Sustainable Development through Natural Gas Network Development in India

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Abstract
Natural gas has been gaining popularity as a fuel for the next century across the globe. The Indian government has been pushing to boost the natural gas share in the energy mix to 15% by 2030. City Gas Distribution (CGD) plays a crucial role in meeting the set target as the Indian government has given it a tag of priority sector. The Indian Government has been aggressively expanding the CGD footprints across India by conducting the bidding rounds for new Geographical Areas (GAs). This paper provides a comprehensive review of city gas distribution and delivers insights on developing a sustainable natural gas business in India.

Keywords: Natural Gas, City Gas Distribution, Geographical Areas (GAs), Pipeline Infrastructure, Sustainable Development

Nomenclature

Abbreviation

CGD City Gas Distribution
GAs Geographical Areas
LNG Liquefied Natural Gas
TCM Trillion Cubic Meter
ONGC Oil and Natural Gas Corporation
GGCL Gujarat Gas Company Limited
GoI Government of India
AGL Adani Gas Limited
CUGL Central Uttar Pradesh Gas Limited
PNGRB Petroleum and Natural Gas Regulatory Board
MoPNG Ministry of Petroleum & Natural Gas
SCADA Supervisory Control and Data Acquisition
DGH Directorate General of Hydrocarbon
NELP New Exploration and Licensing Policy
CBM Coal Bed Methane

1. Introduction

In the current scenario, where the countries are facing a challenge to maintain the air quality amid the midst of growing energy consumption, natural gas has been accepted as the preferred fuel for the twenty-first century. For a country like India, having a billion plus population and positive macroeconomic development sentiments, ensuring energy security and ecological sustainability holds paramount importance. In such scenario, the part of natural gas in forming the country's energy future accept most extreme significance [1].

In India, natural gas contributes around 6% of the total primary energy mix compared to the global average of 24% as shown in figure 1 [2]. The natural gas share in energy mix rose to the maximum in 2010 with around 10.6% contribution in the total energy mix.

However, its share has been falling since then because of decline in domestic gas production and surge in imported LNG prices until 2015. The natural gas consumption surged to 50 BCM in 2016 after five years of continuous decline on the back of increased sales to City Gas Distribution sector [3]. India's natural gas demand-supply gap has been widening which in turn growing the country's reliance on imports in the
form of Liquefied Natural Gas (LNG), making it the fourth largest LNG importer (Figure 2). The current Indian government is focusing on boosting the share of natural gas in Indian energy basket and is seeking ways to augment the natural gas availability as well as to create additional demand for natural gas.

The country plans to reduce its import dependence on crude oil by 10% from the current level by 2022. The country quest to promote natural gas will help in meeting the commitment made at the Paris Climate Summit, which aims to reduce the country’s carbon emission by up to 35% from 2005 levels by 2030 [3]. To make India a gas-based economy, the Government has taken the following initiatives [4]:

- Development of natural gas resources through either domestic upstream activities or developing new facilities to import natural gas in the form of LNG.
- Expansion of natural gas pipeline infrastructure and secondary distribution network.
- Increase natural gas share in key consuming markets like fertilizer, power, transport, and industries etc.

In this paper, we will focus on the role of City Gas Distribution in meeting the second initiative (development of Gas Pipeline Infrastructure and Secondary distribution network)

2. Natural gas history

Human being knows natural gas since ages but its commercial uses are relatively recent. The first instance of natural gas usage was in 1000 B.C., in the form of famous Oracle at Delphi on Mount Parnassus in ancient Greece. The Chinese used natural gas by building the pipeline from crude bamboo for transporting gas that seeped to the surface in 500 B.C. The first commercial use of natural gas took place in Britain in 1785, where natural gas produced from coal was used to lighthouses and streets. In 1821, William Hart, also known as the father of natural gas, drilled the first successful natural gas well in the U.S. in Fredonia, New York. Eventually, the Fredonia Gas Light Company became the first American natural gas distribution company in 1858. During the 19th century, the use of gas was restricted for lighting purpose only. However, with the advent of effective pipelines, use of natural gas was expanded to other fields as well such as heating, cooking, manufacturing, processing and electricity generation [5].

