GREENZO ENERGY INDIA LIMITED
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Blending Low-Carbon Hydrogen into India's Natural Gas Infrastructure

Prepared by

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Message from MD

At Greenzo Energy, we believe that the path to a sustainable future lies in innovative and practical solutions that accelerate decarbonization. India's growing energy demand presents both a challenge and an opportunity—to reduce reliance on fossil fuels while ensuring reliable, affordable energy for all.

Hydrogen blending into the natural gas grid represents a vital step in this direction. By leveraging existing city gas infrastructure, we can begin the transition toward low-carbon energy without waiting for entirely new systems to be built. Even modest hydrogen blends can significantly cut emissions, enhance energy security, and create momentum for scaling green hydrogen across industries.

This report reflects our commitment to driving India's clean energy transformation and supporting the nation's goal of becoming a global leader in green hydrogen. At Greenzo, we remain dedicated to pioneering technologies and partnerships that will make net-zero cities a reality.

Sandeep Agarwal
Founder & Managing Director

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Blending Low-Carbon Hydrogen into India’s Natural Gas Infrastructure

“Green Hydrogen Blending in City Gas: A Step Towards Net-Zero Cities”

1. Executive Summary

The global energy transition is reshaping how we power our homes, industries, and transportation systems. Among the most promising solutions is green hydrogen, produced through electrolysis using renewable energy. India’s energy demand is growing rapidly, particularly in sectors that are difficult to decarbonize, such as peak electricity generation, residential and commercial heating, and industrial processes. Natural gas plays a critical role in meeting these demands, but it is a fossil fuel and contributes to CO_2 emissions. Blending low-carbon hydrogen produced from renewable energy sources, such as wind and solar, into India’s natural gas network offers an opportunity to reduce the carbon intensity of these sectors.

2. Why Blend Hydrogen with City Gas?

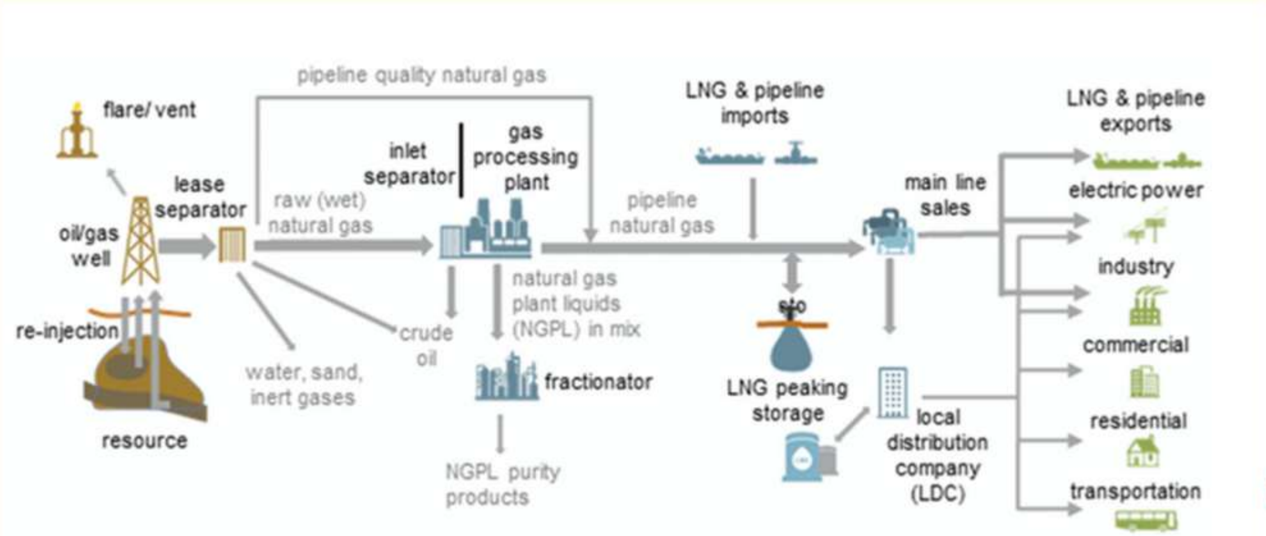
1. Carbon Reduction: Even a 5–20% blend of green hydrogen in natural gas pipelines can significantly cut CO_2 emissions in households, commercial establishments, and industries.

