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Charting the path forward in city gas distribution: Emerging trends and insights

August 2024



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Foreword from FICCI



Ms. Jyoti Vij
Director General, FICCI

It is my pleasure to present the FICCI-PwC Knowledge Report on 'Charting the Path Forward in CGD: Emerging Trends and Insights", unveiled at City Gas Distribution Summit 2024 by the Federation of Indian Chambers of Commerce and Industry.

The City Gas Distribution (CGD) sector has evolved rapidly in recent years and has played a crucial role in India's energy transition and economic growth. As India embarks on an ambitious journey to enhance its energy security, reduce environmental impact, and achieve sustainable development, the importance of CGD cannot be overstated. The increasing demand for natural gas, driven by various end-user sectors including residential, commercial, industrial, and automotive, underscores the critical need for a robust CGD infrastructure.

Over the past few years, significant strides have been made to expand the CGD network across the country. The Indian government's proactive policies, including the allocation of new CGD licenses and substantial investments in infrastructure development, have laid a strong foundation for the sector's growth. The regulatory landscape is continually evolving to facilitate faster and more efficient implementation of CGD projects, ensuring that natural gas becomes a cornerstone of India's energy mix.

The report highlights key factors influencing the CGD sector, including infrastructure development, policy frameworks, energy demand, and economic conditions. This insight is crucial for stakeholders aiming to navigate the complexities of the CGD sector and capitalise on emerging opportunities.

As we convene at the City Gas Distribution Summit 2024, it is imperative to reflect on these developments and deliberate on the future trajectory of the CGD sector.

I hope you will find this report useful. We welcome your suggestions and feedback.

Foreword from PwC



Mr Ajay Deshmukh
Partner, Fuels and Resources, PwC India

With increasing population, the biggest challenge faced by India would be to meet the energy demands sustainably while aligning the production of energy resources with the country's net zero goals by 2070. For this, city gas distribution (CGD) networks have emerged as a beacon of hope. The shift to a sustainable future is possible by harnessing the potential of environmentally responsible solutions. This shift will not only help in minimising emissions but also provide energy security and cost effectiveness.

However, there are several roadblocks on the way to a sustainable future. First is realising the importance of CGD in providing sustainable energy solutions in various sectors followed by need for policy reforms and collective efforts by different stakeholders of the sector.

This knowledge paper deep dives into the importance of CGD as an energy source which is more sustainable in various sectors of India, including residential, commercial, transportation and industry. It provides insights into the current CGD scenario, the significance of CGD in achieving the nation's goal along with the key players and their contribution.

Additionally, the paper sheds light on the challenges and opportunities in the adoption of CGD along with the government initiatives which are promoting CGD. The paper also discusses the technological environment currently present in the country and the future potential the sector holds.

We hope you find this report valuable and invite you to share your suggestions and feedback.

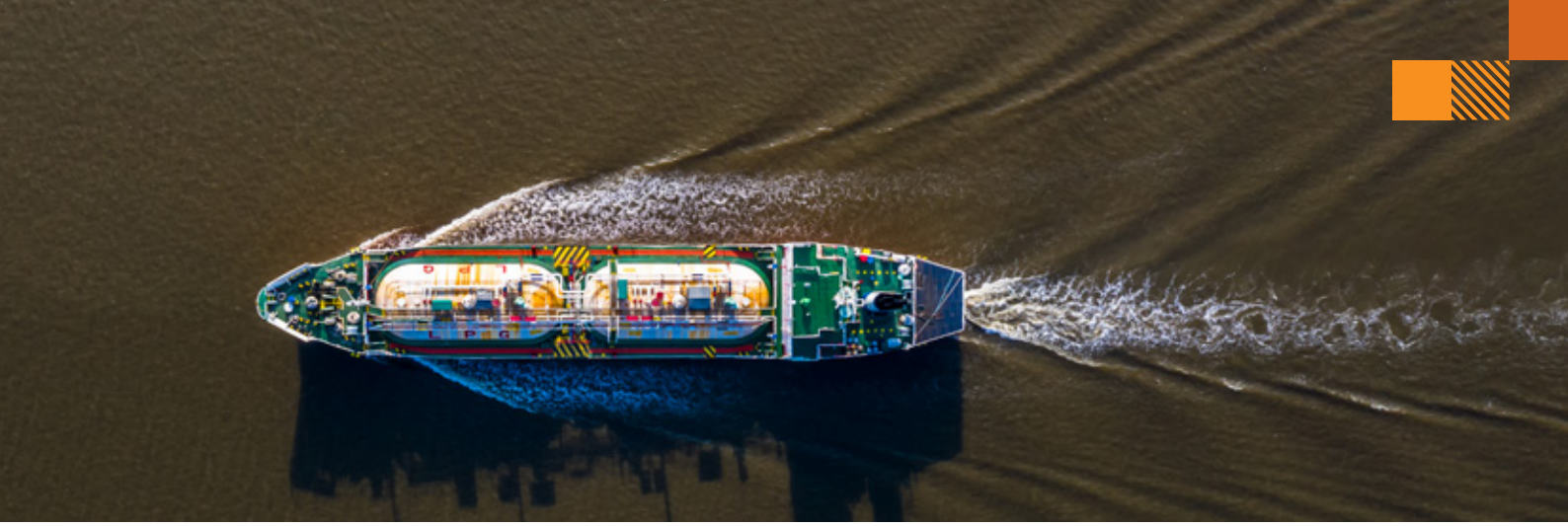


Executive summary

In response to the mounting concerns around the effect of human-generated greenhouse gases on the climate, efforts have been made to reduce emissions across the globe. Securing access to modern, inexpensive, dependable, sustainable, and economical energy services is essential to achieve sustainable development worldwide. Simultaneously, greenhouse gas emissions and the energy sector's carbon footprint also needs to be minimised. Natural gas can play a key role in addressing these environmental concerns while meeting the need for reliable and affordable energy; hence, there is a push towards increasing the usage of natural gas.

The Government of India has undertaken several initiatives in line with its mission of creating a gas-based economy, including an increased focus on the CGD segment. India's CGD industry is expected to grow rapidly owing to favourable government regulations, environmental requirements, and rising urbanisation. It is essential to continue investing in technology, infrastructure, and strategic alliances, for the industry to overcome obstacles and achieve sustainable development. The CGD industry plays a key role in India's energy policy by providing a more sustainable substitute for conventional fuels and advancing the nation's economic and environmental objectives.

Demand within the CGD sector is anticipated to be driven disproportionately by several segments. The growing use of environmentally friendly fuel substitutes for conventional fuels is expected to accelerate the nation's economic expansion. Strong tailwinds for this expansion are also expected to arise from structural factors including increasing infrastructure investments, regulatory backing, and increased public awareness. Navigating the changing landscape of CGD is essential to achieve both short and long term goals for the energy sector.



Introduction

Setting the context for CGD network in India

India is the world's third-largest energy consumer after China and the United States, owing to rising incomes and improved standards of living. Energy consumption has doubled since 2000, and over 80% of the demand is still met by oil, coal, and solid biomass.[1]

At present, the share of natural gas in India's energy mix is approximately 7%.[2] Given its clean attribute, natural gas is the next generation fossil fuel which will play a critical role in India's transition towards a low-carbon and clean fuel-based economy. Gas consumption in India has steadily decreased owing to a decline in domestic production, multiple pricing mechanisms, regulatory and infrastructure issues, and other factors. However, the Government of India has set a target to advance towards a gas-based economy and plans to raise the share of natural gas in the energy basket from 6.7% at present to 15% by 2030.[3] It has also introduced a series of reforms and initiatives to provide wider, cleaner and cheaper energy access across the country. Further, the government has allocated top priority for domestic gas to the CGD sector, followed by fertilisers, power, and other priority sectors.

To build CGD network infrastructure across the country and facilitate, augment, and regulate the downstream segment, the Ministry of Petroleum and Natural Gas (MoPNG) established the Petroleum and Natural Gas Regulatory Board (PNGRB) in 2006 through the PNGRB Act. The PNGRB has been instrumental in facilitating the faster promotion and adoption of natural gas in India through multiple bidding rounds of CGD licenses.