Natural gas has been gaining acceptance globally as a fuel of Twenty-First century because of low carbon footprints. The natural gas industry is growing globally as demand expands and technology development allows newer ways of customizing products and services. Expansion of pipeline networks and LNG tanker fleets are rapidly linking the demand markets (previously isolated by geography) with the supply centers. The world natural gas reserves stand at 193.5 Trillion Cubic Meter (TCM) with 52.6 reserves to production ration in 2017. The reserve size grew at a CAGR of 1.9% during the 2007-2017 period. The natural gas production grew at CAGR of 2.5% from 2.9 TCM in 2007 to 3.7TCM in 2017. The US is the largest producer of natural gas with a 20% contribution to total global production followed by Russia with over 17% share. Similarly, the natural gas consumption grew at CAGR of 2.5% from 2.9 TCM in 2007 to 3.6 TCM in 2017. The demand-supply trends indicate that gas market dominated by 10 countries producing around 68% of global natural gas [6].

Driven by favorable policies to promote natural gas, its consumption in the global transport sector has been growing by 4.4% per year since 2010. This growth is led by China because of the policy initiatives introduced. The country has the largest number of CNG stations (8,400) in the world with 27% contribution [7]. Moreover, natural gas consumption is expected to grow by 2% per year through 2035 and will surpass coal as the second pillar of the global energy mix by 2035 [8]. Notably, natural gas is still not considered as a global commodity as its trade is limited to certain geographies and its usage varies across the countries. As per our research, natural gas markets can be categorized into four slots based on the consumption, pricing affordability, gas availability and gas distribution pipeline network. Figure 3 provides insights on the structure of the different markets.
Driven by the momentum gathered by the CGD industry, the Indian government set up the Petroleum and Natural Gas Regulatory Board (PNGRB) under the PNGRB Act, 2006 implemented on October 1, 2007, to regulate the CGD business. This Act gives a lawful system to the improvement of natural gas pipelines and city or neighborhood gas conveyance arranges in the nation. After the commencement of PNGRB, multiple CGD licensing rounds were conducted to expand the operation the CGD network across pan-India.

### 3. CGD evolution in India

Indian gas distribution market is in growing stage and its footprints of CGD business are very old. Gas distribution in India began in 1857 when Calcutta Gas Company and Bombay Gas Company were started operating under Jt. stock Co-Act 1857 in Calcutta and Mumbai, respectively. The primary input for the supply was coal gas. Subsequently, the industry remained subdued until Assam Gas and Oil and Natural Gas Corporation (ONGC) entered the business in the 1980s. The sector received much-needed boost after the establishment of Gujarat Gas Company Limited (GGCL) and allocation of natural gas to it by the Government of India (GoI). In the early 1990s, the Indian Supreme court directed GAIL to develop CGD network in Delhi, Mumbai, and Baroda. In line with the verdict, CNG was introduced in all the three cities in 1993. In 1995, GAIL formed a JV with BG and Government of Maharashtra to introduce CGD in Mumbai. The name of the registered company was Mahanagar Gas Ltd. Following the line, GAIL formed a JV with BPCL in Delhi to create Indraprashtha Gas Ltd in 1998. The commercial success of these ventures along with the improving natural gas supply provided the much-needed impetus to the India CGD industry by drawing a number of new entrants. A brief look of natural gas as fuel in India is provided in Figure 4.

Currently, the CGD network in India is spread across 90 GAs, which are operated by 36 companies, with over 43 million domestic consumers and 3.1 million CNG vehicles. The five major companies – GGL, IGL, MGL, Adani Gas Limited (AGL) and Central Uttar Pradesh Gas Limited (CUGL) – together holds around 87.6% of the total customer base) and accounts for more than 82% of the gas distribution pipeline network.

### 3.1 City Gas Distribution in India

The CGD network represents the last-mile-connectivity in the natural gas value chain and consists of pipelines network across the landscape of the selected area, covering small industrial to commercial and residential consumers [9]. The basic differentiation between the industry distribution and the industries, which come under the purview of CGD, is the quantity of gas supply. The CGD player can supply gas upto 50,000 standard cubic meter (scm) per day to industrial consumer whereas in case of the industry it may be higher. The CGD segment has witnessed mixed progress in the past few years. Despite the network expansion and awarding fresh licenses at a faster pace, the response has remained lukewarm because of several changes in the bidding parameters. The details of CGD infrastructure operating in India are provided in Table 1.

Indian CGD sector has increased its share in the gas portfolio from less than 5% to about 15% in 2017 [10]. The existing pipeline distribution network increased substantially to 47,000 KM in FY 17 from 26,725 KM in FY12 at a CAGR of about 12% [11]. The total sales during the FY17 were 22 MMSMD. Driven by the CGD expansion in the country, the CNG stations has increased to 1,233 in FY17 from 779 in FY12 at a CAGR of 9.6% [11]. In terms of CNG stations, Delhi leads with 421 stations, followed by Gujarat (396 stations) and Maharashtra (245 stations). In terms of CNG vehicles, Gujarat leads the list with 1,094,973 vehicles, followed by Delhi (939,475) and Maharashtra (685,883) [11]. Together these three accounts for around 86% of the total CNG stations and 89% of the CNG customers in the country.