2. Utilization of Existing Infrastructure: Hydrogen blending leverages current city gas distribution networks, reducing the need for heavy upfront investments in new pipelines.

3. Energy Security: Diversifying gas supply with domestically produced green hydrogen reduces dependency on imported fossil fuels.

3. Current Natural Gas Value Chain

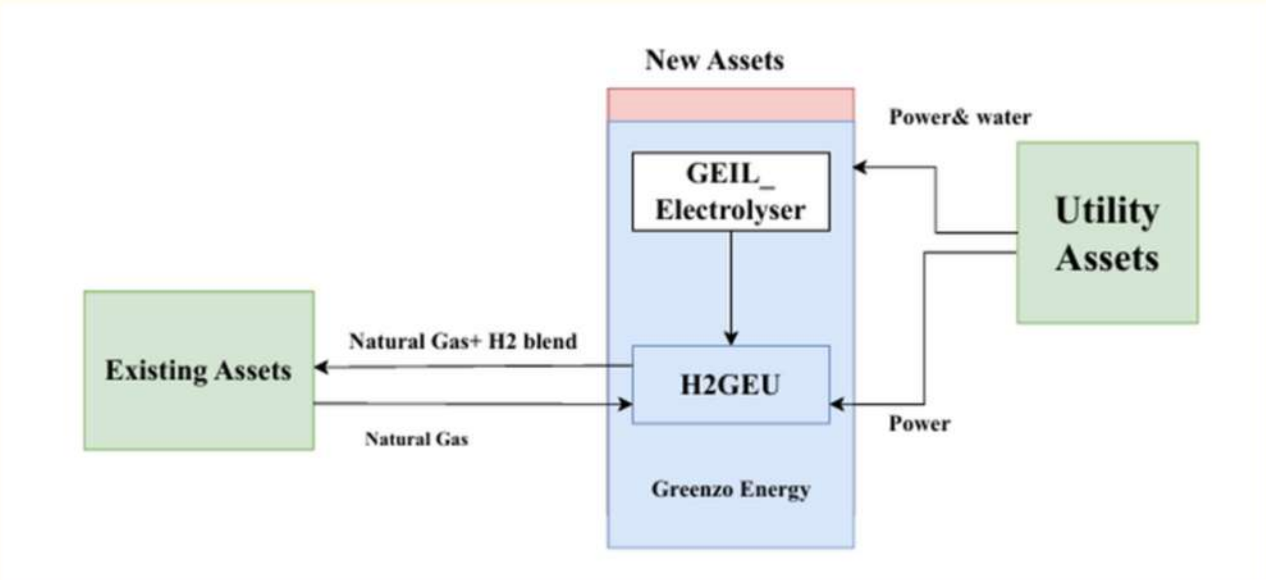
The diagram illustrates the complete natural gas value chain, from extraction to end-use. Raw natural gas is produced from oil/gas wells, separated from oil, water, and inert gases, and sent to gas processing plants for purification.



Pipeline-quality natural gas is then transported through pipelines or LNG imports/exports, with storage facilities managing peak demand. Finally, the gas reaches end-users via mainline sales and local distribution companies, serving sectors such as electricity generation, industry, commercial, residential, and transportation. Integrating hydrogen into this network can reduce the carbon intensity of natural gas across all these sectors.

