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Unlocking Role of Hydrogen for Mobility in India

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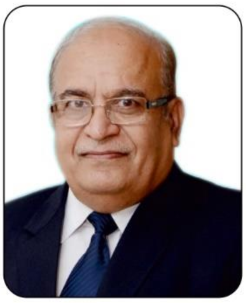
Authored By:



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Unlocking Role of Hydrogen for Mobility in India

Executive Summary

The National Green Hydrogen Mission (NGHM) envisions making India a global leader in hydrogen, with an initial emphasis on scaling up the production of green hydrogen. However, a key challenge remains in stimulating domestic demand, especially given the high current production costs of green hydrogen compared to conventional alternatives. As a result, early policy mandates are focusing on its use in refineries and exporting its derivatives.

India must pay more attention to the role of hydrogen in mobility, which offers a long-term opportunity for transition to cleaner and more sustainable fuels. Hydrogen can be produced from a variety of sources—both fossil-based and renewable—and delivers high energy content with significantly lower emissions, especially when used in Fuel Cell Electric Vehicles (FCEVs).

In contrast to battery electric vehicles (BEVs), which often rely on electricity from a coal-dominated grid, hydrogen-powered vehicles can offer a lower carbon footprint, making them better suited for India's current energy landscape. BEVs further have limitation of range and load carrying capacity, besides need for critical materials mostly controlled by China, thus hydrogen vehicles may have more potential.

In the mobility sector, the development of both vehicle technology and hydrogen supply infrastructure will require time and significant investment. While some pilot projects under the NGHM have begun exploring hydrogen for mobility, a larger, dedicated mission is urgently needed to create the scale of supply and distribution infrastructure required, something that is only viable when a substantial fleet is deployed on the roads.

This report evaluates the environmental impact, energy consumption and breakeven hydrogen prices required for cost parity with diesel and CNG/LNG, particularly in intracity and intercity buses and long-haul trucks. Findings suggest that grey hydrogen can enable early adoption through H_2 ICE vehicles to build initial demand and technical familiarity. Blue hydrogen, used in both H_2 ICEs and FCEVs, offers a viable medium-term pathway due to its scalability and lower emissions profile. Green hydrogen-based FCEVs are identified as the ultimate zero-emission solution for the long term.

The analysis also indicate that if hydrogen can be delivered at around ₹250/kg, it could compete with diesel in H_2 ICE applications. Even at a cost of ₹300–400/kg, hydrogen-based FCEVs, due to their higher efficiency, may be economically viable. Grey hydrogen, already available in India can potentially be delivered at ₹250/kg, making it suitable for early adoption in mobility sector. In contrast, the current cost of green hydrogen at ₹500/kg (including production and delivery), makes it less viable for transport in near term.

Considering these factors, India should adopt a pragmatic approach that includes the use of grey and blue hydrogen to trigger the transition of the mobility sector towards zero emission vehicles and as a step to reduce Scope 3 emissions, until green hydrogen production becomes more cost-effective.

This report highlights India-specific challenges and opportunities and proposes recommendations to accelerate hydrogen adoption in mobility, aiming to support policymakers, fuel suppliers, and automotive OEMs in building a future-ready hydrogen ecosystem.

1. Introduction: Mobility as the Catalyst of India's Hydrogen Revolution

India's decarbonization narrative is at a pivotal inflection point—where clean molecules must move beyond theoretical promise into systems of real-world impact. In this context, hydrogen should no longer be viewed as a singular solution, but rather as a foundational enabler—a versatile molecule that intersects multiple fuels, decarbonization pathways, and sectors, in ways uniquely suited to India's economic structure, industrial diversity, and energy challenges. While the ₹19,744 crore National Green Hydrogen Mission outlines an ambitious roadmap for making India a global hydrogen leader, the early momentum appears to be supply-heavy and application-light as it gravitates towards production targets and manufacturing capacities as well as exports.

The core question facing India's hydrogen ecosystem today is clear: Where is the domestic demand for green hydrogen, especially when its production cost alone hovers around ₹400/kg, as seen in IOCL's recent price discovery? The supply-demand imbalance is real and pressing. In response, many hydrogen developers are now exploring exports of green hydrogen derivatives such as green ammonia and green methanol, which offer more immediate economic viability due to global mandates and offtake readiness.

However, India cannot afford to rely solely on exports. For a truly self-sustaining hydrogen economy, domestic demand must be stimulated. This calls for a pragmatic, phased approach in identifying the production pathways and enhancing the spectrum of the end applications:

What remains underexplored—but holds transformational potential—is hydrogen's application in mobility.

Mobility is not just one of many end-use sectors—it is the most immediate, scalable, and high-frequency arena where hydrogen can shift from an industrial reactant to a consumer-facing energy vector. Unlike in industrial settings where hydrogen is hidden deep within chemical reactions, its use in mobility is dynamic, transactional, and publicly visible. Every kilometer driven by a hydrogen vehicle displaces fossil fuel, reduces emissions, and builds public trust in the hydrogen economy. This is not only symbolic—it is systemic.

India's transport sector presents a uniquely fertile ground for hydrogen. The country's multi-fuel landscape, high vehicular utilization rates, and infrastructural heterogeneity create a distinct competitive advantage. From heavy-duty freight and long-haul buses to inland shipping and regional aviation & drones, hydrogen—whether through fuel cells, internal combustion, or derivative e-fuels—offers sector-specific solutions that battery electric vehicles (BEVs) often cannot match due to grid constraints, thermal limitations, or payload penalties. While BEVs are often promoted as zero-emission solutions, the reality is more nuanced. In countries like India, where the grid is still predominantly coal-based, charging a BEV can indirectly result in significant carbon emissions. Simply put, a BEV cannot differentiate whether it's being powered by coal or solar—and hence, its "zero-emission" label is conditional on the pace of grid decarbonization.

Hydrogen, in contrast, offers a clean mobility solution that is not tethered to the state of the grid. With the ability to generate and consume hydrogen independently—whether via centralized green hydrogen plants, blue hydrogen near refineries, or localized electrolysis units—hydrogen mobility can scale in parallel with generation. This makes it a pragmatic and scalable pathway for decarbonizing transport, especially in sectors where BEVs fall short.

Until the electricity grid nearly decarbonizes, hydrogen vehicles—particularly fuel cell electric vehicles—present a more robust and cleaner alternative for certain mobility segments, offering real emission reductions based on their independent decentralized generation pathways rather than waiting the entire grid to decarbonize.

Mobility, therefore, is not a peripheral application of hydrogen—it is its proving ground. And in the Indian context, it may well serve as the launchpad for global leadership in the hydrogen economy.

The question is not: "How many tons of green hydrogen can we produce and at what price today and when will the green hydrogen come down to affordable level?"

The real question is: "Whether we should wait for green hydrogen costs to fall, or rather strategically unlock demand and create infrastructure in parallel with its scale-up, particularly in the unexplored territory of mobility in India"

While green hydrogen must remain the cornerstone for industrial decarbonization, sectors like mobility offer a unique opportunity to catalyse the hydrogen economy using transitional pathways.

Mobility is distinct because it can leverage the high conversion efficiency of devices like fuel cells, making hydrogen a technically and economically compelling solution even before green hydrogen reaches parity. Therefore, in this sector, other forms of hydrogen, such as blue or even grey, can serve as a bridge fuel—accelerating early adoption, building refuelling infrastructure, and achieving the economies of scale. Meanwhile, green hydrogen can continue its natural scale-up in sectors where it aligns best today, such as refining, ammonia production, and other industrial applications.

This dual-track approach would ensure that hydrogen adoption doesn't remain hostage to cost curves, but evolves dynamically anchored in green, accelerated by transitional fuels, and tailored to the strengths of each end-use sector.

"The electric cars will not be clean until India gets at least 50 per cent of its electricity from renewable sources."

"May be India should move to ethanol, hydrogen and fuel cell options instead of going for electric cars,"

-R.C. Bhargava, Chairman of Maruti Suzuki Ltd.

"As it stands, battery electric vehicles (BEVs) are not suitable for heavy- duty long-haul commercial vehicle applications. Fuel cell EVs require hydrogen with a very high level of refinement, while H2-ICE can operate with lower-grade hydrogen and allows the use of existing infrastructure"

Rajendra Petkar, president & chief technology officer at Tata Motors said.

2. Economic Opportunity of Hydrogen

As countries ramp up their climate commitments, the mode of hydrogen production is undergoing a fundamental transformation. The chart illustrates this shift, showing how global hydrogen production—currently dominated by fossil fuels—is expected to transition significantly toward low-carbon routes like electrolysis and fossil fuels with CCUS by 2050, supporting a more sustainable energy future[1].

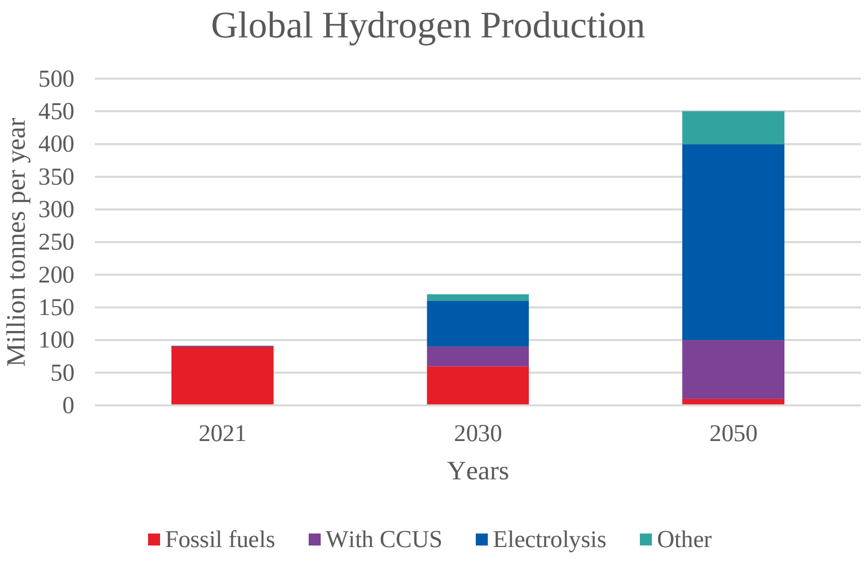


Figure 1 Global Hydrogen Production

While the globe has understood that hydrogen isn't just a climate solution—it's a techno-industrial revolution waiting to be unlocked, India is positioning itself as a major player in the global hydrogen economy, targeting a 10% share of the projected \$700–800 billion annual market by 2050[2]. Domestic hydrogen demand is expected to surge nearly ~30 million tonnes per annum (MMTPA) by 2050, driven by decarbonization in industry, transport, and energy storage.