#### Table 1 Status of CGD infrastructure in India

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Details</th>
</tr>
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<tbody>
<tr>
<td>Number of GAs</td>
<td>90</td>
</tr>
<tr>
<td>States covered</td>
<td>18</td>
</tr>
<tr>
<td>Number of CGD entities</td>
<td>31</td>
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</tbody>
</table>
Pipeline network (KM) | 16,770
---|---
CNG stations | 1,424
CNG Vehicles served (In Millions) | 3.1
PNG Connections (In Millions) | 4.3
Total Gas Sales in FY18 | 24 MMSCMD

### 3.2 CGD Demand Drivers in India

In India, the CGD sectors received a much need push from the government since the turn of the century. The major drivers are diversification in the energy mix, increasing awareness towards clean energy, priority sector status for domestic gas, low pricing against substitute fuels and untapped business opportunities in the downstream gas market. Figure 5 highlights the drivers on for the different CGD segments.

![Figure 5 Drivers for CGD business](image)

### 3.3 CGD Bidding Round for License Distribution

In order to develop a conducive regulatory environment for CGD network in the country, Indian government through Ministry of Petroleum & Natural Gas (MoPNG) constituted the Petroleum & Natural Gas Regulatory Board (PNGRB) in 2007 under the PNGRB Act 2006. The development of CGD network is taking place in a phased manner by conducting bidding rounds. Until now, PNGRB has completed eight bidding rounds where 91 Geographic Areas (GA) have been put forward for CGD implementation. Of these, 56 GAs were awarded through the bidding rounds and rest were on government nomination [12]. Under the ongoing 9th Bidding round, the government has rolled out City Gas networks in another 86 GAs covering 174 districts. After this round, CGD coverage in India will cover nearly 50% of the total 640 districts and about 50% (INR 610 Million) of the population of the country [13]. The planned expansion of CGD networks is likely to generate direct employment opportunity to about 60,000 people and will have a total investment of around INR2100 billion in the next 5 years [12].

### 4. Indian Natural Gas Industry Analysis

Natural gas business holds huge potential globally with opportunities and challenges. The scenario not different from the indian market. Therefore, the in-depth analysis of indian natural gas industry is imperative for devising a suitable strategy for attaining the target of having 15% share of natural gas in total energy mix by 2030 [14]. The strategy should ensure the expansion of distribution network, consumer growth and ensuring sustainable growth. Moreover, the profitability of any company is relative to the overall profitability of the industry and to develop a profitable competitive strategy the company should understand the overall competitive strategy of the industry. For this, the strategists of the corporate sector suggest the porter five forces analysis. Through this, the firm gains the insight about the industry and is able to sustain high rates of return [15].

**Barriers for New Entrants (LOW):** This refers to the force of entrance of potential new competitors in the industry, which can attack the profits of the existing players of the market. In CGD industry, it is quite low as the number of companies is less and industry is in the growing stage. There are many reasons, firstly, capital required to establish a CGD company is not as huge as other segments of oil and gas business. General costs like laying pipelines, labor cost, research cost, material, energy cost, and other costs (regulatory) are there for new entrants in the industry. Secondly, now it is easy to gain access to the channels for distribution in the CGD industry because of competitive bidding. The third and major point for the new entrants in the industry is the government policies that are now transparent and favors every bidder equally.

**Bargaining Power of Buyers (MODERATE):** Without potential buyers, an industry stands nowhere, buyers have a strong influence on the profitability of the industry as they can bring down the prices or demand more services or they may ask for improved quality by negotiating and bargaining among the competitors. For the CGD industry, the prices are set at the national level based on the demand and supply of gas. Gas is usually traded between the two parties over the counter but at a global price. In the case of CGD industry, the willingness to spend on getting a connection is the only power the customer or buyer possess. The buyers of such organizations are usually residential citizens, fertilizers, power generating companies, hotels, etc.

**Bargaining Power of Suppliers (HIGH):** Suppliers can also erode the industry’s returns by increasing the prices or decreasing the quality of the product or
services. Cgd firms have only one network of gas supplier gail and other which include suppliers of equipment, material, engineering, pipeline installation etc. Since, there is only one supplier of gas so they possess a significant high bargaining power, as the dependency on gas requirement is high as it is fulfilled by only one company throughout the nation.