Overview of CGD systems and their importance

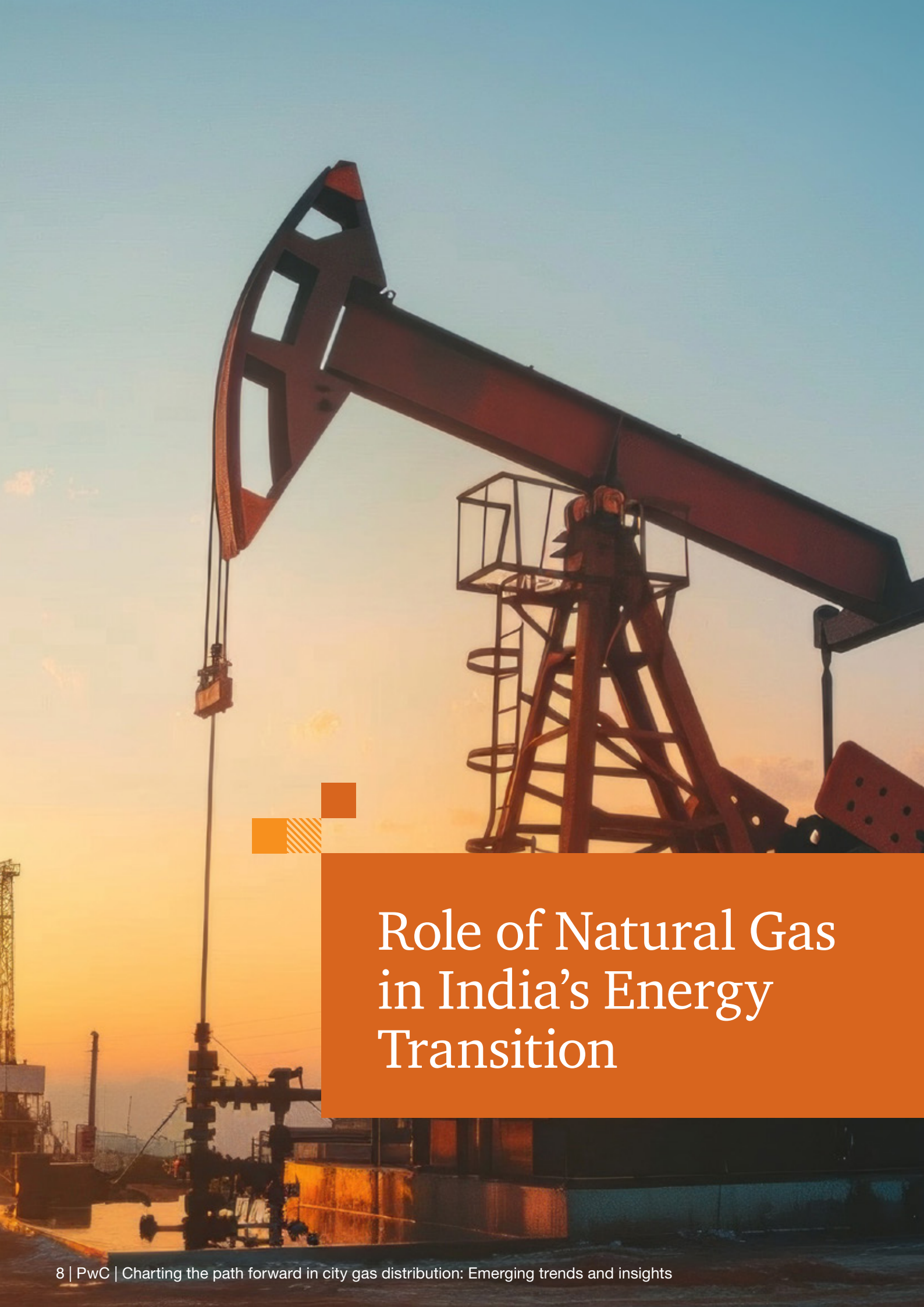
India has set ambitious goals for addressing climate change, pledging at the COP26 Climate Conference in Glasgow in 2021 to achieve net-zero carbon emissions by 2070.[4]

CGD is the last link in the natural gas value chain and is essential for delivering natural gas to end users. It makes it easier to substitute liquid fuels in the transportation, commercial, industrial, and residential sectors. As natural gas is the cleanest fossil fuel, this shift helps the nation reduce emissions by producing less carbon dioxide and other pollutants when used as energy, compared with coal or petroleum-based products. The use of modern pipeline leak detection techniques, such as robotic and acoustic approaches, as well as advancements in cascading systems and smart dispensers, are important industry trends. The CGD sector continues to have bottlenecks in terms of cybersecurity, data integration, and remote data collection, despite showcasing the potential for a promising future.

An increased number of urea plant projects in the fertiliser industry and favourable allocation of gas policies will help in the sector's expansion by boosting natural gas consumption. Despite the high ongoing demand in refineries', the power sector's growth in gas consumption has decreased. In heavy-duty commercial vehicles and private transportation, liquefied natural gas (LNG) and naturally occurring gas (compressed natural gas [CNG]) are still frequently utilised, despite the growing number of electric vehicles (EVs) in public transportation.

The shift aims to diversify primary energy sources and decrease reliance on traditionally polluting fossil fuels. Transitioning to a gas-based economy is expected to support India's climate action commitment of net zero emissions by 2070. This also includes reducing emissions intensity by 45% and cutting total carbon emissions by 1 billion metric tonnes by 2030.[5]

1. https://iea.blob.core.windows.net/assets/1de6d91e-e23f-4e02-b1fb-51fdd6283b22/India_Energy_Outlook_2021.pdf
2. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1987803
3. https://iea.blob.core.windows.net/assets/1de6d91e-e23f-4e02-b1fb-51fdd6283b22/India_Energy_Outlook_2021.pdf
4. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1961797
5. https://pib.gov.in/PressReleasePage.aspx?PRID=1987752



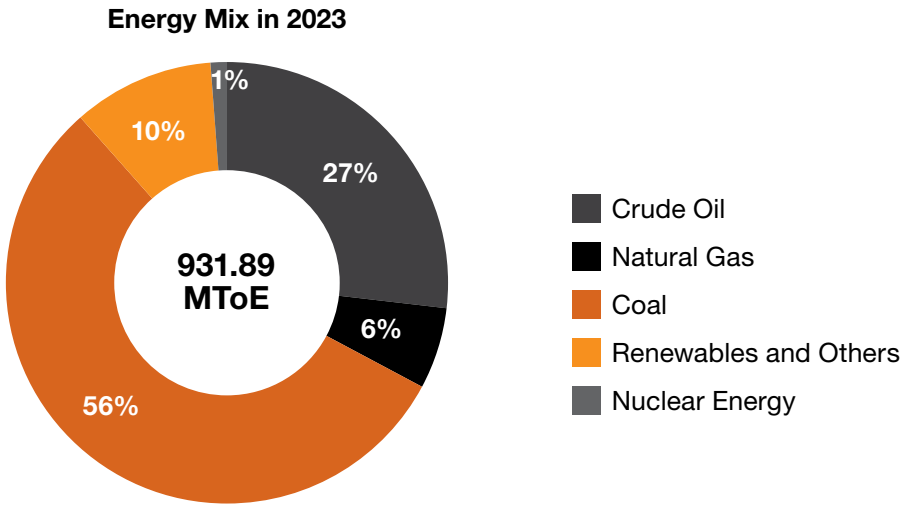
Role of Natural Gas in India's Energy Transition

India's energy landscape is undergoing a rapid transformation, driven by increased per capita energy demand, environmental and climate concerns, and the need for national energy security. In the context of India's ambitious energy transition goals, natural gas is often touted as a 'bridge fuel'. It plays a key role as a cleaner alternative to coal or polluting fuels and as a complement to renewable energy sources. This section of the paper delves into the potential of natural gas in India's energy mix, its role in decarbonisation, the challenges and opportunities associated with its expanded utilisation, and its strategic position in the nation's evolving energy mix.