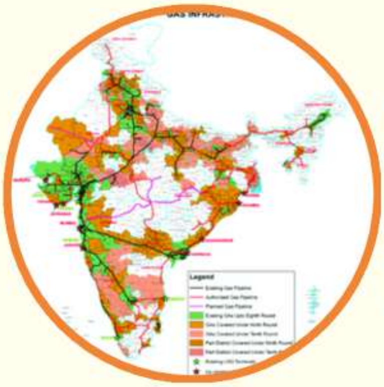
4. Integration of Electrolyser and H_2GEU for Hydrogen Blending in Natural Gas Systems

Blending hydrogen into natural gas infrastructure involves producing hydrogen via water electrolysis using renewable electricity and injecting it into existing gas pipelines. This approach can partially decarbonize natural gas usage without requiring major changes to end-user equipment. It can be applied in urban gas distribution networks, industrial zones, and power plants using natural gas.



Natural gas from the existing G3 assets, which regulates gas pressure for distribution, is directed towards a compound where new assets are installed. An electrolyser, powered by electricity and supplied with water, produces hydrogen. This hydrogen is then fed into the H_2 Gas Entry Unit (H_2GEU), where it is blended with natural gas. The blended stream is sent back through the existing assets for onward distribution to consumers. Existing utility infrastructure provides the required power and water inputs, while also handling drainage and energy flows. This configuration shows how hydrogen blending can be integrated into natural gas networks using a combination of existing assets and newly deployed technologies

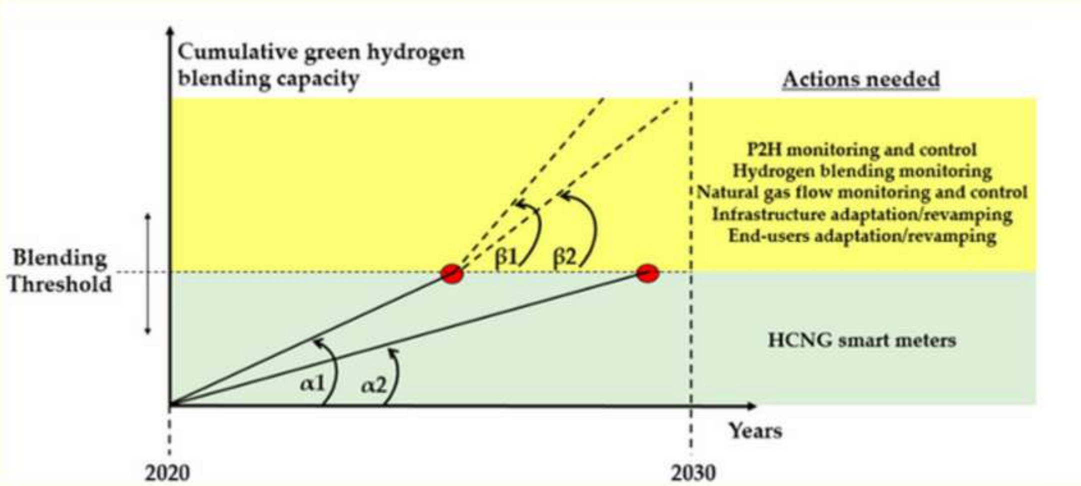
5. India's Roadmap



India has already initiated pilot projects for hydrogen blending in city gas networks through GAIL, Adani Total Gas, and other distribution companies. The government's National Green Hydrogen Mission aims to position India as a global hub, and city gas blending will be a critical enabler of that vision.

Road map of blending hydrogen into natural gas (2020-2030):

The integration of green hydrogen into the natural gas network is envisioned as a gradual process, with cumulative blending capacity increasing steadily over the coming decade. As shown in the diagram, the blending threshold marks a critical point beyond which advanced measures must be introduced to ensure system reliability and safety.



In the initial phase (2020–2030), emphasis is placed on deploying HCNG smart meters and controlled monitoring of blending percentages (α1, α2). Upon crossing the threshold, a more comprehensive framework becomes necessary, including power-to-hydrogen (P2H) monitoring, hydrogen blending monitoring, natural gas flow monitoring, and infrastructure adaptation. In addition, modifications at the end-user level are required to ensure compatibility with higher hydrogen concentrations (β1, β2). This staged strategy not only facilitates the progressive adoption of hydrogen but also mitigates technical, economic, and safety risks associated with large-scale blending, thereby supporting long-term decarbonization of the gas sector.

