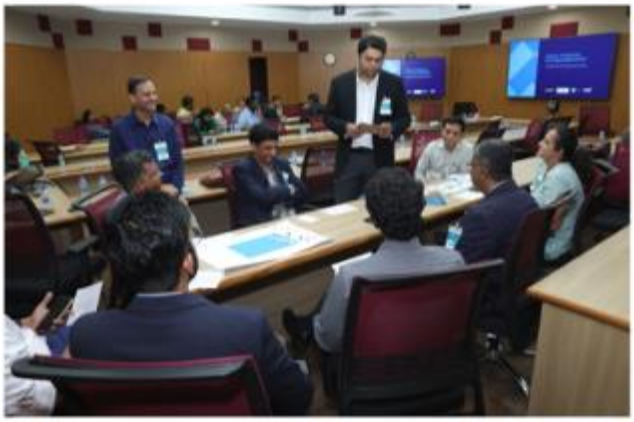
- **Demand Aggregation:**
    - Secure conditional offtake commitments from PSUs and large industrial users, anchored in decarbonisation mandates and procurement quotas
    - *MNRE role:* Embed policy incentives that prioritise domestic technology in public procurement, and set clear adoption targets for Indian-developed electrolysers, fuel cells, storage systems etc.
- **Structured Financing Mechanism:**
    - Offer milestone-based grants, zero-interest loans, convertible grants, and equity tailored to deep-tech hardware for hydrogen startups
    - *MNRE role:* Allocate dedicated funding lines for indigenous R&D, scale-up, and industrialisation; design PLI-type schemes; and fund first-of-a-kind deployments to validate Indian technology at scale
- **Regulatory Enablement:**
    - Create a working group to identify limiting standards, propose new protocols, and fast-track approvals
    - *MNRE role:* Establish TRL-based safety frameworks; streamline permitting and clearances; and set up regulatory sandboxes for emerging indigenous technologies
- **Shared Demonstration Infrastructure:**
    - Build access to certified testbeds and pilot plants via MoUs with CSIR labs, IITs, and PSU R&D units, operated under GOPO (government-owned, private-operated) models
    - *MNRE role:* Invest in specialised infrastructure for validation, such as roll-to-roll catalyst coating facilities, precision fabrication units, and pilot-scale assembly lines geared to indigenous tech scale-up

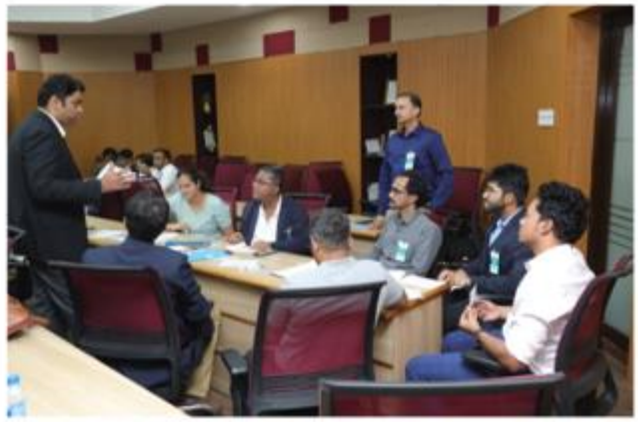
- **Technology Qualification:**
    - Implement a national TRL certification and performance validation system linked to funding and offtake eligibility
    - *MNRE role:* Facilitate creation of dedicated R&D consortia (modelled on US ElectroCat and H2NEW) that bring together academia, start-ups, expert bodies and industry to co-develop a framework to validate technology readiness and monitor technology development progress .

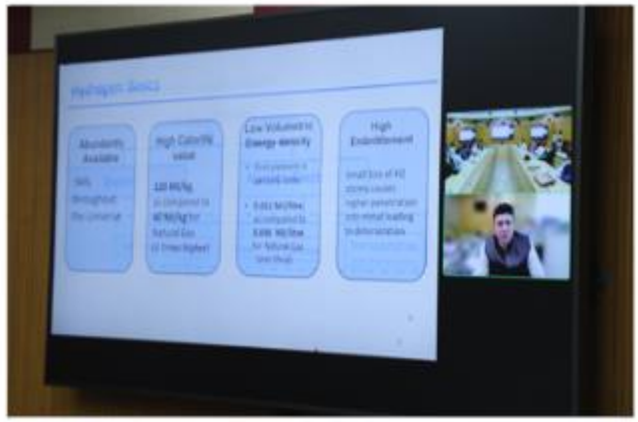
- **Visibility and Knowledge Hub**:
    - Launch an open-access portal to share validated pilot case studies, track deployments, and provide tools/templates for start-ups
    - *MNRE role:* Facilitate tech transfer programmes between labs and industry, promote collaborative innovation platforms, and empower state-level hydrogen hubs with region-specific manufacturing and technology specialisation

Together, this platform, led by MNRE, would serve as the missing bridge between innovation and adoption—enabling India to scale indigenous hydrogen technologies credibly, competitively, and at speed. Such a platform, while government-anchored, could be housed within CoEs or academic/research institutions with private sector linkages