**Threats of Substitute (HIGH):** The substitute or alternative of service or product limits the profit of the other organizations and decreases their value (Brown, pg. 498). In India, the substitute of CGD service is different in a different segment.

- For PNG the substitutes are LPG, Solar, Induction Utensils, wood, etc.,
- For commercial (hotels, restaurants, etc) the substitutes are LPG, diesel, coal, wood, etc.
- For industrial (cement plant, steel plant, power plant, etc) the substitutes are coal, pet coke, furnace oil, diesel, etc.

**Rivalry Among Players in the Industry (HIGH):** Rivalry occurs in all industries. It occurs when companies try to excel or gain an opportunity to make their position strong in society. There are few factors that determine the level of rivalry in an industry. For example, in the cgd industry, the competitive environment is defined as few strong players with large market share (igl, mgl, agl, cugl, etc and many small players with low market shares and power. Other factors adding to rivalry among the competitors in the industry include the number of connections, the span of a distribution network and high fixed and storage cost.

5. **Indian Business Environment Analysis**

Energy security is imperative all the countries witnessing a sustainable economic growth. Fossil fuels are the major sources of energy, constituting around 85% of global primary energy mix. Driven by the heavy demand for fossil fuels (coal, crude oil & natural gas), these products have become a global commodity and getting traded on various exchanges. Therefore, the global factors demand, supply, price, substitute fuels, regulations, and geopolitics influence the global trade of natural gas. In addition to global factors, domestic factors (energy policy, upstream policy, taxes, subsidies, government stability etc.) To affect the natural gas market development in any country, especially in India. In order to assess the possibility of developing the gas market in India, PESTEL analysis could be the vital tool.

**Political:** Political environment has a huge influence on the business environment. Political stability enables the government to take quick decisions and ensure time-bound implementation. Since the change of government in 2014, the Indian government has taken various initiatives to support a natural gas industry such as new gas pricing mechanism, the introduction of Hydrocarbon Exploration Licensing Policy (HELP), domestic gas re-allocation, and deregulation of diesel price. Moreover, the current government has been aggressively pushing to increase the share of natural gas in the country’s energy mix by expanding the CGD gas distribution network and implementing environmental norms to meet the targets set under Paris climate summit.

**Economic:** India has been strengthening his presence in the global economy and is expected to be among the top three economic powers over the next 10-15 years. The country’s GDP is expected to grow by 7.3% in FY19 [16]. Driven by the sustained economic growth and favorable policy initiatives, India’s natural gas demand is projected to reach 138 BCM by 2040 [8].

**Social:** India has been facing consequences of economic growth and growing urbanization since the turn of the century. The toxic air level raised to such a level in the national capital region of the country that its forced the state government to implement odd-even road rationing scheme. Under the scheme, cars with odd and even license plates were allowed to run on alternate days in order to bring down air pollution level [17]. Driven by such incidences, the awareness for adopting green energy has increased in the country. The industrial and commercial consumers are willingly opting for green energy and promoting the use of green energy under their CSR initiatives.

**Technological:** Technology advancement plays a crucial role in promoting natural gas as a preferred fuel. Introduction of fracking technology has changed the natural gas industry landscape in the US. The country has witnessed surged in natural gas production from shale resources and has influenced other countries to follow its success story. In the Indian case, availability of commercial technology at an affordable cost can help in boosting domestic gas production from unconventional sources such as gas hydrates and shale gas. In downstream, technological development in technology (L-CNG, LNG based engines, cashless billing) has enabled CGD companies in expanding CNG retail operations, customer satisfaction and boost sales. Automation systems such as Supervisory Control and Data Acquisition (SCADA) has enhanced the safety measures in the natural gas midstream operations.

**Environment:** India is the third largest emitting country in the world. The country has ratified the Paris climate agreement in 2015, which require the member countries to reduce carbon emissions to keep the global average temperature from rising above 1.5°C [18]. Under the agreement, India has committed to reducing its carbon emissions intensity by 33-35% from 2005 by 2030 [19]. Moreover, the country has
replaced Clean Environment Cess at the rate of INR400 for every tonne of coal with GST Compensation Cess at the rate of INR400 per tonne of coal. However, previously VAT/CST was levied on Clean Environment Cess but no such taxes are charged on GST Compensation Cess [20].

- **Legal:** The natural gas downstream operations in India are governed under the Petroleum and Natural Gas Regulatory Board (PNGRB) Act, 2006. The PNGRB regulate the refining, processing, storage, transportation, distribution, marketing and retail of petroleum products and natural gas (excluding the upstream business). The Directorate General of Hydrocarbon (DGH), a nodal agency set up by the Indian Government for implementation of upstream policies such as New Exploration and Licensing Policy (NELP), HELP and Coal Bed Methane (CBM) policy [21]. Since 2014, the Indian government has introduced reforms (uniform licensing, marketing and pricing freedom, open acreage licensing policy and revenue sharing model) in petroleum sector to provide level playing field to both public and private players.