The Government of India has ambitious aims to increase the natural gas share to **15%** in the energy basket by 2030.[6]

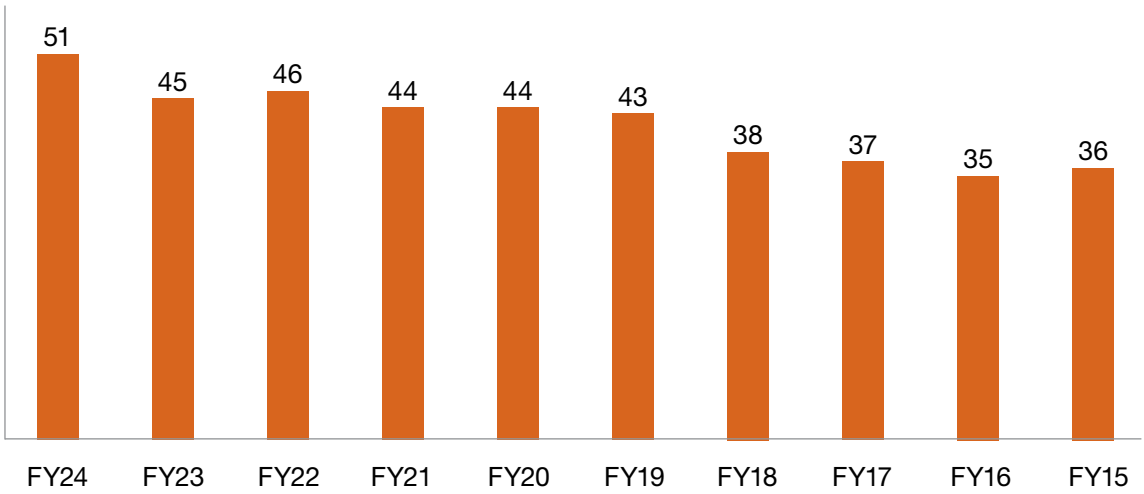
Current Status of Natural Gas in India

Figure 1. Share of Natural Gas in the Energy Basket



Historical Gas Consumption Trend in India

Figure 2. Historical Gas Consumption in India (MMT)[7]

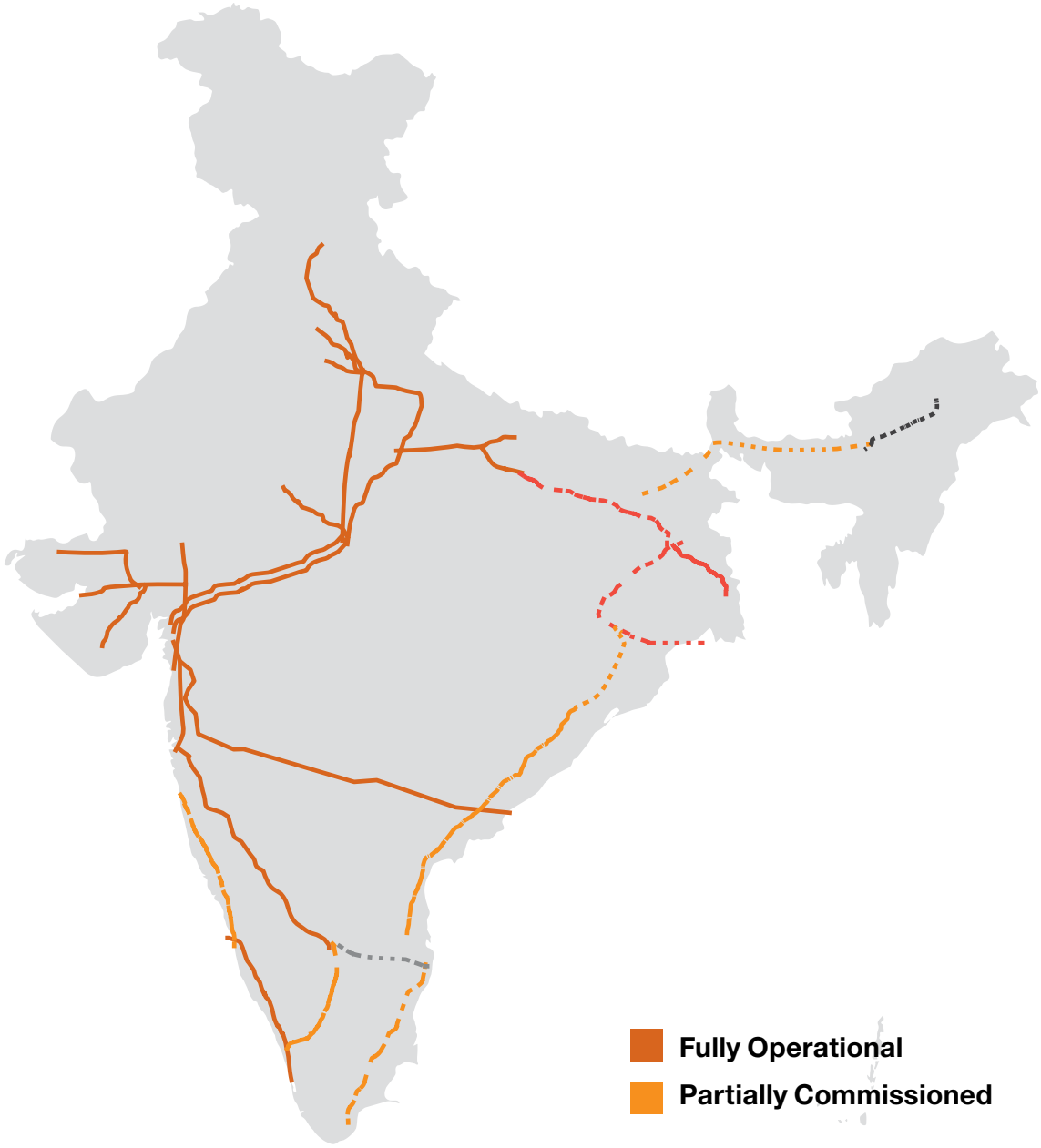


6. https://pib.gov.in/PressReleasePage.aspx?PRID=1987752
7. https://ppac.gov.in/natural-gas/consumption

Natural Gas Pipeline Infrastructure in India

Currently, India has approximately **15,900 km of fully operational common carrier natural gas pipeline network and 7,500 km of partially commissioned network.**[8]

Figure 3. natural gas pipeline network[9]



The natural gas pipeline infrastructure provides an economical and safe method for transporting natural gas from production sources to consumption markets. The gas pipeline grid shapes the structure and development of the gas market. Consequently, the establishment of an interconnected National Gas Grid has been envisioned to ensure adequate availability and equitable distribution of natural gas across the country.

Natural Gas: A Bridge Fuel for India

Natural gas emits half the carbon emissions of coal-based power owing to its higher hydrogen and lower carbon content. Additionally, the higher efficiencies of combined-cycle gas power plants further contribute to a reduction in emissions. Natural gas has emerged as a next-generation, cost-effective, and environmentally friendly fossil fuel substitutes for transportation and electricity generation. Consequently, it has the potential to replace liquid fossil fuels in transportation and coal in electricity generation, thereby contributing to India's transition to a green economy. Additionally, natural gas can be a substitute for polluting traditional biomass fuels used for cooking, thereby enhancing the health of rural women by reducing indoor air pollution.

8 https://ppac.gov.in/download.php?file=rep_studies/1713504264_Snapshot_of_India_Oil_Gas.pdf
9 https://ppac.gov.in/download.php?file=rep_studies/1713504264_Snapshot_of_India_Oil_Gas.pdf

Natural gas as transition fuel

In recent years, India has significantly increased its investments in renewable energy production, including solar and hydrogen. As an alternative and environmentally friendly energy source, natural gas can act as a critical source of energy during the provisional period. Even with the increased focus on the use of renewable energy sources to mitigate the emissions caused by traditional fuels, this may not be sufficient to meet the increasing energy demands.

Role of Natural Gas in Decarbonization

Power Generation: As a developing country, India cannot abruptly divert its valuable resources towards energy transition. Instead, a comprehensive approach is required that utilises multiple fuels to reduce emissions, rather than investing in existing energy infrastructure. Natural gas plays a crucial role in reducing carbon emission as it is a greener substitute for coal and other liquid fuels. It is versatile and can be used for various applications such as cooking, transport, and industrial usage.

The combined utilisation of renewable energy and gas-based generators would make sustainable energy transition swift and cost-efficient. As the storage capacity of natural gas/LNG can be easily enhanced, it provides a flexible energy supply that complements the intermittent output of wind and solar energy. This approach allows for the increased deployment of renewable energy for electricity generation while maintaining round-the-clock stability in the power grid.

Transportation: Natural gas can play a large role in the transportation energy mix as a lower-carbon fuel, complementing advancements in vehicle efficiency, biofuels, hydrogen, and electric mobility. Transitioning heavy-duty vehicles to LNG diversifies the fuel mix and can help reduce harmful air pollution. LNG also has the potential to offer fuel cost savings compared with conventional diesel. Given India's increasing air quality concerns, LNG as a transportation fuel, especially for heavy-duty and inter-state bus transport, can help lower emissions. The Government of India has identified LNG as one of the next-generation fuels.