To meet this vision, an estimated \$300 billion investment will be required across the hydrogen value chain—spanning production, storage, distribution, and infrastructure. This figure is supported by the 2023 report[2], which estimates a global investment gap of USD 380 billion by 2030 to be on a net-zero trajectory, highlighting the scale of investment needed in the hydrogen sector. India aims to manufacture 60 GW of electrolyzers annually by 2030, enabling around 5 MMTPA of green hydrogen capacity[3]. Thus scale-up of grey hydrogen is not only a climate and energy imperative but also a socio-economic opportunity, with the potential to create direct and indirect jobs in manufacturing, EPC, logistics, and operations—underscoring hydrogen's role as a catalyst for sustainable industrial growth. Buoyed by the developments in China, Japan and South Korea, mobility has the potential to emerge as a demand engine in India as well. By avoiding the curtailment of 50 TWh of renewable energy[4], hydrogen has a potential to operate a commercial fleet for 1 billion kms thus catalysing the ecosystem and its deployment in other sectors as well.

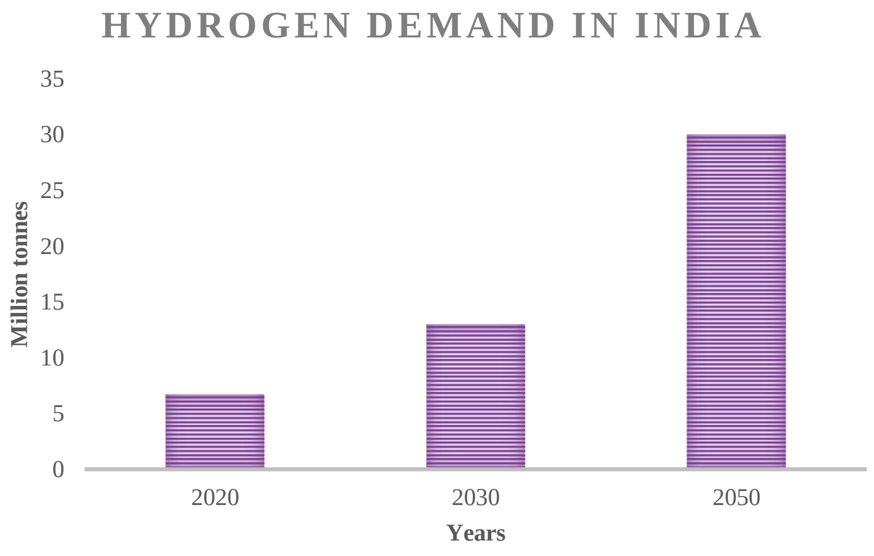


Figure 2 Hydrogen Demand in India

As can be seen in the above figure the hydrogen demand in India is likely to be around 13 million tons. While India has a target of only 5 million tons of green hydrogen by 2030, and hence rest of the demand will have to be met by grey or blue hydrogen. We there for need to ramp up the green hydrogen production or use grey/blue hydrogen till such time we develop sufficient capacities for green hydrogen. India aims to manufacture 60 GW of electrolyzers annually by 2030, enabling around 5 MMTPA of green hydrogen capacity[3]. Thus scale-up of grey hydrogen is not only a climate and energy imperative but also a socio-economic opportunity, with the potential to create direct and indirect jobs in manufacturing, EPC, logistics, and operations—underscoring hydrogen's role as a catalyst for sustainable industrial growth.

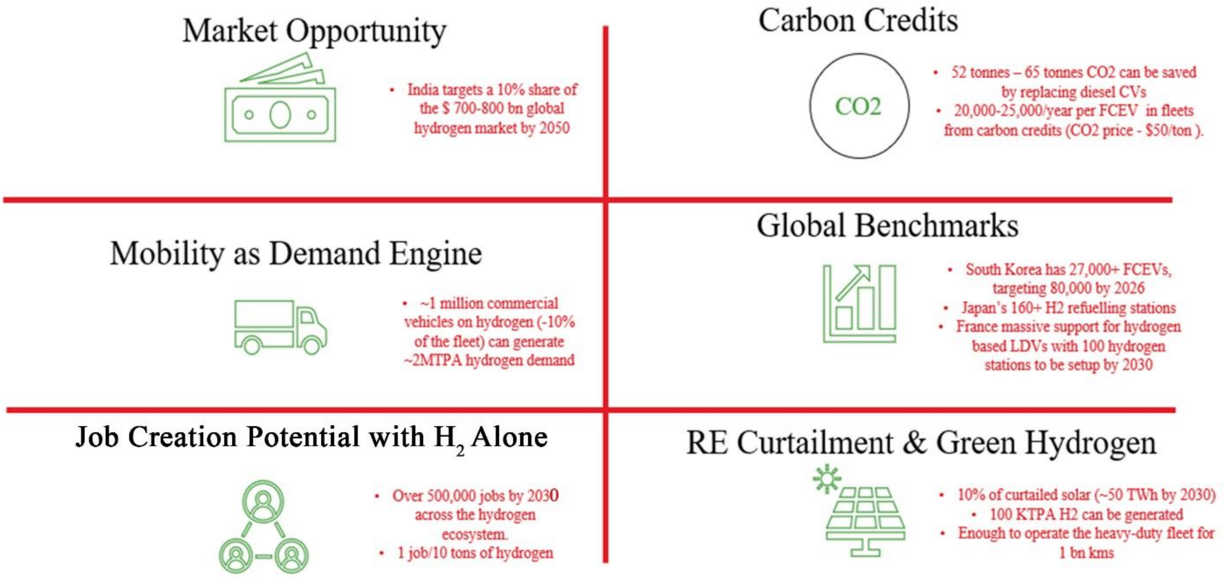


Figure 3 An Overview of Hydrogen's Benefits and Relevance in Mobility

Sources:

1. *Report by Hydrogen Council*
2. *MNRE*
3. *CEA, Govt of India*

3. High Production Costs: The Cost Gap Between Green and Grey Hydrogen

Despite India's aggressive push through the National Green Hydrogen Mission (NGHM), multiple technical, economic, and systemic challenges impede rapid hydrogen adoption, the cost production being the major challenge.

Table 1 Hydrogen Cost Comparison by Pathway and Color

Hydrogen Type	Cost Range (₹/kg)	Cost Range (USD/kg)	Major Drivers
Grey (SMR-based)[5]	₹140–160	$1.70–1.95	Natural gas prices, plant efficiency
Blue (SMR + CCS)[6]	₹190–240	$2.30–2.90	Gas + CCS CAPEX and energy penalty (~10–12%)
Green (Electrolysis)[7]	₹275–525	$3.3–6.5	Electrolyzer cost, RE cost, utilisation rate
Green w/ RTC RE[8]	₹350–575	$4.2–7.1	Storage, overbuild, round-the-clock contracts

Assumptions:

5. Imported LNG @ $9–11/MMBtu, SMR efficiency ~70%

6. CCS costs ~$60–80/t$CO_2$ avoided

7. Electrolyzer CAPEX @$700–1200/kW, RE @ ₹2.5 /kWh, 30–60% capacity factor

8. RTC RE tariffs at ₹2.9–4.5/kWh based on SECI bids

Cost is undoubtedly a central friction point in India's hydrogen transition. While policy narratives focus on scaling up green hydrogen supply, the reality is that the cost delta between green, blue and grey hydrogen remains a core constraint—especially for industrial sectors that operate on regulated pricing and / or low profitability.

In recent tenders for green hydrogen, IOCL discovered production price of INR 397 ($4.67) per kg.

4. Hydrogen: Understated in Mobility ECO System

While hydrogen has found mention in industrial decarbonization strategies—particularly in sectors like refineries and fertilizers—its role in the mobility ecosystem remains understated, both in policy discourse and project deployment. This neglect stems from a legacy framing of hydrogen as a feedstock rather than an energy carrier. In reality, mobility represents the most direct, scalable, and recurring application of hydrogen, and can act as a catalytic sector for jumpstarting the hydrogen economy.

Unlike industry, where hydrogen is retrofitted into existing processes, mobility transforms hydrogen into a prime mover—an end-use vector with measurable, distributed, and high-frequency energy demand. This distinction has profound implications for infrastructure investments, offtake models, and sector coupling.

5. India's Multi-Fuel Coexistence is a Hydrogen Opportunity

Unlike countries moving towards a binary "electric or hydrogen" model, **India's automotive sector is evolving in parallel across five fuel types**: petrol, diesel, CNG, ethanol, and electricity—with emerging interest in methanol and biogas. This multi-fuel mosaic may seem chaotic, but it is actually fertile ground for **hydrogen derivatives**:

- **Neat Hydrogen → Can operate** ICE and fuel cell electric vehicles
- **H_2 + CO_2 → e-Methanol** → Compatible with ICE vehicles and ferry engines
- **H_2 + CO_2 → e-Diesel / e-Kerosene** → Can decarbonize aviation, gensets and tractors
- **H_2 + Bio-CNG blending** → Enables faster rollout without 100% replacement

No other country has this **"infrastructure of readiness"** across fuels. India can thus **"drop-in decarbonize"** with hydrogen far more flexibly than a country locked into a singular energy pathway.

India's diversity in terrain, logistics, and economic activity offers an unparalleled opportunity to develop segment-specific hydrogen strategies, tailored for technology readiness, infrastructure feasibility, and export competitiveness. Each segment brings unique use-cases that reinforce hydrogen's systemic importance—not as a one-size-fits-all solution, but as a flexible molecular strategy across the energy and transportation value chain.

