

**CEDIGAZ Insights n° 24**  
**October 2017**

# **India's vision to a gas-based economy**

## **Drivers and Challenges**

**Sylvie Cornot-Gandolphe**



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## Contents

About the author .....	2
Executive summary .....	4
Introduction.....	6
1. A government initiative to make India a gas-based economy .....	6
Natural gas plays a limited role in the energy mix .....	6
Government vision towards a gas-based economy .....	7
Government control of the gas market.....	8
2. Gas demand by sector .....	11
Industrial sector.....	12
Fertilizers .....	13
Other industrial uses .....	14
Future gas demand by the industrial sector .....	15
CGDs .....	15
PNG connections .....	15
CNG.....	16
Future CGD demand.....	16
Power .....	17
Electricity generation and capacity .....	17
Current gas demand in the power sector .....	18
Future gas demand by the power sector .....	19
Conclusion: outlook for future gas demand.....	21
3. Main drivers and obstacles to increased gas demand .....	22
Sustainability .....	22
Security of supply considerations .....	24
Affordability.....	25
Development of gas infrastructure .....	26
A doubling of the transmission grid .....	26
LNG playing a bigger role .....	27
International gas pipelines under consideration, but no progress .....	27
Conclusion: Gas demand in India is the wild card of the global gas market.....	28
Annex 1: Gas transmission network in India .....	30
Annex 2: LNG import terminals.....	32
Annex 3: Main LNG contracts.....	33
List of Tables, Figures and Boxes.....	34
References.....	35



## Executive summary

Thanks to India's rising economy and population, the country's outlook for growth in energy demand is robust. The role of gas in the country's energy mix, however, is hard to determine. Today, India's primary energy mix is dominated by coal and oil. The role of natural gas is limited: only 6% in 2016. But the government wants to make India a gas-based economy and raise the share of natural gas in the energy mix to 15% by 2022, although the timing remains uncertain. This paper analyses gas demand trends in India by 2025-30 and draws on two reports recently published by the Oxford Institute for Energy Studies (OIES) and the Bureau of Economic Geology (BEG)/Centre for Energy Economics (CEE), University of Texas.

Gas consumption in India is driven by five sectors: fertilizer (34% of total gas demand in fiscal year 2015-16), electric power (23%), refining (11%), city gas distribution, including transport (11%), and petrochemical (8%) industries. In 2016, after five years of consecutive declines, gas consumption increased to 55 bcm, boosted by sales to city gas distribution mainly. The country faces a widening gap between indigenous gas production and demand, which is met by increasing Liquefied Natural Gas (LNG) imports. LNG imports surged by 34% over 2015 to 25 bcm in 2016, making India the fourth largest importer in the world.

The gas market is characterized by two segments: one using gas at allocated government-controlled prices and the other paying market prices for imported LNG. The first segment, which includes city gas distribution, fertilizer plants, LPG plants and grid-connected power plants, accounts for about three quarters of total gas demand. This segment mainly relies on domestic gas production, complemented by LNG imports whose prices are subsidized by the government. The fertilizer industry, which receives heavily subsidized natural gas in order to support the farmers in India, dominates this segment. Since July 2014, the top gas utilization priority has been allocated to city gas distribution for households and transport, with the aim to significantly expand city gas distribution throughout India. The second segment includes other industrial users and merchant power plants. This segment mainly relies on imported LNG. Power generation from merchant power plants is often too expensive for the almost bankrupt local state electricity distribution companies to purchase. Therefore gas-based power plants have a very low utilization rate and many are stranded assets. As government regulation, not market prices, determines gas allocation, consumption distortions occur. The government recognizes that the current gas allocation policy restricts gas market development by making it difficult to identify the 'true' gas demand.

Increasing the role of gas to 15% of India's primary energy mix would mean that annual gas consumption would increase to above 200 bcm in the future. However, based on current energy and climate policies, gas demand is expected to grow to only 70 bcm in 2020, 90 bcm in 2025 and 115 bcm in 2030. Gas mainly substitutes or complements oil products rather than coal. The industrial sector, including fertilizers, leads the growth. The role of gas in the power sector is limited to meeting peak demand and load balancing needs and the sector is not expected to drive a surge in gas demand. Rather the government relies on renewables and high-efficiency coal to meet its commitment to reduce the country's carbon emission intensity by up to 35% by 2030.