LNG for long haul transportation: LNG, in its cryogenic liquid form, occupies up to three times less space compared with CNG, offering higher energy density and a greater vehicle range. This characteristic makes LNG an ideal fuel for India's extensive fleet of long-haul, heavy-duty trucks that currently depend on diesel. Therefore, the future of LNG-powered heavy vehicles, particularly trucks, is exceedingly promising. Although there are several viable alternatives for short-distance travel in urban centres, options are limited for heavy-duty long-haul transportation. EVs currently face challenges related to range and cost, as well as the infrastructure needed for heavy-duty trucking. LNG stands out as the only viable and mature immediate alternative for long-distance transportation and can facilitate the transition to greener trucking.

Mining: With developments in digital transformation, the mining and metal industry would require investments, new skillsets and innovations, and a motivated workforce to overcome roadblocks in decarbonisation. Many mining companies have already set targets to reduce their environmental impact in response to national targets. However, the pressure on miners to decarbonise more aggressively than others is immense because the impact of these industries is far more severe than that of others. This is one of the reasons why it is crucial to adhere to the Paris Agreement's goal of limiting global temperatures. The primary focus of most mining companies is on Scope 1 (direct emissions) and Scope 2 (indirect emissions).

- Enhancing efficiency in operations to reduce the excess consumption of water and energy sources.
- Using renewable energy sources that place less stress on traditional fuel sources, and mechanising and electrifying the process can help.

Challenges

Infrastructure Development:

Gas contributes only 2% to power generation, although the availability of other competitive substitutes places expensive gas-based power on the backburner to become an anchor for gas sector consumption.[10] Owing to the enhanced economies of scale for battery storage and increasing utilisation of renewable energy assets, this proposes strong resistance to the usage of gas in the medium term. Infrastructure development is not consistent with the desired consumption trends. Cleaner and more cost-efficient alternatives compete with consumption avenues; therefore, the role of gas in the medium and long term does not provide a strong outlook.

10 https://iced.niti.gov.in/energy/electricity/generation/power-generation

Price Volatility:

Indian gas consumption patterns have been deemed to be highly price sensitive. Volatile pricing leads to unpredictability in demand and can lead to deserted assets if the significant investments made are based on lower prices or expected demand. With the increasing availability of alternative fuels, consumers tend to shift to cheaper alternatives when gas prices increase.

Import Dependence:

Approximately 48% of all LNG is imported.[11] Although these imports provide a limitless supply, they are far costlier than the prices set by the administered pricing mechanism (APM) for domestically produced gas. Growth in the country's oil and gas production has remained sluggish, leading to increased reliance on imports. Heavy reliance on imports has proven to be one reason for slow growth in the country's gas sector.

Policy and Regulatory Framework:

Ensuring the government's effective role as a facilitator in improving the availability of resources and ensuring proper quality has proven to be a key challenge. Reforming the subsidy system in the fertiliser sector is critical. Further, it is the government's responsibility to ensure that subsidies are directed to concerned farmers' accounts instead of heavily subsidising the entire industry, allowing farmers more freedom in setting prices and marketing their product.

Technological Advancements:

Currently, India lacks a strong hold on technology in the gas sector. The existing gas infrastructure is deprived of up-and-coming technologies used for extracting, transporting, and storing natural gas. Additionally, there is a need for increased focus on innovative techniques in the carbon capture and storage technologies which might be able to mitigate environmental impacts. Better investments in advanced technologies for regasification processes are vital for the cost-effectiveness of LNG imports and its increased efficiency. Various technologies, such as cloud computing, smart grids, and smart meter installations, can help optimise the accessibility of natural gas to consumers, reducing losses and leading to the growth of the sector.

Policy and Future Outlook

- **Infrastructure Investment and Development:**
  The government plans to invest USD 67 billion in the natural gas business over the next six years to stabilise prices for the end customers.[12] Legislative and regulatory frameworks have also been supportive in recent years for the promotion of natural gas.
- **Price Stabilization Measures:**
  Gas pricing is part of India's current efforts to efficiently manage the natural gas sector and the equilibrium of interests of producers and consumers. With notifications from the MoPNG, the gas pricing must be updated on a monthly basis. Updating prices shows India's dedication to aligning its energy policies with global standards, supporting domestic production, and ensuring fair prices for all stakeholders. With close observation of global energy markets and implementation of the policy framework, the government is focused on stabilising prices and promoting growth in the natural gas sector.
- **Policy and regulatory support:**
  The government must play a significant role in improving the quality and quantity of available resources. Aggressive and dynamic reforms should be introduced to drive progress in this sector. Extensive structural reforms are required, particularly in the subsidy system, to enhance production capabilities.
- **Domestic Exploration and Production:**
  The development of domestic infrastructure is important to reduce import dependence, which currently stands at approximately 48%.[13]
- **International Cooperation:**
  As the prices of natural gas imports are currently low, India should aim to secure contracts with gas-abundant countries such as Iran, Myanmar, and Turkmenistan, from where gas can be transported to India using a pipeline network.

11 https://ppac.gov.in/download.php?file=rep_studies/1721113509_Snapshot-of-India-Oil-Gas-data-June-2024.pdf

12 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2003077

13 https://ppac.gov.in/download.php?file=rep_studies/1721113509_Snapshot-of-India-Oil-Gas-data-June-2024.pdf





CGD Sector Overview

Current State of CGD: Snapshot of the current infrastructure and operations

Figure 4. Value Chain of CGD sector:



CGD Authorizations:

To make natural gas available to the public, the government has placed strong emphasis on the expansion of CGD networks across the country. The pace of CGD licensing has increased remarkably from the 9th round of the CGD Bidding onwards, along with growing interest from companies to apply. After the 12/12A CGD bidding round, potential coverage of the population is expected to reach approximately 100%, achieving almost complete coverage of the country's area, except for the Andaman and Nicobar and Lakshadweep Islands.[14]

CGD Infrastructure:

Currently, India boasts a significant infrastructure in the CGD sector, featuring 13,118,891 domestic piped natural gas (PNG) connections.[15] This extensive network provides households with a cleaner and more efficient cooking fuel, reducing their reliance on traditional polluting energy sources.

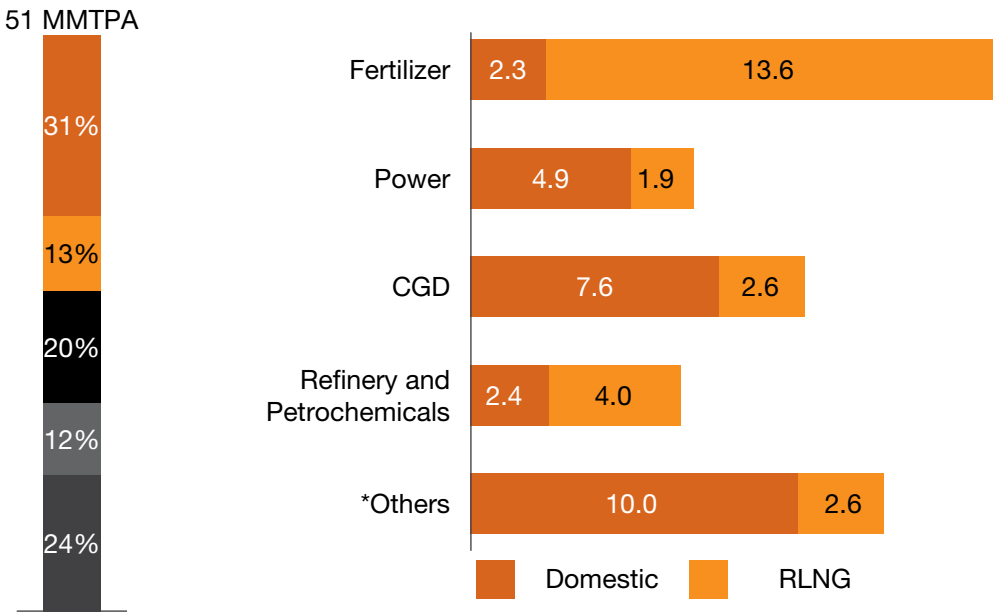
Additionally, 6,959 CNG stations exist across the country.[16] These stations play a crucial role in the transportation sector by offering a cleaner fuel alternative, thereby contributing to lower emissions and supporting the nation's environmental goals.