Table 2 Hydrogen based sustainable technologies for muliple mobility segments

Segment	Hydrogen Intervention	Technology	India-Specific Considerations
Heavy-duty trucks	Grey/Blue/Green H_2	H_2 ICE, Fuel Cells	India has 3.5M+ trucks[9]; over 70% logistics by road[10]; BEVs may not be viable due to terrain, payload loss, and refuelling time; domestic OEMs testing H_2-ICE
Rail	e-Diesel / H_2 ICE / Fuel cells	Drop-in e-fuels, H_2 combustion / electrochemical conversion	Electrification is not possible on all routes hydrogen trains already operational in Germany; India has low axle-load branch lines ideal for hybrid engines
Shipping	e-Methanol	Solid Oxide fuel cells, dual-fuel engines	India has 13 major and 200+ minor ports; methanol bunkering is feasible at scale[11]
Aviation	SAF / e-Kerosene	Jet A1-compatible engines	India among fastest growing aviation markets; hydrogen-derived SAF can help Indian airlines meet CORSIA/ICAO targets
Last mile	Batteries (grid-linked) / Range extender for niche applications	BEVs (2W/3W) / fuel cells	>75% of India's mobility is 2W/3W[12]; short-range, low payload; well-suited for Li-ion/Na-ion; electricity cost is dominant driver

Source:

9. Estimates by MoRTH (2023)

10. NITI Aayog – India Transport Sector Assessment (2021)

11. Annual Report 2023: Ministry of Ports, Shipping and Waterways

12. SIAM

6. Where Hydrogen Becomes Kinetic: Visibility, Velocity, and Value

In industrial contexts (refining, ammonia, methanol), hydrogen plays the role of a **reactant**—a means to an end. It is consumed silently, in closed-loop systems, with no consumer visibility. By contrast, **hydrogen in mobility is visible, transactional, and dynamic**. It powers engines, drives kilometers, and replaces fossil fuels in real time. This visibility offers three unique advantages:

6.1 Demand Decentralization

Mobility distributes hydrogen demand across thousands of vehicles and refuelling points. It avoids the single-point risk of large industrial buyers and enables demand aggregation from multiple fleets, OEMs, and public transport agencies.

For example, converting just 10% of India's commercial vehicle fleet (~1 million vehicles) to hydrogen could create a baseline demand of ~2 million tonnes/year, 40% of the National Hydrogen Mission's target.

[Assumes an average annual consumption of ~2 tonnes of hydrogen per vehicle, based on medium- to heavy-duty commercial operations with fuel cell or hydrogen-ICE technologies.]

6.2 Natural Clustering for Infrastructure

Unlike industrial applications that require long-distance pipeline transport of hydrogen, mobility enables local production-use loops. Urban depots, truck routes, and bus terminals naturally cluster hydrogen demand, allowing co-location of small-scale electrolyzers and refuelling stations. This sharply reduces Capex per unit delivered.

A single 50-bus depot using 25 kg H_2/day/bus demands nearly **1.25 tonne/day**, enough to justify a **1.5–2 MW electrolyzer powered by a solar mini-grid**.

6.3 Value Chains & Revenue Feedback Loop

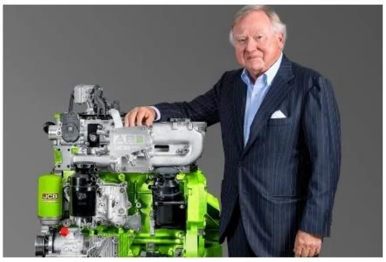
Hydrogen-powered vehicles generate quantifiable and frequent demand, enabling bankable cash flows for producers. Unlike refineries, fertilizers or steel sectors where hydrogen offsets emissions silently, mobility enables visible ESG credits, carbon offset sales, and green branding.

According to our estimates, FCEVs in public fleets could generate ₹20000–25,000 per vehicle annually in carbon credit value, assuming ₹4,000 per ton CO_2 and conservative emission savings of 5–10 tons per year.

7. India-Specific Mobility Characteristics That Suit Hydrogen

India's unique mobility landscape presents several characteristics that make hydrogen a particularly suitable solution, especially for commercial and heavy-duty transport. The country's freight and passenger vehicles often operate over **long distances**, carry **heavy loads**, and function under **high utilization rates**, making **fast refuelling and long range** critical—two strengths where hydrogen, particularly fuel cell and H_2 ICE technologies, outperform battery electric vehicles. Moreover, India has a high concentration of **intercity logistics corridors**, **urban-to-rural transit routes**, and **hub-and-spoke fleet operations**, which align well with centralized hydrogen refuelling infrastructure.

India also is a rural and developing economy with lot of construction activities going on. Even the decentralized RE power generation can help to locally produce hydrogen. Hydrogen can compliment the solar or wind power in far flung areas for power generation round the clock. The hydrogen engines or fuel cells could also provide energy for off road equipment, tractors and power generators.



"JCB plans to manufacture hydrogen-powered engines in India, following their commercial adoption in the UK. The company sees its Ballabhgarh plant as an ideal location for participating in the hydrogen initiative, as it already produces diesel engines for JCB's global operations."

Source: Mint News.

Lord Bamford, Chairman JCB with Hydrogen Combustion Engine

India's transport ecosystem has characteristics that align better with hydrogen than batteries or any fossil fuel, especially in heavy and commercial segments:

High Utilization Rates: Commercial vehicles in India operate **14–18 hours/day**, making long charging downtime infeasible. Hydrogen refuelling (~10-15 minutes) fits current operations.

Payload Sensitivity: BEVs may lose ~20–25% payload due to battery weight in long-haul applications. Hydrogen offers **lighter systems**, preserving freight economics.

Hot Ambient Conditions: India's climate (~45°C summers) **degrades lithium battery performance** and life. Hydrogen systems are thermally more stable.

Low Grid Reliability: In Tier-2/3 cities and highways, **electric grid stress and outages** make fast-charging infeasible. Decentralized hydrogen refuelling with backup solar/biomass generation offers resilience.

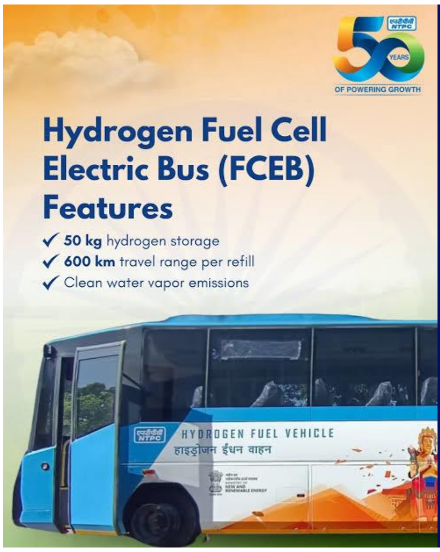
Enviornment and Sustainability: Inherent disadvatages of diesel vehicles: PM and NOx emissions are the key detterents for diesel vehicles besides the crude oil import implications

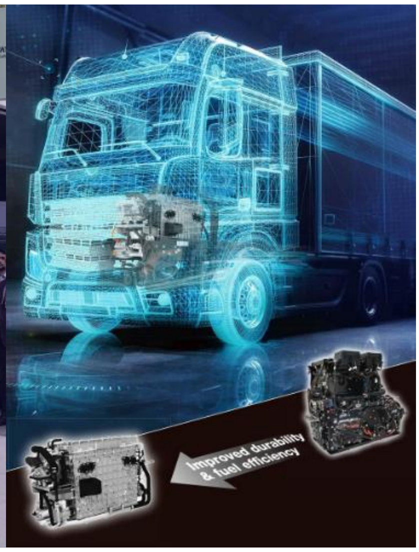
8. Global Benchmarks Show Mobility Leads Hydrogen Adoption

Countries with successful hydrogen pilots have typically **led with mobility**:

- **Japan**: Over 160+ hydrogen refuelling stations and thousands of FCEVs, with heavy government backing for public transport hydrogen adoption.
- **South Korea**: Over 27,000 FCEVs on road (2023), targeting 80,000 by 2026.
- **Germany**: Hydrogen trains operational on regional lines. Mobility is the lead application in their national hydrogen strategy.
- **France**: Massive support for hydrogen based LDVs with 100 hydrogen stations to be setup by 2030.

India's hydrogen mobility journey is only just beginning under the National Green Hydrogen Mission, but real impact will require a dedicated, mission-mode national programme that accelerates large-scale adoption. Experience from within the sector and other sectors has shown that cost reduction and supply chain reliability are only achievable when adoption reaches a critical threshold. To unlock the full potential of hydrogen in transport—whether through fuel cell electric vehicles (FCEVs) or hydrogen internal combustion engines (H2-ICE)—India must implement a coordinated, nationwide strategy that aligns policy, infrastructure, and industry efforts. Without this integrated approach, the promise of hydrogen mobility risks remaining confined to pilot projects thus missing the transformation of a sector to scale.





Source: NTPC **Source: Tata** **Source: Toyota**

9. Why Mobility could be India's Optimal Starting Point for Hydrogen

The success of hydrogen in India hinges on identifying sectors where adoption can scale rapidly, deliver visible impact, and unlock economic value in the near term. Among the various use cases, mobility—particularly through hydrogen internal combustion engines (H_2 ICEs) and fuel cell electric vehicles (FCEVs)—offers the most compelling starting point. Unlike industrial sectors such as refineries and fertilizers, which require ultra-low hydrogen prices and long infrastructure transitions, the mobility sector benefits from shorter adoption timelines, policy visibility, retrofit-friendly technologies, and strong job creation potential. The table below compares hydrogen's role and readiness across key sectors, highlighting why mobility stands out as the most pragmatic launchpad for India's hydrogen economy.