6. GLIMPSES OF GREEN HYDROGEN WORKSHOP







7. ANNEXURE 1: THE AUTHORS

Milan Kaur, Manager, Xynteo
Milan has 9+ years of experience in consulting, across strategy, deal origination, market access, program design, and stakeholder engagement in healthcare, circular economy, and decarbonisation

Varun Desai, Manager, Xynteo
Varun has 9 years of global experience in low-carbon energy systems, renewable energy, energy storage. Prior to Xynteo, Varun worked at GTI Energy, evaluating first-of-a-kind energy transition project, validating techno-commercials and developing business case

Dr. Nikhil Tambe, CEO- IITM Energy Consortium
Nikhil has 20+ years of experience in research and technological innovation, focusing on energy transition and low-carbon technologies. He is currently the CEO of the Energy Consortium at IIT Madras, where he oversees the development of industry-academia government collaboration to enable a low-carbon future

Dr. Bhaskar Jha, Consultant, Xynteo
Bhaskar brings over 10 years of experience across clean energy research, low-carbon technology development, and sustainability advisory. His expertise spans bioenergy, green hydrogen, and circular economy solutions, combining deep academic research with on-the-ground advisory support

ANNEXURE 2: LIST OF DELEGATES

Name	Designation	Organisation
Achintya Venkat	Co-founder and CTO	Hylan One
Ajeet Babu	CEO and Co-founder	Gudlyf Mobility
Alok Kumar	Founder	Saarthi Green Tech
Anand Vasappanavara	Principal Systems and Controls	EH Group
Anuradha Ganesh	Co-founder and Director	Arantree Consulting
Anurag Pandey	Business Head	Reliance
Arjun Chandra	Sales Manager	Alfa Laval
Dr. Aravind Chandiran	Associate Professor	IIT-Madras
Atul S C	CEO	Diffuson Coatech LLP
Atul Verma	Chief Technology Officer	Adani New Industries Ltd
Bharath Srivatsa	CEO	Hylan one
Bhaskar Bose	Chief Technology Officer	Jackson Green Pvt. Ltd.
Gaurav Kumar Poricha	Techno-Economic Analyst	Technip Energies
K. Sunil Kumar	DGM-Supply Chain	Adani New Industries Ltd
Lynn Rouse	Strategic Relationships Manager	Chevron - Innovation and Technology Ventures
Mohit Tiwari	Technologist – India Innovation Hub	Technip Energies
R. Subramaniam Arunachalam	Associate Vice President	Technip Energies
Rama Venkatesan	Technology Scaleup and Deployment Manager	Chevron India
Rohith Kumar J	Process Engineer	Chevron India
Roshan Shetty	Process Engineer	Baker Hughes
Sanjana Iyer	Senior Manager	ARAI-AMTIF
Santosh Gurunath	CEO and Co-founder	H2CO
Smitesh Shenoy	General Manager	Jackson Green Pvt. Ltd.
Sruthi Kattamanchi	Researcher	Shell, Bengaluru
Sudeep Ambare	CEO (ARAI - AMTIC)	ARAI-AMTIF
Sunil Cavale	Investment Manager	Speciale Invest
Supriya Patwardhan	Chief operating officer	Hydrovert
Suresh N	Co-founder	Ashwatta
Uday Karthik Meduri	Team Leader	Baker Hughes
Venu Varma	Founder	Hycell Engage
Vesna Mirkovic	Strategic Relationships Manager	Chevron - Innovation and Technology Ventures
Vijai Balachandran	Technologist – India Innovation Hub	Technip Energies
Vikrant Urade	Principal Researcher	Shell, Bengaluru

About Xynteo:

Xynteo is a specialist advisory firm, based in Europe and India, on a mission to help global organisations and investors accelerate sustainable impact and value creation.

Our tailored solutions help organisations achieve meaningful, measurable results. We unlock systemic challenges through collaboration, devise sustainable value strategies, bring to life economically viable transformation, and generate impact across the investor portfolio lifecycle

About Energy Leap:

Energy Leap is a technology and business accelerator platform conceptualised and operated by Xynteo for enabling production and consumption of green hydrogen through deployment of scalable technologies

Energy Leap supports high potential startups to accelerate their prototype to commercialisation journey through strategic deployment of support areas such as market access, business advisory and capital unlock. Energy Leap is supported by leading partner organisations such as SED Fund Technip Energies, RICH (Hyderabad), NASSCOM, IITM Energy Consortium, IIMA Ventures, Ankur Capital and Transition VC

About Energy Consortium at IITM:

The Energy Consortium at IIT Madras is an interdisciplinary platform that brings together academia, industry, and government to accelerate low-carbon energy innovation and drive India's net-zero journey. With over 50 faculty, 250+ researchers, and global partners such as Shell, Chevron, Aditya Birla, and Infosys, it focuses on areas like carbon capture, green hydrogen, energy storage, and microgrids.

Through initiatives such as the TREND Setter program and partnerships with global institutions, the consortium aims to translate research into scalable solutions, targeting 1 gigaton of CO_2 reduction by 2035

Learn more about Energy Leap: xynteo.com/coalitions/energy-leap

Learn more about IITM Energy Consortium : energyconsortium.org