Furthermore, India has 6,234 retail outlets for alternative fuels such as CNG and compressed biogas (CBG).[17] These outlets enhance the accessibility of eco-friendly fuel options, promoting a shift towards more sustainable energy consumption across various sectors. This robust infrastructure underscores India's commitment to advancing its CGD network and fostering a greener future.

Market Dynamics

Market Scenario:

Figure 5. Sector wise Natural gas consumption for FY 23-24



*Other sector includes industries like glass, ceramic, sponge, iron, steel, etc.

14 https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2040078
15 https://ppac.gov.in/
16 https://ppac.gov.in/
17 https://ppac.gov.in/

Gas consumption in FY 24 stood at 51 MMTPA.[18] Of the total natural gas consumption, the fertiliser sector accounted for the highest consumption (31%), while the CGD sector accounted for 20%, the power generation sector accounted for 13%, and the refineries and petrochemicals accounted for 12%. Other sectors, including the glass, ceramic, iron, and steel industries, accounted for the remaining 24%.[19]

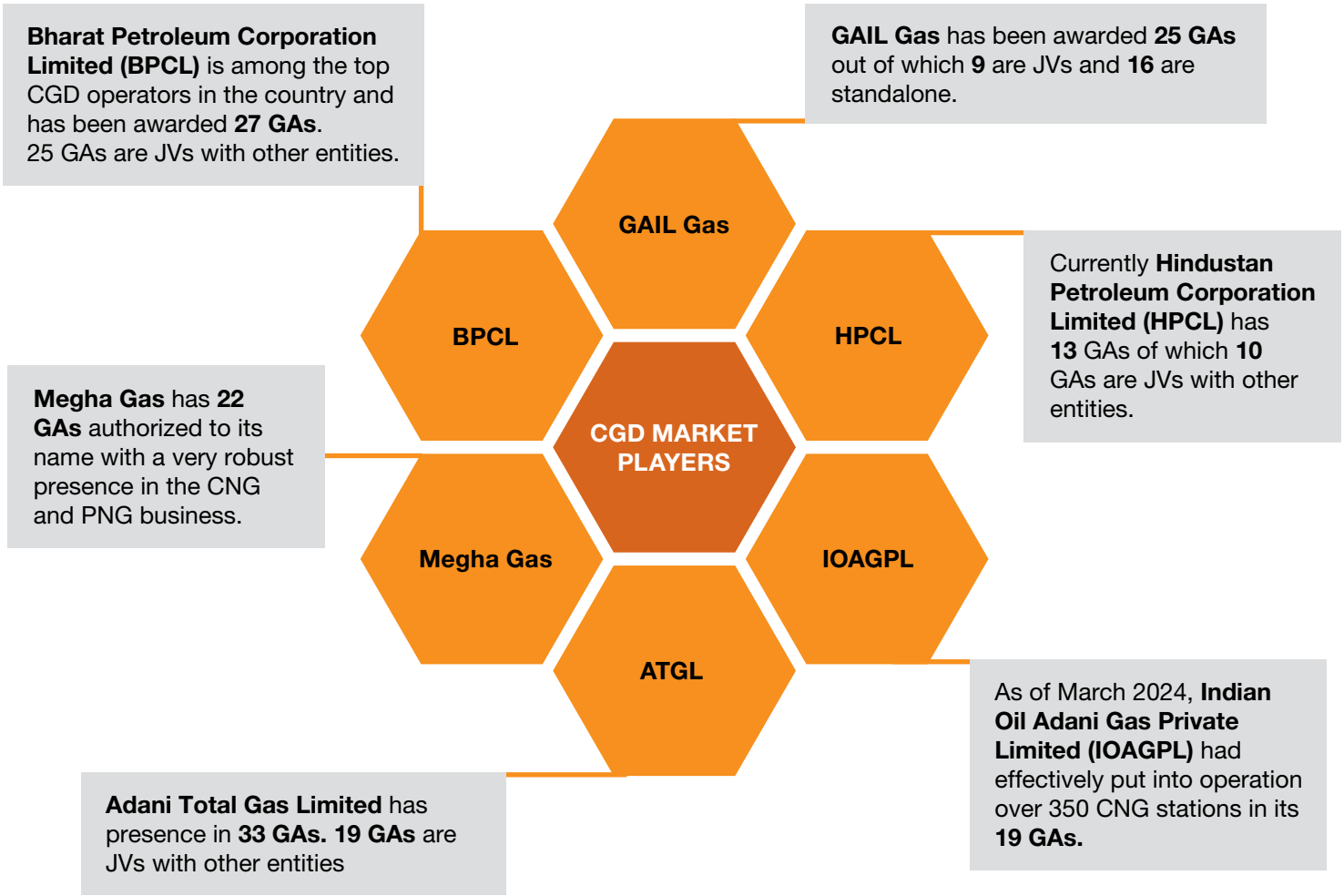
The CGD sector has grown in recent years as the share of natural gas consumption has grown from 11% in FY16 to 20% in FY24.[20]

Key Players in the CGD Sector:

CGD firms implement distribution infrastructure in regions licensed by the regulator, which are referred to as geographical areas (GAs).[21]

Market Scenario:

Figure 6. Major players in city gas distribution business



The sale of natural gas in the CGD sector by these entities was approximately ~10.3 MMT for FY23, of which 8% was in households, 34% in industrial and commercial sectors, and 58% in the transport sector.[22]

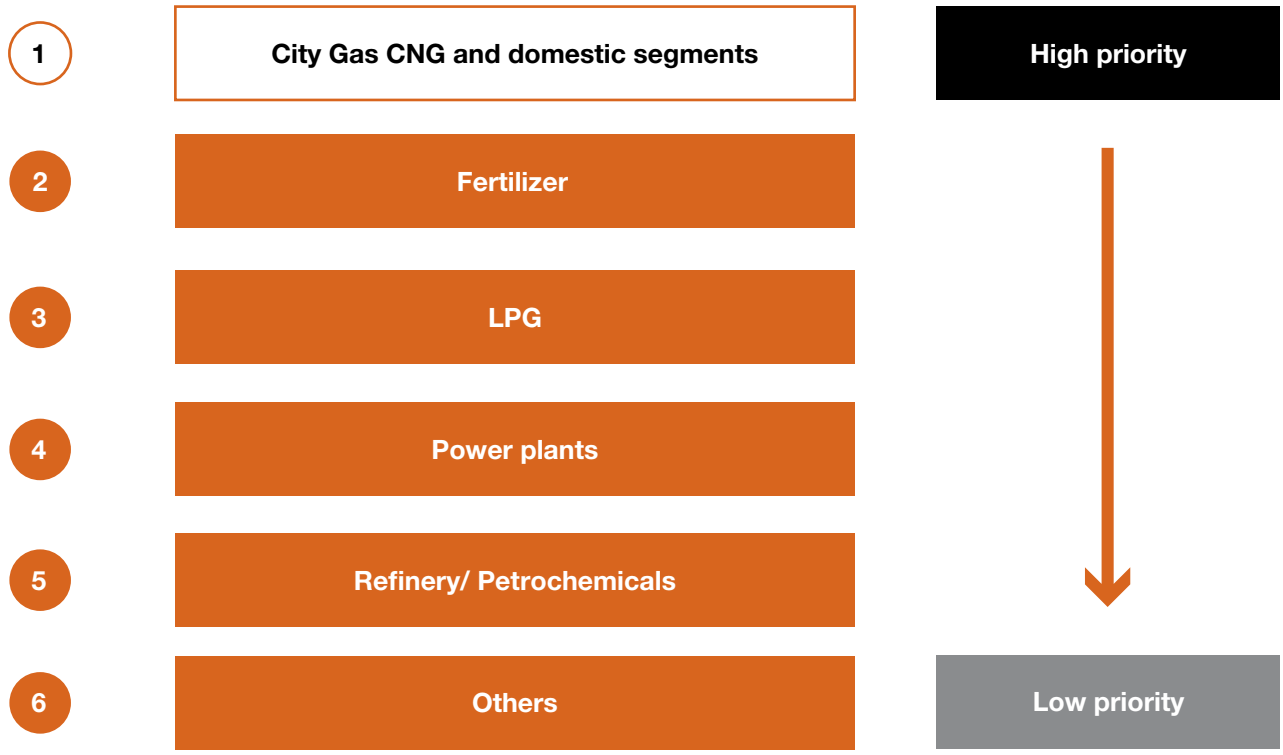
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22 https://ppac.gov.in/download.php?file=rep_studies/1719411262_Final_Book_June%202024_Final_for_upload.pdf

Regulatory Environment: Overview of regulations impacting CGD Sector

The PNGRB is the primary authority regulating and overseeing the CGD sector in India. The PNGRB grants authorisation to entities to develop CGD networks within specified GAs. These authorised CGD entities have the exclusive right to provide a holistic scope , starting from laying the foundation to the operation, maintenance, and even expansion of a city or local natural gas distribution networks. These networks comprise pipelines, online compressors, and other allied equipment and facilities, for an economic life of 25 years. Marketing exclusivity for a common or contract carrier is limited to eight years. After completion of this exclusivity period, the authorised entity should be able to provide on-demand access to other entities and recover transportation rates for CGD from an entity accessing the CGD network.