Table 3 Hydrogen Comparison by Sector and Use Case

Parameter	H_2 Mobility – ICE	H_2 Mobility – FCEV	Refineries	Fertilizers (Urea)
Hydrogen Role	Fuel for combustion engine	Fuel for electrochemical conversion	Chemical feedstock	Chemical feedstock
Capex Implication (Relative scale 1-5)	1	2	5	4
Hydrogen Price Tolerance	**Up to $3.5–4.5/kg** due to low upfront cost and known tech	**$4–6/kg** possible with incentives and bulk demand	Must be **<$1.5–2/kg** to be competitive with grey H_2	Must be **~$1/kg** to sustain fertilizer subsidies
Fuel Efficiency (vs Diesel)	1.1–1.2x lower (but manageable with policy support)	2–2.5x higher	N/A	N/A
Tailpipe/Stack Emissions	Near-zero tailpipe (with lean burn, EGR)	Zero tailpipe	Reduction of Scope 1 only	Reduction of Scope 1 only
Adoption Curve	**Short** – easy retrofits in existing diesel fleets	**Medium** – needs infra, OEM readiness	Very slow – high sunk cost	Medium – requires plant-level changes
Fuel Infrastructure Requirement	Needs 350/700 bar or LH_2 dispensing infra	Needs 350/700 bar or LH_2 dispensing infra	Cause redundancy of NG infra Requires either H2 pipeline or land for onsite production	Cause redundancy of NG infra Requires either H2 pipeline or land for onsite production
Deployment Pathway	**First-use case friendly** – intercity buses, garbage trucks, municipal vehicles	Ideal for long-haul logistics, buses, clean zones	Centralized plants; complex retrofitting	Large plants, remote locations, low visibility
Public Visibility & Policy Support	High – Indian OEMs already testing H_2 ICEs	High – policy support needed	Very low – back-end industrial use	Zero – no visibility, user disconnect
Economic Multiplier Effect	**Strong** – MSMEs for retrofits, service hubs, hydrogen trucking	Strong but higher entry barrier due to evolving technology	Low – driven by few large PSUs	Medium – mostly PSU driven
Technology Familiarity (India)	**Very High** – matches existing engine maintenance ecosystem	Low – dependent on imported tech, trained manpower	High – refinery operators trained, but not flexible	Medium – needs new skillsets for green H_2/ammonia
Job Creation Potential	**High** – mechanics, drivers, service infra, fabrication units	High – FCEV-specific manufacturing, supply chains	Low – central plants, low job intensity	Low – highly automated processes
Time to Market (2025 readiness)	**Short (12–18 months)** – pilot ready	Medium (3–5 years) – needs ramp-up	Long (5+ years)	Long (5+ years)

10. The Colour Neutral Approach

As India advances its hydrogen ambitions, a rigid focus on green hydrogen alone could inadvertently impact early momentum. Given the scale and urgency of decarbonizing mobility, India must adopt a more pragmatic, color-neutral approach that leverages existing assets while paving the way for future technologies. A flexible strategy—one that incorporates grey, blue, and green hydrogen based on availability, infrastructure readiness, and regional economics—can accelerate deployment, reduce upfront costs, and build critical demand ecosystems. This section outlines how each hydrogen pathway can contribute uniquely to India's mobility transition, beginning with the asymmetric advantage offered by grey hydrogen.

A Pragmatic, Color-Neutral Approach to Hydrogen Mobility in India

Grey Hydrogen: India's Asymmetric Advantage

- Leverage CNG ecosystems for large-scale hydrogen mobility pilots
- Enable distributed piloting at low infrastructure cost

Blue Hydrogen: India's Strategic Leverage

- Repurpose gas infrastructure with carbon capture systems
- Reduce redundancy and give flexibility

Green Hydrogen: The Final Frontier

- Unlock curtailment for mobility applications
- Enable Scope 3 reductions for OEMs

10.1 Grey Hydrogen Makes Sense in Early-Stage Mobility: India's Asymmetric Advantage

Despite its carbon intensity, grey hydrogen—produced via steam methane reforming (SMR)—offers a unique transitional advantage for India's hydrogen mobility ambitions. Rather than waiting for green hydrogen costs to fall or for nationwide infrastructure to be built, India can pragmatically leverage its existing industrial hydrogen and compressed natural gas (CNG) ecosystems to pilot hydrogen mobility at scale.

10.1.1 India's Unique CNG Ecosystem as a Springboard

India has the second-largest CNG vehicle fleet globally, with over **6 million vehicles** and **5,000+ stations**[13]. This widespread infrastructure provides an immediate platform for deploying hydrogen mobility through **H_2-ICE retrofits**. These vehicles can be converted with minimal cost and effort, bypassing the current limitations of fuel cell vehicle (FCEV) imports and charging infrastructure.

Source:

13 PNGRB 2024 Report

10.1.2 Grey Hydrogen Enables Distributed Piloting at Low Infrastructure Cost

India already produces over **~6 million tonnes of grey hydrogen per year**[14], out of which 70%-75% is consumed in refineries and fertilizer plants. Diverting just **0.5% of this for mobility pilots** can enable **deployment in over 1,000 hydrogen buses across 10 cities**. Instead of waiting for large pipeline networks or CH_2 infrastructure, India can initiate **localized hubs** near hydrogen production centers for early-stage rollout.

10.2 Blue Hydrogen is a Balanced Path: India's Strategic Leverage

India's expanding natural gas network, new LNG terminals, and geology suitable for carbon storage provide the ingredients for a **blue hydrogen pathway**. Unlike green hydrogen, blue hydrogen builds on **legacy infrastructure**, leveraging gas assets for a cleaner future.

10.2.1 Repurposing Gas Infrastructure

Co-located **carbon capture systems** particularly around **refineries and petrochemical hubs** can be retrofitted to produce **blue hydrogen** those can reduce emissions by over **90%**, giving new life to underutilized assets, if used for enhanced oil recovery.

10.2.2 Blue reduces redundancy and gives flexibility

Blue hydrogen reduces asset redundancy and enhances flexibility by extending the operational life of existing Steam Methane Reformers (SMRs) in Indian refineries, which have seen significant capital investment. It also indices flexibility in operation with integration of biogas-based hydrogen production within the same SMR infrastructure.

10.3 Green Hydrogen: The Final Frontier, Tailored for Indian Realities

While green hydrogen remains the long-term goal, India's approach must continue to align with its renewable energy profile, industrial makeup, and job creation needs.

10.3.1 Unlocking Curtailment for Mobility

India is on track to install **25–30 GW of solar annually**. By 2030, **50+ TWh of solar may be curtailed** due to grid limitations. Converting just **10% of this curtailed power** into hydrogen yields:

- **~0.1 million tonnes of H_2/year**
- Enough to operate ~**10,000 hydrogen buses**, transforming intercity and high-mileage freight sectors

10.3.2 Enabling Scope 3 Reductions for OEMs

As Indian auto manufacturers export to emission-regulated markets, hydrogen adoption in domestic logistics can offer **certified Scope 3 reductions**. This supports EU CBAM or similar compliances likely to be implemented in the future. Similarly, the mandates for adoption of SAF in aviation and methanol in shipping can be competitively met by the Indian OEMs through adoption of hydrogen technologies.

Source:

14 NITI Aayog Green Hydrogen Report 2022

11. Hydrogen Vehicles and Refuelling Infrastructure: A Nuanced Comparison with an Indian Lens

As we weigh the options towards low-emission mobility, it is critical to evaluate the relative strengths and limitations of emerging propulsion technologies. The following table provides a high-level qualitative comparison between BEVs and FCEVs across key performance and infrastructure parameters. The assessment uses color-coded indicators to visually represent the favourability of each technology on specific criteria.

Table 4 Comparison of Vehicle Technologies on various Parameters

Parameter	Battery EV (BEV)	Hydrogen Vehicle	Diesel	CNG
Source of electricity – impact on environment	🔴 (coal-heavy grid)	🟢 (RE-based potential)	🔴 (fossil fuel)	🔴 (fossil fuel)
Tank-to-wheel efficiency	🟢	🟡	🔴	🟡
Charging / Refuelling Infrastructure cost	🟡 (grid-heavy, urban constraints)	🔵 (evolving, distributed)	🟢 (existing)	🟢 (existing, scalable)
Emission at source	🔴 (if grid is coal-based)	🟢 🟡 (green H_2) (blue H_2)	🔴 (high CO_2, PM)	🟡 (lower CO_2, but CH_4 risk)
Heavy-duty suitability	🔴 (range/payload issues)	🟢	🟢 (current standard)	🟡 (limited for heavy duty)
Critical Mineral requirement	🔴 (Li, Co, Ni)	🟢 (less critical mineral need)	🟢 (minimal)	🟢 (minimal)
Payload penalty	🔴 (battery weight)	🟡 (tank size trade-offs)	🟢 (no penalty)	🟢 (light mods)
Refuelling / Recharge time	🔴 (long charging)	🟢 (Same as CNG)	🟢	🟢
Energy storage resilience	🔴 (thermal issues, degradation)	🟢 (thermally stable)	🟢	🟢

🟢 **Green** – Very favourable

🟡 **Yellow** – Moderate/average

🔴 **Red** – Unfavourable

🔵 **Blue** – Context-dependent or improving with innovation

India’s transition to clean mobility is constrained by foundational challenges in its power grid, climate, and urban infrastructure. Despite advances in renewable energy, the grid remains coal-heavy and congested, particularly in urban centres, limiting its ability to support widespread fast-charging infrastructure for electric vehicles. Battery electric vehicles (BEVs), while effective in certain contexts, suffer efficiency losses in India’s extreme heat and depend heavily on imported lithium and cobalt—posing strategic risks. In contrast, hydrogen offers a decentralized, thermally stable alternative. Produced off-grid through renewable energy and electrolysers, it can bypass grid limitations and deliver clean mobility solutions, especially in Tier-2/3 cities, industrial zones, and high-temperature regions. The diesel and CNG vehicles especially in the heavy duty segment need effective alternative solutions those shall be beyond batteries due to the inherent reasons highlighted in the above table.