Further growth in India's gas demand depends on several factors. Due to the nascent stage of the gas market, development of gas infrastructure is the most critical enabler for transition to a gas-based economy. Because the ability of end-users to pay high prices for gas-fired power generation and for gas as feedstock is limited, increased gas demand requires continued low prices and government financial support for the fertilizer and power sectors. Increasing domestic gas production is critical and a pre-condition to increase the share of gas in the electricity mix. In light of the country's



growing import dependency, the price of imported LNG will also shape future gas demand in the country.

The government has taken several steps to enhance the availability of gas in the country, including intensification of domestic exploration and production activities, notably with the adoption of a new hydrocarbon exploration and licensing policy (HELP), liberalized gas price regime, and support to LNG imports and to the creation of a national gas grid across India. However, despite the positive steps taken to incentivize natural gas business in the country, a clear and integrated policy that defines—and clearly demarcates—the role of natural gas in India's energy mix is still missing.



## Introduction

This report analyses gas demand trends in India by 2025-30 and discusses the main drivers and obstacles for increased gas demand, including the competitiveness of gas against competing fuels. The report is based on two recent studies:

- India's Gas Market Post-COP21, by Sen Anupama, Oxford Institute for Energy Studies (OIES), June 2017 (hereafter 'OIES report')
- Current and Future Natural Gas Demand in China and India, by Miranda Wainberg, Michelle Michot Foss, Gürcan Gülen, and Daniel Quijano, Bureau of Economic Geology (BEG)/Centre for Energy Economics (CEE), University of Texas at Austin, April 2017 (hereafter 'BEG/CEE report')

OIES provides its own quantitative assessments, while BEG/CEE provides a qualitative assessment of forecasts published by the Energy Information Administration (EIA) and the International Energy Agency (IEA).

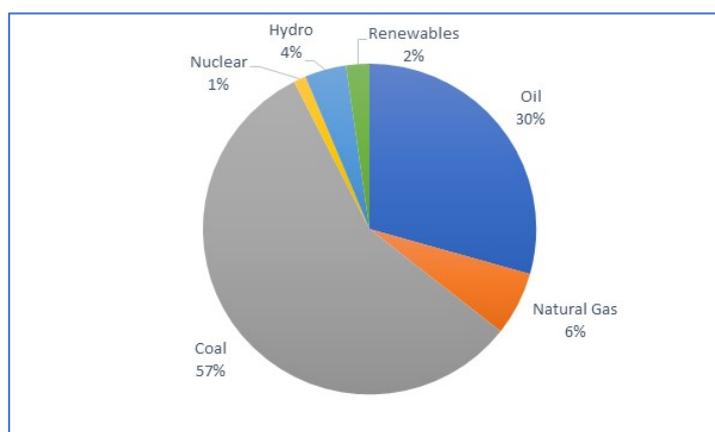
The first part of this report describes recent gas supply and demand trends in India and underlines the importance of key recent policies, such as the initiative to make India a gas-based economy, the Gas Utilization Policy (GUP) and gas pooling schemes. The second part summarizes the main outcome of the two reports on gas demand in the four main consuming sectors: fertilizers, other industries, City Gas Distribution (CGD), and the power sector. The third part assesses the main drivers and obstacles for increased gas demand in India. The conclusion gives final remarks on future gas demand trends.

## 1. A government initiative to make India a gas-based economy

### *Natural gas plays a limited role in the energy mix*

India is the third-largest energy consumer in the world after China and the United States. In 2016, the country consumed 724 million tons oil equivalent (Mtoe) of commercial energy.<sup>1</sup> India's energy mix is dominated by coal and oil, which accounted for 57% and 30% respectively of total primary energy supply (TPES) in 2016. The share of natural gas was only 6.2%.