For sourcing gas, the government allocated the highest priority for domestic gas supply to CGD for distribution to domestic households (PNG) and the transport segment (CNG).

Figure 7. Current domestic gas allocation priority





Leveraging Technology in the CGD Sector

Technology's Role in India's CGD Sector

India's CGD sector is undergoing rapid transformation, driven by the increasing demand for cleaner fuels, energy security, and the government's push for a gas-based economy. Technology is emerging as a key enabler in this evolution, not only enhancing efficiency and safety but also increasing customer experience and reliability. Technology will play a pivotal role in the CGD sector and has the potential to drive sustainable growth.

Technology Driving the Evolution of CGD

Network Optimization: Technologies responsible for improvement in the CGD industry include Internet of Things (IoT) devices and sensors that help in the real-time monitoring of parameters such as gas levels, pressure, and temperature throughout the system. This real-time data assists in predictive maintenance and efficient distribution planning. Leveraging technologies such as advanced analytics, artificial intelligence (AI), and the geographic information system (GIS) facilitates the analysis of historical data, enhanced mapping of routes, and optimal planning, resulting in effective management of assets.

The implementation of network optimisation technologies in the CGD sector results in reduced operational expenses owing to optimised routes and planning, reduced downtime and lower maintenance expenses through predictive analytics, optimal resource allocation, and inventory management. This makes the entire supply chain efficient, reliable, and cost-effective.

Customer Experience: Mobile applications, customer portals, and CRM systems are few of the technologies which are currently transforming customer interactions in the CGD industry. With mobile applications and online portals, customers have easier access to several services that assist them in placing orders, tracking deliveries, and efficiently managing accounts. CRM systems enable businesses to understand customer requirements and propose services by providing personalised experiences. Augmented reality (AR) technology is at a nascent stage, and its use is developing in the CGD sector. One such approach is the use of AR for customer engagement through virtual product demonstrations and training.

These technologies impact the CGD sector to a large extent, improving customer satisfaction through convenience and customised services, increasing customer retention through improved service quality, and strengthening brand reputation among customers.

Safety and Security: Real-time monitoring systems, drones, and cybersecurity solutions enhance the safety norms in the CGD sector. With the help of sensors and IoT devices, real-time monitoring systems can detect leaks and pressure anomalies, inspect several other hazards, and enable immediate responses. Drones equipped with cameras and sensors can be used to inspect infrastructure, identify potential issues, and monitor hazardous and remote areas. Robust cybersecurity is also required to protect sensitive data and information as the industry moves towards digitisation.

With the utilisation of technologies for safety and security, the risk of accidents and incidents is reduced through proactive monitoring, improved security against physical and cyber threats, and compliance with safety regulations and standards, which, in turn, reduces legal liabilities.

Challenges:

Infrastructure Development: The CGD sector faces several challenges in the development of existing infrastructure. A few key challenges are high initial costs for upgrading or developing new infrastructure, complex and expensive integration of the new technology with the existing infrastructure, and regulatory hurdles leading to delays and additional costs.

Despite these challenges, there are several opportunities for infrastructure development, such as the use of smart meters along with sensors, which have been adopted in several regions of the country to better monitor and efficiently distribute gases. The adoption of automation and digital tools to update the existing infrastructure can improve the operational efficiency and reliability of the system and yield substantial long-term cost savings through reduced maintenance requirements.

Data Management: Handling large volumes of data from different sources is challenging and requires substantial storage and processing capabilities. The integration of data from diverse systems and sources results in layers of complexities requiring advanced management solutions. Ensuring the accuracy and quality of data is vital for decision making which becomes a challenge when the data management is inefficient.

Significant opportunities are also present, such as advanced analytics using big data to develop insights from present data to optimise operations and predict maintenance requirements. Real-time data management can improve decision-making processes and responsiveness to operational issues. Additionally, the analysis of trends through collected data can help drive innovation and reveal new business opportunities, leading to competitive advantages.

Cybersecurity: With the development of digital infrastructures, the risks of cyberattacks and data breaches have increased, requiring more comprehensive and advanced security measures. As the nature of cyberthreats evolves, there is a continuous requirement to update and adapt to improved security protocols.

Investment in high-end cybersecurity technologies, such as next-generation firewalls and advanced encryption systems, can improve the defence against cyber threats. AI-driven security can help analyse patterns and anomalies in real time, thereby enabling proactive threat management. Investing in training and education programs for employees would keep them well-informed of existing threats, thus cultivating a security-conscious culture within the organisation. Collaboration between major CGD players and cybersecurity experts can help build more effective security solutions, thereby facilitating the sharing of threat intelligence. These are some of the key opportunities in cybersecurity for players in the CGD industry.

Regulatory Framework: Companies in the CGD sector face challenges related to regulatory compliance, including understanding complex and changing regulations, as well as experiencing setbacks in updates and balancing innovation with safety norms. Generally, companies struggle with a slow pace at which frameworks adapt to new technologies, making it difficult for innovations to advance.

There are significant opportunities for improvement, such as well-designed regulations to help quickly adopt new advanced technologies by presenting all guidelines and incentives clearly. Introduction of innovation-friendly policies encourage advancement on the technological front while adhering to safety and compliance standards. Additionally, collaborating with regulators can help develop supportive policies that are beneficial to both the industry and consumers.

Recent and Advanced Technologies in CGD

CGD systems play a critical role in urban energy infrastructure by delivering natural gas to residential, automobile, commercial, and industrial consumers. Technology is a game-changer for India's CGD sector, offering immense potential to improve efficiency, safety, reliability, and customer satisfaction. By addressing the challenges and leveraging the opportunities, this sector can accelerate its growth and contribute to India's energy transition goals. We explore the most advanced technologies and their impact on transforming CGD networks and enhancing their efficiency, safety, and sustainability.

Supervisory Control and Data Acquisition (SCADA) technology:

SCADA technology has helped revolutionise the monitoring and control of CGD operations. Technologies such as the SCADA system help in providing a detailed overview across different operations and overseeing different aspects, such as CNG stations and pipeline networks, to manage the network more efficiently. Typically, all field equipment is connected to a remote terminal unit panel, allowing critical signals to be wirelessly transmitted to a central control hub.

The SCADA system offers a detailed overview of every compressor and helps monitor digital data. Critical areas, such as the flame detector and its combustive limits in compressors, are closely observed to ensure safety and efficiency. The system is facilitated by user-friendly dashboards that showcase dispenser parameters and sales data, promoting adaptability and accessibility.

The transition from traditional logbook mechanisms to digital logbooks and remote access to process parameters enhances monitoring and control, thereby ensuring optimal efficiency and throughput in pipeline segments.

GIS Mapping: GIS has significantly enhanced the efficiency of CGD entities by aiding in planning, engineering, and the operations and management of CGD networks. GIS mapping is useful for facilitating integration with various gas businesses that leads to better analysis, decision making, and planned network systems.

Software companies operating on GIS can develop a wide range of solutions designed for various applications. Gas companies have adopted these applications to support their operations, yielding better data quality and timely detection and resolution of these issues.

GIS mapping helps with multilayer data, involving customers, workers, assets, and gas stations, and gathers them into a single platform. Enterprise mapping systems help integrate all the information gathered, allowing for the descriptive analysis of data.

One of the main benefits of GIS mapping is the location-specific data, different business functions, analysis of various locations, and the provision of spatial data. This mapping system allows companies in the CGD sector to outline their entire pipeline network and obtain information on every device from any location and time.