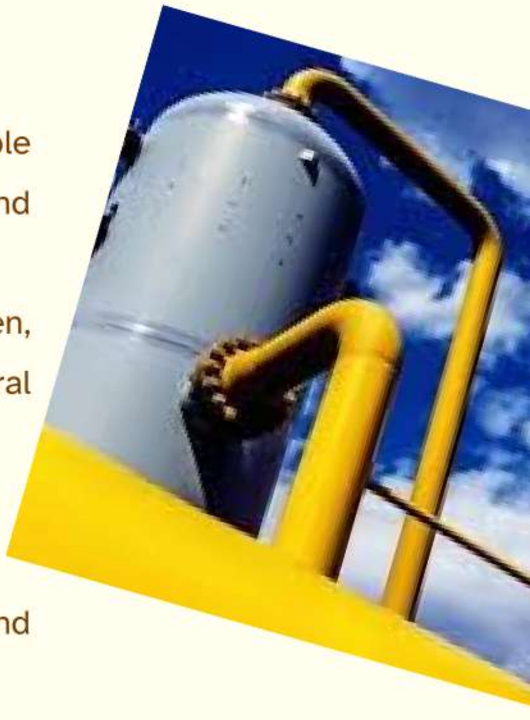
6. Greenzo Energy's Contribution

At Greenzo Energy India Limited, we are playing a pivotal role in enabling this transition. Our expertise in green hydrogen production technologies, advanced electrolyser manufacturing, and patented bipolar plate innovation positions us as a trusted partner for city gas distribution companies.

- **Electrolyser Solutions:** Greenzo is developing high-efficiency electrolysers tailored for Indian conditions, making hydrogen production more cost-effective.
- **Industry Partnerships:** We work with steel, glass, and city gas operators to design pilot projects that integrate hydrogen safely into existing systems.
- **Sustainability Impact:** By supporting hydrogen blending in CGD networks, Greenzo is helping reduce carbon intensity in urban living, directly contributing to India's net-zero vision.
- **ESG Value Creation:** Our solutions empower industries and gas distributors to meet environmental, social, and governance (ESG) commitments while enhancing long-term competitiveness.

Application in India:

6.1 Hydrogen Production:



- Hydrogen can be produced using surplus renewable electricity from solar parks in Rajasthan, Gujarat, and Tamil Nadu or wind farms in Maharashtra and Gujarat.
- Electrolysers convert electricity into green hydrogen, which is then stored or directly blended into the natural gas grid.

6.2 Hydrogen Blending and Storage:

- *Two scenarios are considered:*

a. With hydrogen storage: Hydrogen is produced and stored in buffer tanks before blending into pipelines.

b. Without hydrogen storage: Hydrogen is blended directly into the natural gas flow as it is produced.

6.3 Impact on Emissions:

- Modeling studies based on Ontario and the U.K. can be applied to Indian conditions:
  a. *With hydrogen storage:* CO_2 emissions could be reduced by approximately 9,000–10,000 metric tonnes per year in a mid-sized city's gas network.
  b. *Without storage:* CO_2 reductions may be around 3,500–4,000 metric tonnes annually.
- Aggressive adoption aligned with India's renewable energy and decarbonization targets could significantly increase emissions reductions.

6.4 Economic Implications:

- Using low-cost renewable electricity, hydrogen blending could reduce operating costs of gas-fired power plants by 5–7%.
- Industrial users could also benefit from partial substitution of natural gas with hydrogen without major modifications to existing infrastructure.

7. Conclusion

Blending green hydrogen with city gas is a low-hanging fruit in the clean energy transition. It accelerates decarbonization, ensures efficient infrastructure utilization, and builds momentum for a hydrogen-ready economy. With companies like Greenzo Energy driving innovation and partnerships, the vision of cleaner, smarter, and net-zero cities is no longer a distant dream it is becoming a reality.

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