6. **Challenges Associated With Indian CGD Industry**

Despite Indian government push to increase natural gas share in the primary energy mix, the country still stands among the countries with the lowest per capita gas consumption. In order to make the natural gas a preferred fuel in India, CGD network expansion is the must. However, sector growth is restricted by certain challenges.

- **Inadequate pipeline infrastructure:** Lack of pan-India pipeline grid, a congested city with high population density, stakeholder activism and a necessity to securing approval from multiple agencies for the right of way (RoW) affects the CGD network expansion plan in a big way.
- **Regulatory approvals and state administration support:** Procedural delays in securing necessary clearances lead to project delay and cost overrun. Moreover, State Governments along with district level administration have a crucial role in obtaining statutory approvals from various agencies, for e.g., clearances for setting up CNG station, conversion of public transport to CNG, switching from coal to natural gas etc.
- **Gas availability and pricing:** Despite implementing the new mechanism for domestic gas allocation, gas demand from industrial and commercial sector is meeting through the import of costlier RLNG. Conversion to gas and subsequent volume growth depends on the cost economics and affordable gas supply.
- **Sizeable capital investment and scale of operations:** A typical CGD network costs around INR 250-300 crore [22]. Generally, the service volume of such network is around 1.5 MMSCMD. The volume growth is slow and achieving customer penetration of 50%-60% takes around 9-10 years. Thus, ensuring a long pay-back period.
- **Managing safety mandate:** Healthy, Safety and Environment (HSE) norms are must for fuel like natural gas. With CGD network expansion, it is imperative for the companies to educate consumers about the potential HSE risks.
- **External factors impact:** There are important external factors, which can impact the overall returns of the CGD entity, such as such as crude prices, regulations, and policies.
- **Quality human resources:** Given CGD industry is focusing on the expansion, therefore, having adequate personnel with prior CGD or pipeline experience is the must.

7. **Developing Sustainable Strategy for the Development of Natural Gas Market in India**

In order to achieve sustainable growth for natural gas market development, the indian government needs to continue with the reforms, maintain the pace of implementation and develop a comprehensive strategy. The strategy should address core strategic issues such as supply security, infrastructure development, gas pricing, and subsidy. Ensuring uninterrupted gas supply at an affordable price is a pre-requisite for the development of the natural gas market. The increased supply will introduce gas-to-gas competition and will help in moving towards the market-based pricing from the formula-driven pricing. However, the falling domestic gas production coupled with lack of investment in the upstream sector remains a major bottleneck in increasing the gas supply.

Furthermore, the failure in achieving any breakthrough in developing the transnational gas pipeline is also a big deterrent in the market development. Both the pipelines have been in discussion (Iran-India and TAPI) for the longest time [23]. The feasibility of these pipelines is dependent on the landing price of the natural gas and geopolitics involved [24].

In the current scenario, the LNG import is the best available option for the country. With the new supply capacity coming across the globe, the time is perfect for India to enter into a long-term contract and buy from the spot market. However, the pricing will remain a concern for the commercial viability of imported LNG. The Indian government quest to develop India as a trading hub could help in boosting gas consumption in the country. A vibrant trading hub would help in integrating the domestic market with the global gas market and will provide opportunities for financial institutions to
8. DEVELOPING SUSTAINABLE STRATEGY FOR THE DEVELOPMENT OF NATURAL GAS MARKET IN INDIA

The reforms introduced by the Indian Government has provided the required impetus to the CGD business. The rising interest in CGD bidding rounds conducted by PNGRB witnessed participation from private players, which indicates that the government has addressed major constraints. The public-private JV has emerged as the new model for CGD business in India.

The expansion of CGD network would enable the PNGRB to meet the government mandate of reaching one crore domestic connection population by 2020 and would increase CNG share in the country’s fuel mix. The increasing competition coupled with continuous vigil from the regulatory agency will make professional management of CGDs a prerequisite. The focus of CGD companies would be more on developing the market and sustainable market growth instead of winning new GAs.

However, there are still issues (such as supply security, inadequate pipeline infrastructure, lack of skilled human resources and transnational pipeline) which are plaguing the growth of the natural gas market in India. Therefore, it is imperative for policymakers along with all the stakeholders to come together and give natural gas industry the right impetus to expand its share in the primary energy mix.

Reference

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