Advanced Metering: Advanced metering technologies, including mass- and volume-based meters, play a crucial role in gas operations. The use of flow meters helps simplify the process of balancing and tracking gas flows at CNG stations. The shift to thermal and mass flow meters in compressors is necessary to increase the efficiency and accuracy of gas meters.

Smart meters have proven to be crucial for increasing the accuracy of readings, leading to precise billing and improved leak detection. To shift to a customer-led approach, consumers must be able to access real-time data on their consumption, which can help them manage their usage more precisely, reduce the hassle of manual readings, and provide convenient billing methods. Technologies such as smart meters provide enhanced two-way communication and help better implement calibration strategies.

Major CGD operators in India are investing heavily in new technologies, primarily for cost-effectiveness in the value chain, enhanced safety, and better operational monitoring.

Pipeline Monitoring and Maintenance:

Leak Detection Systems: Installing leak detection systems along a pipeline helps maintain the integrity of the gas distribution system by limiting environmental damage and preventing accidents. They help detect leaks in the system and alert operators to potential safety hazards. Robotic wireless in-pipe leak detection systems are gaining more attention than traditional detection systems. This robotic system comprises a robot equipped with various types of sensors to inspect pipelines for leaks, navigate to the spot, and repair the pipeline infrastructure. Acoustic sensors identify the location of a leak by detecting high-frequency sound waves generated by the escaping gas. Similarly, optical sensors use the principle of light transmission to detect changes in gas composition, indicating leaks. The high sensitivity of these sensors helps accurately identify the spot and enables rapid response.

Intelligent Pigging: Intelligent pigging is a crucial technology used in the CGD sector for pipeline inspection and maintenance. This technology helps assess the internal condition of the pipeline by providing real-time data on corrosion, metal loss, dents, or any other anomalies in the pipeline. With the early detection of such issues, operational efficiency increases and the safety of the gas distribution network is significantly enhanced, reducing the risk of leaks, accidents, and service disruptions.

Digital Transformation:

Information Technology and Operational Technology (IT-OT) Convergence: Another major technological transformation in the CGD sector is possible through IT-OT convergence. Using OT software data generated from the CGD network, the IT-OT convergence enables CGD companies to make faster decisions. IT systems can then be used to analyse these data in real-time. IT-OT convergence will benefit CGD operators in reaching faster decisions through the integration of automation in the process , reducing human dependency which reduces the margin of human error and simultaneously leads to significant value creation.

For example, to deploy 5,000 smart gas meters in Mumbai, **Mahanagar Gas Limited (MGL)** collaborated with technology provider to use an extremely low-power, long-range wide area (LoRaWAN) network. With the implementation of such technology, MGL will be able to simultaneously monitor thousands of smart meters. Another example of the use of technology is by GAIL India Limited which uses drone technology for areal monitoring of the Hazira-Vijaipur-Jagdishpur gas pipeline to check for any physical irregularities, encroachments, or incursions.

Cloud computing: Cloud computing has the potential to dramatically change the CGD sector by offering significant benefits, such as improved operational efficiency through automation, real-time network oversight, advanced data analytics, and better compliance management. This technology transforms data into a crucial asset for strategic planning and decision-making, rather than just a secondary product.

For a cloud-based CGD solution to be effective, it should feature key components designed to meet industry challenges:

Immediate Data Retrieval and Mobile Access: Accessing operational data instantly from any location via mobile applications allows for quick and accurate decision-making.

Adaptive Infrastructure: The system should be designed to scale and adapt as operations grow.

Intelligent Data Analytics: AI can process large datasets to provide actionable insights that enhance strategic planning.

Process Automation: Automating routine tasks can reduce human error and increase operational efficiency.

Enhanced Security Measures: Protecting sensitive operational and customer data is essential.

Gas Management Systems (GMS): Current NGPL networks are facing several challenges, such as the independent collection of data and lack of real-time monitoring, leading to errors and inefficient management of gas flow. Delays in identifying leaks is another major challenge which can lead to hazardous situations involving uncontrolled pressure, resulting in pipeline ruptures and accidents. This would also lead to significant gas loss, billing errors, and shortfalls in revenue.

The implementation of GMS will facilitate the generation of accurate data using automated sensors and real-time monitoring, resulting in improved gas flow visibility. GMS would also help detect leaks in advance and regulate pressure to enhance safety and prevent accidents. Data analytics can facilitate predictive maintenance which enables the early detection of issues and efficient planning. Overall, GMS would be helpful in managing the quality of gas while ensuring a reliable supply and automated collection of data for standardisation in reporting, while aiding regulatory compliance.

Machine learning (ML) and AI: ML/AI offer transformative possibilities for the CGD sector, particularly in predictive maintenance, demand forecasting, and anomaly detection. Key applications include the following:

- ML models analyse historical equipment performance data, such as pressure and temperature, to predict failures or maintenance requirements before they occur. This proactive approach minimises downtime and extends the lifespan of the equipment.
- Algorithms can accurately predict gas demand by analysing historical consumption data, weather patterns, and other relevant factors. This helps optimise the supply chain, storage capacity, and delivery schedules for efficient and cost-effective distribution.
- ML/AI systems can continuously monitor sensor data to detect and locate gas leaks in real-time. This enables rapid response and repair, reduces safety risks, and minimises gas loss.
- Real-time data on gas supply, demand, and weather conditions can be analysed to optimise pipeline operations, reduce energy consumption, and improve safety and efficiency.
- By establishing normal operational patterns, ML/AI algorithms can flag deviations, helping to identify potential equipment failures, inefficiencies, or abnormal consumption patterns for proactive maintenance and improvement.
- ML/AI can predict the remaining useful life of equipment by analysing sensor data and maintenance records, enabling better planning of maintenance activities and prioritisation of replacements.

Energy Consumption Optimization: ML/AI models analyse energy consumption data to suggest optimisation strategies, such as adjusting setpoints and schedules or identifying inefficient equipment, to improve energy efficiency and reduce costs.

Vehicle and Transportation Optimization: ML/AI models can optimise the use of mobile cascades for gas transportation from mother to daughter stations by analysing data from flow meters, weather conditions, and logistics systems.

Smart and Automatic Meter Reading Systems:

Over the years, smart meters have gained traction in the country. With the advancement of SCADA technology, companies are investing in smart meters and advanced metering systems which exclusively improve the billing process and enhance leak detection.

With the installation of smart meters, the process of obtaining accurate readings has become a matter of ease for CGD operators nationwide.

Prepaid smart gas meters are emerging as a prominent trend in the CGD industry. These meters have a built-in valve and a prepaid processor that uses LoRaWAN to connect to a central server and wireless communication to connect to a local or wide area network in addition to measuring gas usage. This enables automated billing and remote monitoring.

Companies such as **Gujarat Gas Limited (GGL)** have integrated automated metering initiatives for residences in GIFT city. Smart meters increase the accuracy and transparency of billing. GGL has successfully installed 1000 smart meters in the first phase of their project and aims to reach approximately 200,000 houses in the next five to seven years.

Benefits of Advanced Technologies in CGD

Advanced technologies are transforming CGD systems, enhancing operational efficiency, and leading to more intelligent and resilient urban energy infrastructures. Improved distribution, pressure control, and gas flow management are made possible by these smart technologies and automated control systems which, in turn, result in the efficient use of resources and reduced operating expenses.

Gas distribution networks can be efficiently planned, designed, and maintained using GIS and advanced mapping tools which facilitate efficient asset management. Furthermore, the incorporation of advanced analytics can predict maintenance requirements, allowing for timely repairs, reducing downtime, and increasing the lifespan of assets. Advanced leak detection technologies and real-time monitoring aid in the swift identification and resolution of leaks and faults in gas distribution systems. This reduces the risk of accidents and ensures a safer distribution network. Additionally, smart metering and online billing can provide customers with more accurate billing and convenient access to services, thereby increasing customer satisfaction.





Challenges in CGD Sector

Over the next decade, the CGD sector is poised for significant investments and activities. However, the extensive task of developing a nationwide distribution network must be undertaken with a focus on safety standards and the profitability of the investing companies.