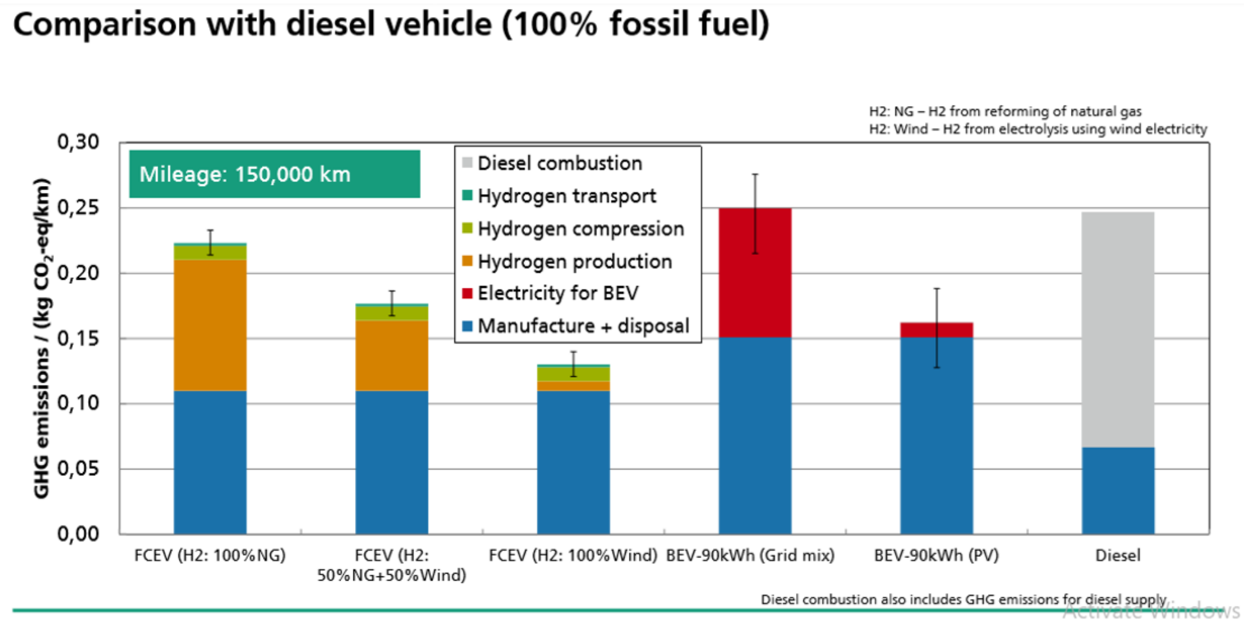
Hydrogen’s additional advantages include land efficiency, energy resilience in rural areas, and alignment with national self-reliance goals. It enables urban deployment with minimal land and power requirements, and its compatibility with India’s agricultural and biogenic ecosystem supports rural hydrogen production from local feedstocks. While BEVs serve short-range and light-duty applications, hydrogen is better suited to heavy-duty, long-haul, and high-utilization sectors—unlocking segments where BEVs face natural limitations.

11.1 A Comparative Analysis of technologies appropriate for Heavy duty applications

Due to varied emissions and carbon intensities associated with different mobility pathways, it is essential to analyse the different modes and powertrains in the context of different hydrogen colours. Considering that the passenger car segment of the mobility sector is already disrupted by the battery vehicles, this analysis focuses on finding alternatives for the heavy-duty vehicles.

Although, heavy-duty vehicles (HDVs) — such as intercity trucks and buses—constitute less than 5% of the total vehicle population in India but contribute disproportionately to vehicular pollution and significant amount of CO2 emissions. They are also responsible for over 60% of particulate matter (PM) and nearly 50% of nitrogen oxides (NO_x) emitted by on-road transport, largely due to their high fuel consumption, long operating hours, and reliance on diesel[13].

In a Fraunhofer study reported the comparison of green house gas emissions of diesel vehicles with battery electric vehicles and fuel cell electric vehicles, which is reproduce below:



We ourselves also compared the different powertrain technologies in terms of their overall emissions and energy consumption. These parameters are the critical decision making metrices to enable the strategic deployment of these technologies for multiple mobility applications within the heavy-duty segment.

CO2 Emissions:

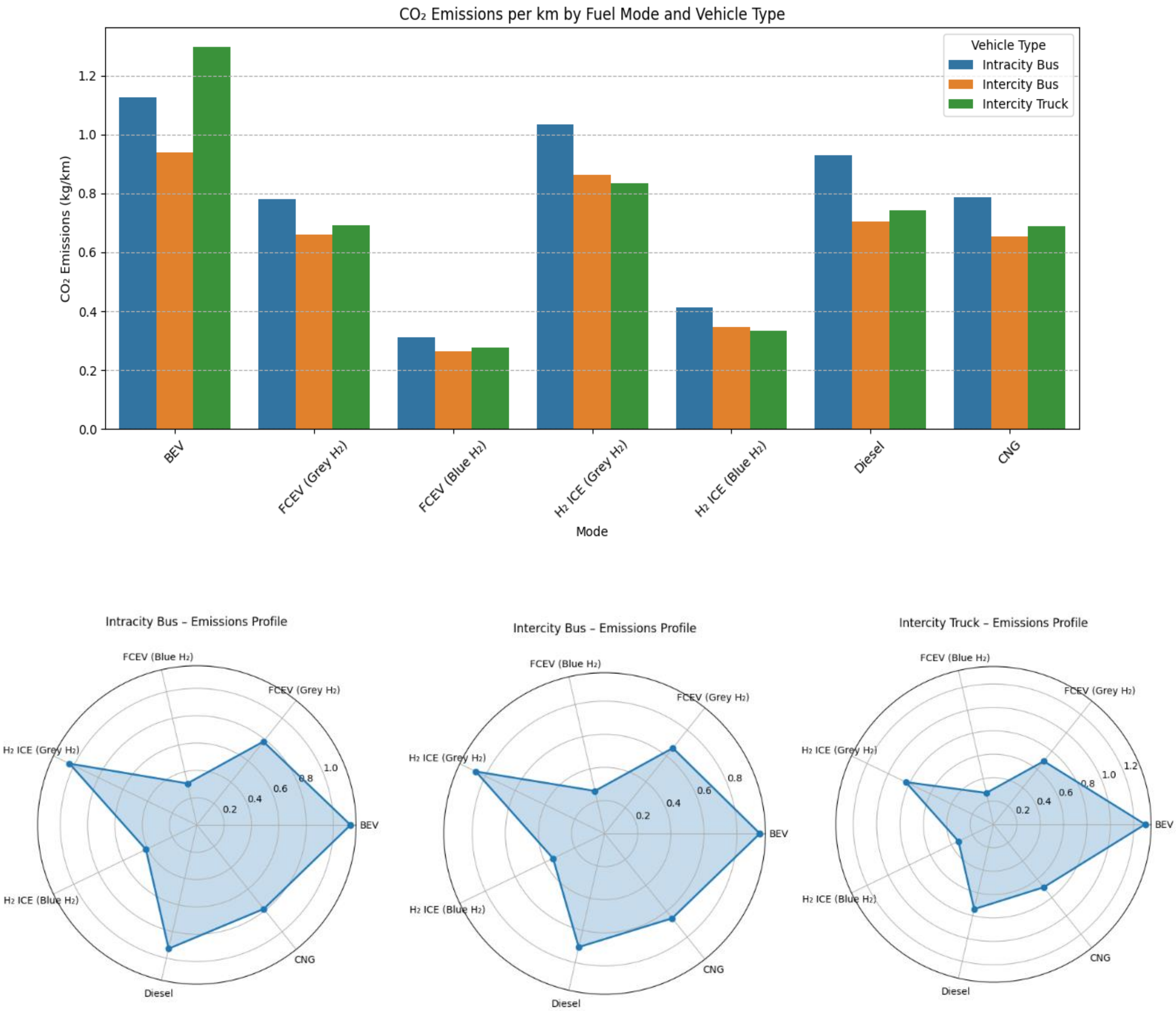
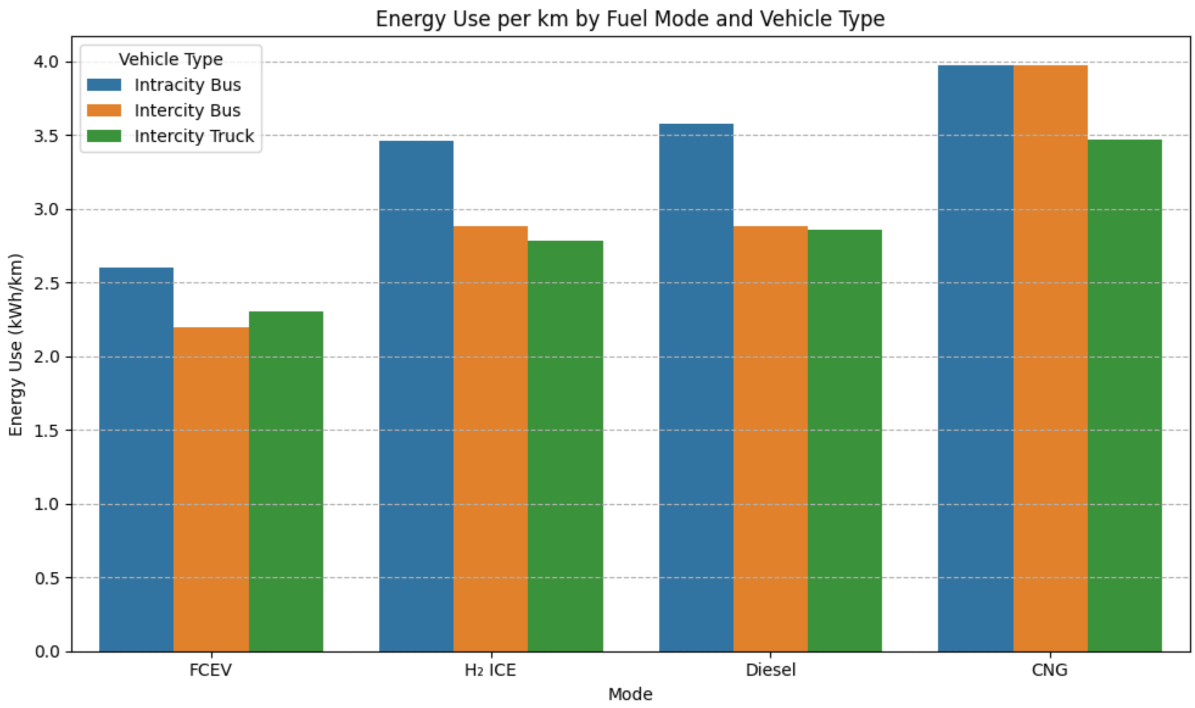


Figure 4 CO2 emissions for different Vehicle types operating on various fuels

Source: Authors analysis with assumptions

Although green hydrogen could be the ultimate zero or near zero emission solution, Figure 4 highlights that fuel cell electric vehicles (FCEVs) powered by blue hydrogen consistently offer the lowest emissions in all segments—whether intracity buses, intercity buses, or long-haul trucks. In contrast, vehicles powered by diesel and battery electric vehicles (BEVs) based on India's current coal-heavy grid show relatively higher emissions. This is particularly evident in intercity trucks, where diesel emissions remain high due to large fuel consumption and where BEVs inherit high upstream grid emissions. Hydrogen internal combustion engines (H_2 ICEs), though less efficient than FCEVs, still outperform diesel when powered by blue hydrogen, offering a moderate emissions profile. Compressed Natural Gas (CNG) performs better than diesel, particularly in buses, but still emits more than hydrogen-based alternatives, indicating that the growth of CNG / LNG may not align with deep decarbonization targets.