Pricing Method:

Pricing is a major challenge for the CGD sector. Despite the continuous increase in international natural gas prices, India still imports approximately 48% of its natural gas requirements.[23] Maintaining a stable gas supply at reasonable prices is crucial given the price-sensitive nature of the Indian market. The APM determines gas prices based on a set formula, with the CGD segment prioritising gas allocation, followed by the fertiliser and power sectors. As the CGD sector expands, the allocation to the power sector will likely decrease, further complicating supply dynamics. Currently, most domestically produced gas is capped and priced lower. However, increasing the availability of this gas in the CGD sector poses a challenge. Additionally, power companies with multiple supply sources tend to choose the cheapest energy source, complicating the pricing landscape. Ensuring stable gas prices for end customers with fixed tariffs necessitates long-term international contracts and greater investments in enhancing domestic production.

Safety Standards:

Supervision of safety standards involves multiple agencies, leading to regulatory complexities. Although the government has made efforts to provide cheap gas to CGD companies, there is no fixed formula or mechanism for controlling the prices at which these companies can sell PNG and CNG. This pricing freedom can lead to inconsistencies and potential exploitation. CGD companies require sufficient margins to justify the substantial investment in the sector. Furthermore, regulatory challenges include issues of exclusivity. Marketing exclusivity is granted to CGD companies for a limited period, whereas infrastructure exclusivity lasts for 25 years.[24] Although marketing exclusivity has ended in older areas, new entrants are hesitant because of additional regulatory requirements, thereby prolonging infrastructure exclusivity.

Certified Suppliers:

A significant challenge in the CGD sector iis the lack of certified suppliers of key equipment within the country. The sudden surge in demand has overwhelmed existing suppliers, who are now operating well beyond their capacity.

Gas Swapping and Financial Closure:

Concerns have been raised regarding gas swapping and the financial closure of projects. These issues complicate the financial and operational viability of CGD projects and affect their timely execution.

23 https://ppac.gov.in/download.php?file=rep_studies/1721113509_Snapshot-of-India-Oil-Gas-data-June-2024.pdf

24 https://www.pngrb.gov.in/OurRegulation/pdf/Consolidated-Regulations/GSR198.pdf



Government Support for the Sector

In 2007, PNGRB was designated as the regulator to safeguard the interests of consumers and entities involved in the gas transmission and distribution industry.

Figure 8. Formation of a regulatory board [25]

1998
SC Ruling

- Supreme Court ruling in 1998 for use of CNG
- Priority given to transport sector in gas allocation
- Attractive pricing ensured conversion

2006
PNGRB Act

- PNGRB Act introduced in March 2006
- Act regulates the downstream oil and gas business in India
- Its objective is to promote competition and protect consumers' interest

2007
Onwards

- The Government of India notified the Act (except Sec 16) and the Board in Oct 2007
- CGD regulations notified in March 2008
- PNGRB published EoIs for >60 cities in 2008

The government of India has demonstrated a resolute commitment to building CGD infrastructure. This objective has been supported by several actions, such as the **Ministry of Labour and Employment awarding the CGD network 'public utility status'** and the provision of domestic gas to the industry under the **no-cut category**. The **Ministry of Housing and Urban Affairs** has also suggested amending building regulations to include PNG at the design stage and designating land plots for CNG stations in towns and master plans. The Ministry of Defence has released guidelines for the use of PNG in residential areas. Additionally, the government is investigating methods to make gas prices more reasonable.

Tier 1 sectors entail **LPG plants, grid-connected gas-based power plants, CGD for homes and transportation, and fertilizers**, which are given priority with respect to producing domestic gas.

Currently, **90%** of the gas produced domestically is consumed by these Tier 1 industries. The remaining **10%** is then distributed as CGD for industrial and commercial customers, captive and merchant power plants, and other commercial consumers.[26] Tier 2 consumers include **steel plants, refineries, and petrochemical facilities.**

With a financial allocation of Rs 9.94 billion for FY2024–2025, the government has authorized regulations for the development of pipeline infrastructure for the introduction of CBG into the CGD network. Significant focus has been placed on expanding CGD networks nationwide with the aim of covering 407 districts and potentially providing gas access to over 70% of the population. These distribution networks will facilitate the supply of cleaner cooking fuel, such as PNG, to households and industrial and commercial units, and CNG for vehicles. [27]

Gas penetration in the eastern and southern regions of India is limited because of their distance from terminals on the west coast, which incur higher tariffs. To address these issues of lower capacity utilisation and skewed industrial development, the government has implemented a uniform pipeline tariff system. Under this, the overall capital and operating expenditure are pooled and distributed over the pooled volume of the interconnected pipeline system. This allows facilitates doing away with large variation in tariffs between different natural gas pipelines and encourages more customers to shift to natural gas.

25 https://mopng.gov.in/en

26 https://ppac.gov.in/uploads/rep_studies/1689760261_PPAC_READY%20RECKONER-FY2022-23_web_compressed-compressed-min_compressed.pdf

27 https://ppac.gov.in/uploads/rep_studies/1689760261_PPAC_READY%20RECKONER-FY2022-23_web_compressed-compressed-min_compressed.pdf

Way forward

Natural gas consumption in the CGD sector is forecasted to increase by the end of the decade, surging from its current levels to a significantly higher range. This notable increase in demand will be driven predominantly by the expansion of the commercial, industrial, and residential segments. There is a need for policy and infrastructural reforms by various stakeholders in this sector.

Here is the proposed strategy roadmap for the same:

CGD Companies

There is a need to shift from supply-to customer-led strategies to better meet market demands, enhance client satisfaction, and build loyalty.

Preparing for the evolving market landscape, including the rise of EVs and other alternative energy sources, can help companies cater to the demand fluctuations that may arise in the coming years.

Government and Regulators

Developing and implementing a consistent and unified regulatory strategy to streamline sector operations could help cater to both existing and new companies in the CGD sector.

There is a need for substantial investments in the CGD sector to support capacity enhancement, technology adoption, and upcoming infrastructure development.

Implementing strategic measures to tackle issues such as skilled personnel shortages, slow approval processes, volatile gas prices, and underdeveloped vendor networks can help build trust among companies and suppliers and smoothen the process.

Technology Companies

An increased focus on developing and offering advanced technologies, such as smart meters and GIS mapping, supports the enhancement of the CGD infrastructure and the overall customer experience.

Collaboration with various CGD companies to integrate cutting-edge solutions to improve efficiency and safety standards is essential .

Financial Institutions and Investors

Financial institutions and investors must identify and invest in promising projects in the CGD sector to support its growth.

They must develop strategies to mitigate the risks associated with volatile gas prices and other fast-changing market dynamics.

Further, they must prioritise investments in areas that offer high returns, such as infrastructure expansion and technology upgrades in areas such as SCADA technology, cloud computing, ML and AI.

As India works towards achieving its net zero targets and reducing the dependence on traditional fuel sources, it is crucial to ensure that all upcoming initiatives and investments are aligned to the 17 sustainable development goals set by the UN.

Conclusion

The CGD sector is pivotal for India's energy transition, offering a more efficient and cleaner alternative to traditional fossil fuels. By expanding its CGD network, the country aims to reduce emissions, enhance energy security and drive economic development. Significant progress in infrastructure, technology and market dynamics has been made possible through the government's ambitious plans and substantial investments.

Technological innovations such as SCADA systems, IT-OT integration and smart metering, which collectively enhances operational efficiency and customer satisfaction, are foundational to the sector's growth. However, this journey is not without challenges. Issues related to supply chains, infrastructure limitations and regulatory hurdles must be addressed to sustain the sector's momentum.

Government incentives and policies are crucial to mitigate these challenges and foster a growth-friendly environment. The focus on developing CGD utilisation and expanding the pipeline infrastructure underscores the commitment to a clean and equitable energy future.

Ultimately, the evolution of the CGD sector is critical for India to meet its net zero commitments and transition to a gas-based economy. Collaboration among industry stakeholders, policymakers and technology providers is essential for overcoming current challenges and ensuring the sector's continued success and growth. Through these coordinated efforts, the CGD sector can contribute significantly to India's future prosperity, sustainability, and environmental conservation efforts. Increasing public awareness of the benefits of natural gas and the safety measures in place can boost acceptance rates and reduce resistance, facilitating the smoother implementation of CGD programmes.

The expansion of the CGD industry is vital for India to realise its gas-based economy and fulfil its climate action promises. Policymakers, technology providers and industry participants must join forces to address existing challenges and ensure the sector's ongoing success and development.

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Established in 1927, FICCI is the largest and oldest apex business organisation in India. Its history is closely interwoven with India's struggle for independence, its industrialisation, and its emergence as one of the most rapidly growing global economies.

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Data Classification: DC0 (Public)

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