Energy Use:



Source: Based on authors analysis with assumptions

Figure 5 Energy consumption for different Vehicle types operating on various fuels

Across all categories, FCEVs show lower energy use compared to other combustion-based alternatives, reflecting the inherent efficiency of the electrochemical fuel cell process. H_2 ICEs, exhibit energy consumption levels lower than CNG and diesel vehicles. While the fuel cell technology matures, H2ICE could be an effective interim solution for overcoming the diesel and CNG demerits particularly related to the particulate matter emissions. Also, if promoted, on grey and later blue hydrogen, the technology can act as the fastest bridge to enable hydrogen ecosystem development. Both intercity bus and truck segments promoted on H2ICEs can perform the role for the extra urban geographies like what battery electric vehicles are playing for the city environment by offsetting the emissions to the production centre away from the point of use.

Operational Cost:

Moving beyond the CO2 emissions and energy consumption discussed in the above let us, this analysis focus on a critical dimension of the transition: the operating fuel cost per kilometre. Specifically, the attempt is to estimate the break-even hydrogen price at which H_2 ICEs and FCEVs can match the fuel cost of conventional diesel or CNG/LNG-powered vehicles across three key segments—intracity buses, intercity buses, and intercity trucks. It is based on current fuel prices and the industry qualified fuel economy numbers that reflect actual duty cycles in India.

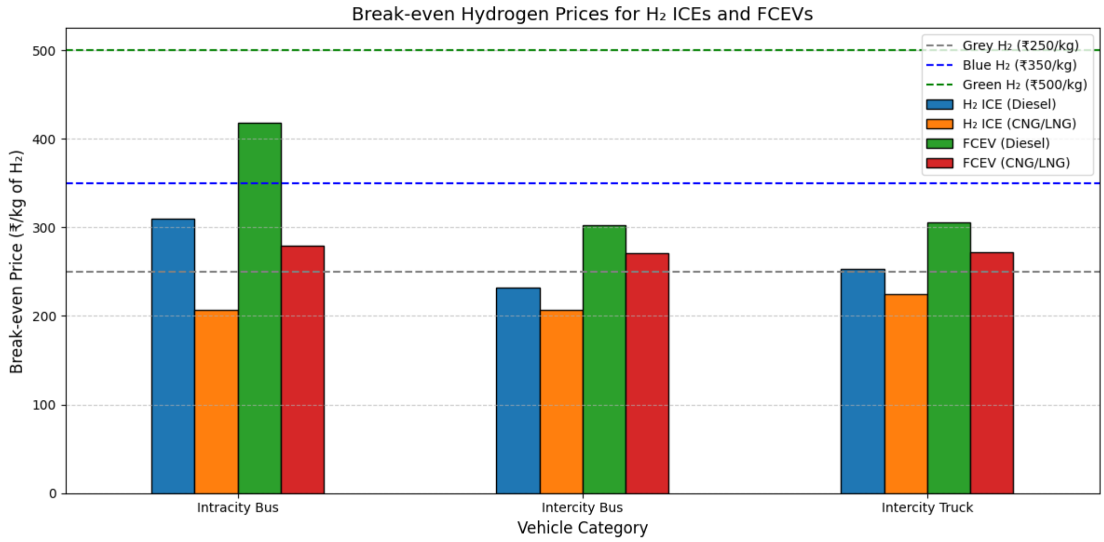


Figure 5

Benchmarking the Operational cost for different Vehicle types operating on various fuels

***FCEV (Diesel)**: FCEV that to replace diesel vehicle* **/ FCEV (CNG/LNG):** Fuel Cell Electric Vehicle replacing a vehicle running on CNG or LNG. / **H_2 ICE (Diesel):** Hydrogen-powered Internal Combustion Engine as a replacement for diesel vehicle / **H_2 ICE (CNG/LNG):** Hydrogen-powered engine replacing a vehicle running on CNG or LNG / **BEV:** Battery Electric Vehicle—runs purely on batteries charged via grid electricity.

Salient Points of discussion

1. H_2 ICEs are nearing viability with grey hydrogen in most cases

- The break-even bars for H_2 ICE (CNG/LNG) in all three vehicle categories are just below or around ₹250/kg, the benchmark for grey hydrogen.
- This implies that H_2 ICE trucks and buses can already operate economically using grey hydrogen—especially for long-haul applications like intercity buses and trucks.

2. FCEVs require hydrogen costs to fall below ₹300/kg for competitiveness

- The FCEV (Diesel) break-even bars range from ₹303 to ₹418/kg, while the FCEV (CNG/LNG) bars lie just below ₹280/kg.
- This indicates that FCEVs are not yet viable at current green hydrogen prices (₹500/kg) but could be approaching feasibility with blue hydrogen (~₹350/kg)—especially in intercity truck and bus applications.

3. Intracity buses are the least cost-competitive segment for hydrogen

- Both H_2 ICE and FCEV break-even values for intracity buses are consistently higher than in intercity applications.
- This reflects lower fuel economy and heavier auxiliary loads (e.g., air conditioning, stop-go traffic), making urban buses less attractive for early hydrogen deployment purely on cost basis.

4. Intercity trucks and buses are the best early adopters

- These segments demonstrate lower break-even hydrogen prices due to better fuel economy, consistent operating hours, and higher daily utilization, especially for fleet vehicles.
- They are ideal for aggregating hydrogen demand around hubs and corridors, enabling grey-to-blue-to-green transition strategies.

5. Cost parity with diesel is achievable sooner than with CNG

- For FCEVs and H_2 ICEs, break-even with diesel (₹310–418/kg) is easier than with CNG/LNG (₹207–279/kg) due to CNG's lower cost per km.
- Thus, hydrogen adoption shall aim to replace diesel first, particularly in heavy-duty fleets, before displacing CNG.

However, it is important to note that this analysis does not account for the capital cost of vehicles, which remains significantly higher for FCEVs and, to a lesser extent, H_2 ICEs. While hydrogen may become cost-competitive on a fuel-per-kilometre basis, the overall total cost of ownership (TCO) still depends on the vehicle purchase price and infrastructure access.

Innovative models based on capital subsidies, green financing, carbon credits, or vehicle-leasing services can bridge the cost gap.

Key takeaways from findings in Section 11.1:

1. Intracity Buses

- Fuel Cell Electric Vehicles (FCEVs) powered by Blue Hydrogen emerge as the most suitable long-term solution, offering clean tailpipe emissions and better adaptability to urban traffic cycles than BEVs (especially in a coal-heavy grid).
- Green hydrogen should be the ultimate target, for energy security and meeting the net zero objectives.
- Grey hydrogen must be avoided for urban transport, where visible emissions and carbon accountability matter more.

2. Intercity Buses

- Grey hydrogen operating the fuel cell vehicles is acceptable in early-stage deployments—especially for fleet aggregation and market seeding—but only with a roadmap to transition to blue and green hydrogen.
- H_2 ICEs (using blue hydrogen) can serve as a practical mid-term deployment option, enabling rapid rollout due to engine compatibility.
- Blue hydrogen FCEVs further improves emissions performance while providing extended range for long-haul applications.
- Ultimately, green hydrogen must replace blue to meet India’s net-zero targets for public intercity mobility by the early 2040s.

3. Intercity Trucks

- This segment shows the highest readiness for grey hydrogen as a starting point, especially where refineries or captive hydrogen sources are nearby.
- H_2 ICE trucks can be deployed immediately on grey hydrogen, with infrastructure sharing from LNG/diesel corridors.
- In the medium term, FCEVs (using blue hydrogen) are recommended for better energy efficiency and range scaling.
- As the hydrogen ecosystem matures, green hydrogen must become the final fuel pathway, particularly for export-linked logistics and zero-emission freight corridors.

11.2 Hydrogen Refuelling Infrastructure

A successful hydrogen mobility ecosystem hinges not only on the vehicles themselves but equally on the availability, accessibility, and affordability of hydrogen refuelling infrastructure.

Despite its immense potential, hydrogen refuelling infrastructure presents a distinct set of challenges in the Indian context—ranging from technical complexities and capital intensity to operational viability and regulatory readiness. One of the most critical aspects that needs careful attention is understanding the duty cycles and utilization patterns of different hydrogen-fuelled vehicle categories.

For instance, intracity buses operate on fixed, predictable routes with centralized depot refuelling opportunities, while intercity trucks and buses require high-throughput stations at strategic highway nodes to meet tight turnaround times. Designing hydrogen stations without aligning with these real-world duty cycles leads to underutilized assets or congested operations—undermining investor confidence and public trust.

Lack of standardized refuelling protocols limited trained workforce and land & permitting challenges must also be considered for thoughtful planning and execution.

12. Conclusion: Without Mobility, Hydrogen Will Falter

Mobility is not an adjunct to hydrogen — it is the **single most powerful accelerator** of the hydrogen economy. It is the **only sector** that simultaneously enables:

- **Demand aggregation** (fleet-based deployment can predict volumes)
- **Distributed infrastructure rollout** (localized H_2 stations tied to vehicle hubs)
- **Cost deflation via learning curves** (scaling electrolyzers, compressors, tanks)
- **Public awareness** and visible government commitment (hydrogen buses/trucks)

12.1 Why Mobility is a Make-or-Break for Hydrogen in India

- **Fertilizers and refineries** use hydrogen, but their demand is capped, and transitions are slow
- **Steel and cement** need hydrogen at high temperatures, but technology maturity is decades away
- Only **mobility offers the combination of scale + pace + public visibility**

12.2 Hydrogen Mobility Enables Circular Energy Models

In India, hydrogen used in mobility can link:

- **Biomass/biogas → CO_2 → e-fuels**
- **Decentralized RE → electrolyzer → Multiple fleets**
- **Waste-to-H_2 projects → Industrial and Automotive**

No other sector enables this level of **sector coupling**, making mobility **the keystone use-case**.

12.3 India Can Leapfrog the "Chicken-Egg" Problem

- Build a parallel demand for hydrogen use in mobility based on color agnostic approach to pull hydrogen infrastructure
- Once H_2 infra starts scaling up, it can accelerate the deployment in other sectors like **refineries, steel, fertilizer & power** due to robust supply chain
- Thus, mobility doesn't just benefit from hydrogen — it **births the ecosystem**

13. What Next?

13.1 India's Early-Stage Hydrogen Program Should Embrace Practical Imperfection

While India rightly pursues green hydrogen as the end goal, a pragmatic, phased approach is essential to accelerate the hydrogen transition across the transport sector. Recognizing that infrastructure, cost, and technology maturity vary significantly across regions and vehicle categories, India must adopt a **"multi-colour hydrogen strategy"** that leverages **grey, blue, and green hydrogen** in a **targeted and sequential manner**.

- **Grey hydrogen** can serve as an important launchpad—particularly for retrofitted hydrogen ICE trucks and other pilot deployments where industrial grey hydrogen is already available. This helps aggregate early demand, reduce upfront costs, and build technical familiarity.

- **Blue hydrogen** should be the mainstay of medium-term adoption, especially for both H_2 ICE and FCEV platforms, as it delivers deep emission reductions and is more readily scalable with CCS-ready infrastructure.

- **Green hydrogen** must be strategically reserved and deployed in high-impact zones—such as urban corridors, export-oriented hydrogen hubs, and ESG-sensitive applications like public transit—while ramping up electrolyzer capacity and renewable energy integration.

Table 5 Energy Transition Roadmap for Key Vehicle Categories

Vehicle Category	Best Technology (Long-Term)	Practical Transition Fuel	Hydrogen Colour Pathway	Policy Focus
Intracity Buses	FCEV (Green H_2)	FCEV (Blue H_2)	Blue → Green	Mandate ESG-driven targets for municipal fleets; prioritize green H_2 procurement
Intercity Buses	FCEV (Green H_2)	H_2 ICE (Blue → Green H_2)	Grey → Blue → Green	Support retrofits, hydrogen blending, and green H_2 cost-reduction measures
Intercity Trucks	FCEV (Green H_2)	H_2 ICE (Grey → Blue H_2)	Grey → Blue → Green	Use grey to kickstart demand; incentivize long-term shift to green supply

India's mobility landscape is vast and heterogeneous—with variable fleet maturity, fuel access, and investment capacity across regions and use cases. A flexible and inclusive hydrogen transition, starting with what is feasible (grey), scaling with what is cleaner and available (blue), and ultimately converging to what is truly sustainable (green), is both economically sensible and climate aligned.

This colour-calibrated approach balances India's infrastructure realities with its climate commitments—accelerating action in the short term without compromising long-term ambition.

Recommendations to catalyse Hydrogen Mobility in India

India stands at a defining moment to shape the future of low-carbon mobility. While pilots under the National Green Hydrogen Mission (NGHM) have laid early groundwork, the real opportunity lies in scaling from proof-of-concept to nationwide adoption—especially in hard-to-electrify segments like freight, buses, and non-road transport. The following recommendations aim to convert ambition into execution with institutional precision and economic pragmatism.

1. Launch a Dedicated "National Hydrogen Mobility Mission" (NHMM)

This mission should act as the third strategic leg complementing the NGHM and FAME scheme, explicitly focused on:

- Scaling pilot learnings to full commercial fleets in logistics, urban buses, ports, mining, and rail yards.
- Integrating green hydrogen-powered FCEVs into Phase-III of FAME, with tailored subsidy slabs based on TCO thresholds rather than technology type.
- Anchoring mobility demand to stimulate domestic electrolyzer utilization, build refuelling infra, and create predictable offtake.

2. Refuelling Infrastructure: Build Fast, Build Smart, Build Indian

To unlock deployment, infrastructure must lead vehicle adoption. We recommend a five-pronged refuelling strategy:

2.1. Embed Hydrogen into Gati Shakti Master Plan

- Overlay hydrogen station planning onto logistics zones, dry ports, intercity freight corridors, and expressways already identified under Gati Shakti.

2.2. Conditional Viability Gap Funding (VGF) + PPP

- Structure early station rollouts as PPP-lite with VGF covering 40–50% of capex, tied to minimum service performance, safety compliance, and demand-linked clawbacks.

2.3. Cluster-Based Rollout via Hydrogen Valleys

- Design dedicated programs for hydrogen vehicles around valley-based clusters for integrated infra and demand concentration.

2.4. Ownership Innovation – Franchise + Anchor Models

- Franchise-O&M hybrid: Allow MSMEs to run stations under PSU/OEM tech umbrella.
- Anchor Demand Model: Co-locate hydrogen infrastructure (like refuelling stations, storage, and dispensers) at or near locations with large, predictable hydrogen demand like NHAI toll fleets, Indian Railways yards, or PSU logistics arms to reduce investor risk.

2.5. Indigenization with Strategic Licensing

- Establish licensing frameworks for localized manufacturing of dispensers, compressors, tanks, and integrate them under PLI or Make in India.

3. Mandated National Hydrogen Corridors

- Declare hydrogen-ready segments of the Golden Quadrilateral and Dedicated Freight Corridors with 100–150 km spacing of H_2 refuelling hubs.
- EV and hydrogen infrastructure should be co-planned to enable shared grid, land, and service investments.

4. Adopt a Pragmatic, Colour-Agnostic Hydrogen Rollout

- Embrace grey and blue hydrogen in early-stage deployments to seed mobility infrastructure and build demand-side learning curves.
- Use grey H_2 for retrofit pilots; blue H_2 for medium-term logistics; reserve green for policy-sensitive zones (e.g., Delhi-NCR, ports, export-oriented hubs).

5. Green Hydrogen Freight Incentive Scheme (GH-FIS)

- Launch a performance-linked freight decarbonization scheme under MoRTH or DPIIT to incentivize logistics players, e-commerce majors, and fleet operators who adopt hydrogen-powered trucks and cargo handlers.
- Provide per-kilometre incentives (e.g., ₹5–₹10/km) for verified hydrogen truck movement over national highways or in industrial corridors.
- Link the scheme with carbon credit issuance, allowing operators to earn additional revenue via tradable credits.

6. Strategic E-Fuels Roadmap

- Conceive and aggressively pursue the national programs on e-methanol, e-diesel, and SAF in pilot zones by 2027.
- Enable tax and carbon-credit portability for logistics operators using green e-fuels.
- Incentivize ports and refineries to act as bunkering hubs under Maritime India Vision.

7. Retrofitting as a National Programme

- Launch a carefully curated H_2-ICE retrofit pilot program targeting in-use intercity diesel freight fleet.
- Provide time-bound GST reduction and accelerated depreciation for retrofitted vehicles.

8. Skill, Certify, Deploy: National Hydrogen Workforce Platform

- Create a Hydrogen Mobility Skill Council (HMSC).
- Certify hydrogen mechanics, station operators, and first responders.
- Link skilling to localized job creation in Hydrogen Valleys and Gati Shakti zones.

9. Codify Safety & Certification to Unlock Private Participation

- Create a unified H_2 refuelling code—harmonized with PESO, OISD and BIS—and fast-track safety certifications via a single-window system.
- Include safety standards for mobile hydrogen refuelling units, which are vital for flexibility in the early years.

Moving Towards Hydrogen Mobility in India

Hon'ble | MINISTER FOR NEW AND RENEWABLE ENERGY, **Shri Pralhad Joshi**

Shri Santosh Kumar Sarangi MNRE Secretary

"At World Hydrogen Summit in May 2025, the Secretary mentioned that India has made remarkable strides in green hydrogen development. The country has allocated 862,000 TPA production capacity annually to 19 companies, and awarded 3,000 MW annual electrolyzer manufacturing capacity to 15 firms, and we have launched pilot projects in steel, mobility, and shipping sectors."

Shri Abhay Bakre, National Green Hydrogen Mission Director, MNRE

Pilot Projects on Hydrogen Fuelled Buses and Trucks Launched under the National Green Hydrogen Mission

Ministry of New and Renewable Energy has sanctioned five pilot projects consisting total of 37 vehicles (buses and trucks), and 9 hydrogen refueling stations. The vehicles that will be deployed for the trial include 15 hydrogen fuel cell-based vehicles and 22 hydrogen internal combustion engine-based vehicles. These vehicles will run on 10 different routes across the country viz., Greater Noida – Delhi – Agra, Bhubaneshwar – Konark – Puri, Ahmedabad – Vadodara – Surat, Sahibabad – Faridabad – Delhi, Pune – Mumbai, Jamshedpur – Kalinga Nagar, Thiruvananthapuram – Kochi, Kochi – Edappally, Jamnagar – Ahmedabad, and NH-16 Visakhapatnam – Bayyavaram. The above projects are awarded to major companies like TATA Motors Ltd, Reliance Industries Limited, NTPC, ANERT, Ashok Leyland, HPCL, BPCL, and IOCL.

The total financial support for selected projects made available will be around Rs. 208 Crore from the Government of India. These pilot projects are likely to be commissioned in the next 18-24 months, paving the way to the scaleup of such technologies in India.

Dr. Anil Kakodkar, a former chairman of the Atomic Energy Commission, has spoken extensively on the role of hydrogen in India's energy future, particularly in the context of achieving a low-carbon economy and diversifying energy sources. He has emphasized the importance of hydrogen production from renewable and nuclear energy sources, as well as the potential for using surplus biomass to generate hydrogen or hydrogen substitutes for industry and transportation.

Moving Towards Hydrogen Mobility in India

Hon'ble Union Minister for Road Transport and Highways, Shri Nitin Gadkari inaugurated the world's most advanced technology-developed Green Hydrogen Fuel Cell Electric Vehicle (FCEV) Toyota Mirai at New Delhi. Toyota Mirai is India's first Fuel Cell Electric Vehicle (FCEV), which is completely powered by Hydrogen

Shri Nitin Gadkari visits Parliament in hydrogen-powered car, emphasizes on need to spread awareness about green Hydrogen for sustainable development

Union Minister for Road Transport and Highways Shri Nitin Gadkari visited Parliament House by Hydrogen based Fuel Cell Electric Vehicle (FCEV) today. Demonstrating the car powered by 'Green Hydrogen', Shri Gadkari emphasised the need to spread awareness about Hydrogen, FCEV technology and its benefits to support hydrogen-based society for India.

Source: PIB

The benefit with EV (Electric Vehicle) is that people have been working on it, both globally and in India for a long period. But, I think, for hydrogen the pace of catching up may be faster than we expect," says Vikram Gulati, Country Head and Executive VP (Corporate Affairs & Governance), Toyota Kirloskar Motor. Mirai, which has sold around 20,000 units in the past 9 years, is one of the first mass produced hydrogen fuel cell vehicles globally.

Moving Towards Hydrogen Mobility in India

Hon'ble Minister, Petroleum and Natural Gas Shri Hardeep Puri Launches
Hydrogen Fuel Cell Powered Bus, Says Domestic Demand to Increase By 4 Times.

Hydrogen Fuel Cell Bus launched in New Delhi

New Delhi, India (25 September 2023): In a momentous step towards a greener and more sustainable future, Union Minister Hardeep S Puri recently flagged off India's first Green Hydrogen Fuel Cell Bus from Kartavya Path in New Delhi. This significant development underscores India's commitment to clean and green energy solutions, positioning the nation as a potential global hub for hydrogen production and export.

Speaking at the event, Union Minister Shri Hardeep Singh Puri emphasized the revolutionary nature of India's venture into clean and green energy. He echoed Prime Minister Modi's vision, stating that green hydrogen would not only drive green growth and create green jobs but also serve as a global exemplar for the transition to clean energy.

Puri highlighted Prime Minister Modi's announcement from the historic Red Fort in Delhi, where he unveiled plans for self-reliance in energy production. This vision involves a multifaceted approach, including electric mobility, a gas-based economy, and a focused mission on Green Hydrogen. Puri underscored the importance of this mission while addressing the gathering at the flag-off ceremony.

Source: Urban Transport News

India Invests USD 25 Million in Hydrogen Hubs to Boost Green Shipping

India is investing USD 25 million in developing hydrogen hubs at key ports as part of its green shipping initiative, said Union Minister for New and Renewable Energy Pralhad Joshi during his keynote address at the Hamburg Sustainability Conference in Germany.

Source: Fuel Cells Works, Oct. 2024

Government issues Guidelines for Pilot Projects for utilizing Green Hydrogen in Shipping Sector

The Government of India has come out with guidelines for undertaking pilot projects for using green hydrogen in the shipping sector. The guidelines, named "Scheme Guidelines for implementation of Pilot projects for use of Green Hydrogen in the Shipping Sector", have been issued by the Ministry of New & Renewable Energy (MNRE) on 1st February, 2024, under the National Green Hydrogen Mission.

Source: PIB

Hydrogen: The Key to Decarbonizing the Global Shipping Industry?

Photo: VINCENZO PINTO/AFP/Getty Images

Maritime shipping accounts for approximately one-quarter of all emissions from the global transportation sector. Emitting nearly one billion tons of CO2 per year, the shipping industry faces intense pressure to decarbonize in the coming decades. The International Maritime Organization (IMO), the United Nations' regulatory body for shipping, called for a 50 percent reduction in greenhouse gas (GHG) emissions by 2050, compared to 2008 levels, in order to align the industry with the objectives of the Paris Climate Agreement.

Source: Center for Strategic & International Studies

Military hydrogen-cell drones poised for big take-off

As drones continue to reshape the nature of warfare, the limitations on range and power are becoming the difference between success and defeat on the battlefield. Now, an Israel-based drone company and U.S. manufacturing company Mach Industries are working together to co-produce hydrogen fuel cell powered drones, which offer big advantages in range but have previously faced challenges that have kept them from the battlefield.

Source: Patrick Tucker, Science & Technology Editor, Defense One

Moving Towards Hydrogen Mobility in India

India's Railway Minister Hon'ble Shri Ashwini Vaishnaw announced the development of the world's most powerful hydrogen fuel-run train engine with 1,200 horsepower.

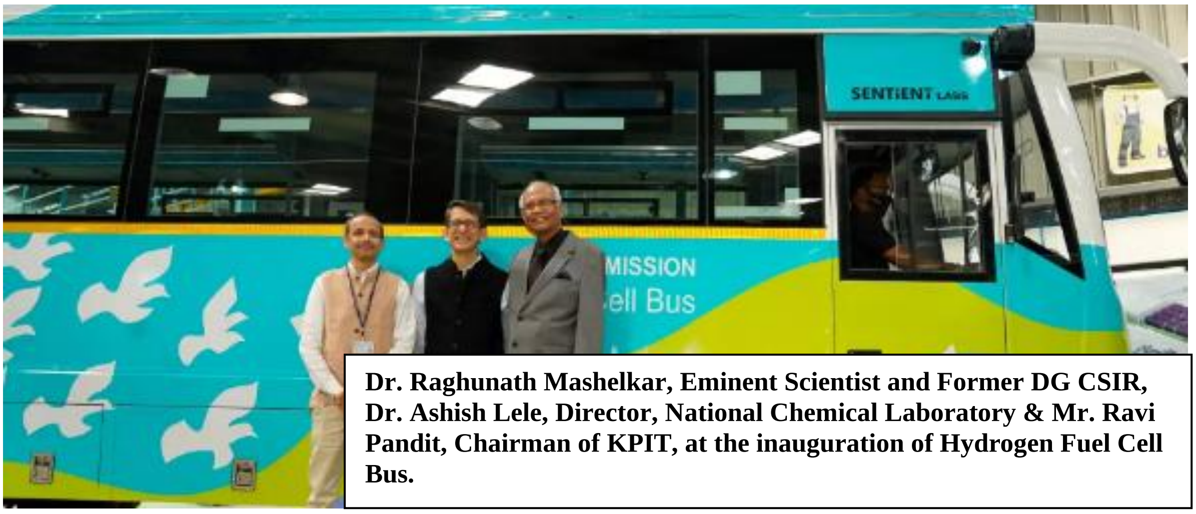
The train is set for trials in Haryana, marking India's leadership in green energy rail solutions.

Source: Fuel Cells Works, Jan. 2025

Indian Railways to begin trials of India's first hydrogen train

An official was quoted as saying, "Indian Railways (IR) will have 35 trains under the Hydrogen for Heritage initiative at an estimated cost of Rs. 80 crore per train, with an additional Rs. 70 crore investment in ground infrastructure per route on various heritage or hilly routes."

Source: Business Standards



Dr. Raghunath Mashelkar, Eminent Scientist and Former DG CSIR, Dr. Ashish Lele, Director, National Chemical Laboratory & Mr. Ravi Pandit, Chairman of KPIT, at the inauguration of Hydrogen Fuel Cell Bus.

"Hydrogen not only offers zero tailpipe emissions but also positions us at the forefront of next-generation fuel and transportation technology. We are working for converting the CNG vehicle to hydrogen which will not just be an environmental upgrade but it is a strategic step to start using hydrogen for mobility. We feel that such conversions can accelerate the early transition to hydrogen mobility with larger fleet on road, necessary for rapid creation of supply and distribution infrastructure."

Mr. Gagan Agrawal, Joint MD, Shigan Group

Moving Towards Hydrogen Mobility in India

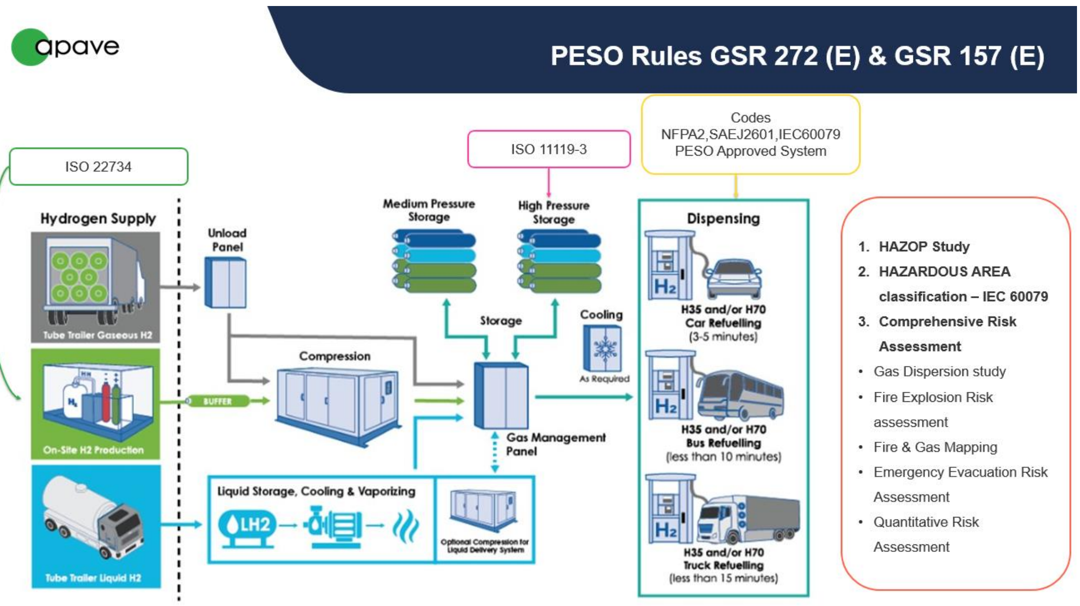
"RIL in collaboration with Ashok Leyland has come up with Internal Combustion Engine (H2-ICE)."

Dr. N Saravanan, President, and Chief Technology Officer, Ashok Leyland said, "Working with RIL, we have once again demonstrated our technological leadership and our commitment to the Clean Mobility Mission.

Safety in Handling of Hydrogen

"Safe Handling of Hydrogen is Important During Production, Storage, Supply & Distribution"

-Nilay Ball, Apave



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