**Figure 1: India Primary Energy Supply, 2016**



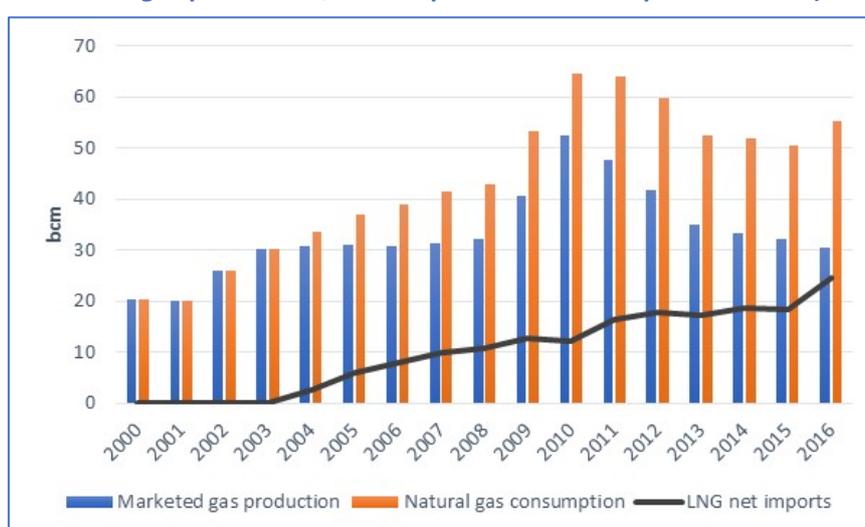
Source: BP

<sup>1</sup> BP (2017). Non-commercial energy, mainly traditional biomass, adds about 200 Mtoe per year to TPES.



**Gas consumption has declined since 2010**, when it reached 65 bcm and accounted for 10.6% of TPES. The decline in domestic gas production and the high price of LNG imports until 2015 resulted in a degree of gas demand destruction. However, **2016 could be a turning point**. Following five years of consecutive declines, gas consumption in 2016 totalled 55 bcm, an increase of 9.3% compared to 2015. The increase was mainly driven by rising city gas sales, and to a lesser extent by the power sector. Since peaking in 2010, marketed gas production has gradually dwindled as a result of declining production of mature gas fields and persistent recovery issues on the offshore Krishna Godavari (KG)-D6 block operated by Reliance Industries. Natural gas production fell by 4.5% to 30.6 bcm in 2016.<sup>2</sup> As domestic gas production continued its decline, LNG imports rose sharply, up 34% over 2015 to 24.6 bcm in 2016. They accounted for 45% of total gas supplies. **India is now the fourth largest importer of LNG in the world** and its imports are likely to grow as more LNG import terminals are built in the country (see Section 3).

*Figure 2: Natural gas production, consumption and LNG imports in India (2000-2016)*



Source: CEDIGAZ

### **Government vision towards a gas-based economy**

India's natural gas supply and demand outlook is changing. **The Government of India (GoI) wants to make India a gas-based economy** 'by boosting domestic production and buying *cheap* LNG'.<sup>3</sup> India has set a target to **raise the share of gas in its primary energy mix to 15% by 2022**, although the timing is uncertain. According to the Ministry of Petroleum and Natural Gas (MoPNG), moving to the level of 15% would mean that annual gas consumption would increase from about 50 bcm to above 200 bcm in the future.<sup>4</sup> This would require adequate availability of natural gas through domestic production as well as imports, adequate investments in pipeline, LNG import terminals and CGD infrastructure and even financial support in the form of incentives.

<sup>2</sup> CEDIGAZ (2017).

<sup>3</sup> Reuters, India to gradually move to gas-based economy, Dharmendra Pradhan says, 6 May 2016, <http://in.reuters.com/article/india-energy-economy-idINKCN0XX0PQ>

<sup>4</sup> EnergyInfraPost, India On Its Way To Become A Gas Based Economy: Dharmendra Pradhan, 6 December 2016, <https://energyinfrapost.com/india-way-become-gas-based-economy-pradhan/>



### **Box 1: Main government initiatives to promote natural gas**

To improve the share of natural gas and promote a gas-based and clean fuel economy, **the GoI has adopted a systematic approach to focus on all aspects of the gas sector:**<sup>5</sup>

- development of gas sources either through domestic gas exploration & production (E&P) activities or through building up facilities to import natural gas in the form of LNG,
- development of adequate gas pipeline infrastructure including nationwide gas grid and CGD network, and
- development of gas consuming markets including fertilizer, power, transport and industries.

Some important specific initiatives taken to enhance the domestic natural gas production, expand the gas pipelines and secondary infrastructure and develop the gas consuming markets are as under:

- 100% Foreign Direct Investment (FDI) in many segments of the hydrocarbon sector.
- Notification of a new Hydrocarbon and Exploration Licensing Policy (HELP) on 30 March 2016 (see Section 3).
- Adoption of a Discovered Small Fields (DSF) policy to offer to global investors discovered small fields of Oil and Natural Gas Corporation (ONGC) and Oil India Limited (OIL), which had not been put into production by these companies. Under the DSF policy, the government has awarded 31 contracts (23 onshore and 8 offshore) in the DSF Bid Round of 2016.
- Linkage of gas prices to the market/important hub prices under the New Domestic Natural Gas Price Guidelines of 2014 (see below).
- Marketing and pricing freedom for new gas production from Deepwater, Ultra Deepwater and High Pressure-High Temperature areas, subject to certain conditions.
- Marketing and pricing freedom for gas produced from Coal Bed Methane (CBM) fields to incentivize CBM operations in the country.
- A capital grant of 40% for development of 2,650 km-long Jagdishpur-Haldia & Bokaro-Dhamra natural gas pipeline to ensure supply of natural gas to eastern India.
- Reduction of basic customs duty on LNG from 5% to 2.5% in the 2017 federal budget to boost LNG demand in industrial and commercial sectors, especially power, petrochemical, fertilizer and CGD, and also help in reviving stranded capacity of power and fertilizers plants.
- Gas pooling mechanism for fertilizer sector to encourage utilisation of fertilizer units in the country.
- Priority for allocation of domestic gas accorded to Piped Natural Gas (PNG)/Compressed Natural Gas (CNG) segments to meet 100% of their demand and faster roll out of PNG connections and CNG stations to promote the use of natural gas in the transport sector, households and small industries.

### **Government control of the gas market**

Like many Asian emerging gas markets, India's gas market is controlled by the federal government which directs gas supplies to key strategic sectors and sets the level of gas prices and subsidies to specific customers.

<sup>5</sup> Lok Sabha, Natural gas share in energy components, Ministry of Petroleum and Natural Gas, 17 July 2017, <http://164.100.47.190/loksabhaquestions/annex/12/AU185.pdf> and Ministry of Petroleum and Natural Gas, Steps being taken to make India a Gas based economy, 21 November 2016, <http://pib.nic.in/newsite/PrintRelease.aspx?relid=153957>



### *The Gas Utilization Policy*

Due to the shortage of domestic gas supplies, **the gas market is under control of the federal government which directs domestic gas supplies to certain key sectors according to the 'Gas Utilization Policy' (GUP)**. Domestic gas production is allocated in priority to Tier 1 sectors: first, CGD for households and transport, then, the production of fertilizers, LPG plants, and finally grid-connected gas-based power plants. These Tier 1 users consume about 90% of total domestic production. All domestic gas left over (around 10%) is then released into a more general second tier of consumers, which includes: steel, refineries and petrochemical plants; then CDG for industrial and commercial consumers; captive and merchant power plants; and other consumers, feedstock and fuel.<sup>6</sup>

**Fertilizer producers had the number one priority for many years until July 2014 when they lost the top slot to CGD for households and transport.** This change reflects the Modi government's desire to significantly expand CGD throughout India. When he was governor of Gujarat state, Prime Minister Modi oversaw the establishment and expansion of very successful CGD operations which he would like to replicate nationally.<sup>7</sup>

If domestic gas supplies are not sufficient to meet 100% of Tier 1 demand and/or physical constraints impair the Tier 1 consumer's ability to take domestic gas, LNG is supplied to these customers at a subsidized price. These consumers accounted for about half of LNG imports in fiscal year (FY) 2015-16.<sup>8</sup> Tier 2 customers mostly rely on LNG imports and accounted for the other half of LNG imports in FY2015-16. Notably, gas-fired merchant power plants are supplied with LNG to produce power that is often too expensive for the almost bankrupt local state electricity distribution companies (Discoms) to purchase (see Section 2).<sup>9</sup>

**The fertilizer and power sectors are the major gas consumers in India.** They consume about 60% of total gas consumption in FY2015-16 (see Section 2). In order to develop the gas market, in March 2015, the GoI implemented a **Fertilizer Gas Pooling Scheme** which has encouraged the utilization of installed gas-based fertilizer units in the country. The Gas Pooling policy ensures the supply of gas at a uniform delivered price to all fertilizer plants on the gas grid for urea production. The policy was enacted because of uneven gas procurement prices for urea producers, where prices were contingent on whether the gas was sourced from the domestic or import market, or varying combinations of both.<sup>10</sup>

Similarly, in April 2015, the GoI adopted a **temporary subsidy scheme to facilitate the use of LNG in the power sector** and avoid gas-fired power plants to become non-performing assets. The financial mechanism envisaged importing additional spot LNG in FY2015-16 and FY2016-17 to supply these plants, so that they could generate power up to a targeted plant load factor (PLF). Exemptions from taxes and levies and reductions in transportation and regasification charges were included in the scheme to make the cost of power affordable. Financial support to Discoms was also included. The subsidy was aimed at reviving around 18 Gigawatts (GW) of idle gas-fired power capacity in an attempt to reduce India's chronic electricity supply shortages at the time.<sup>11</sup> This lifted short-term gas generation and LNG demand: LNG consumption by the power sector increased from 3 mcm/d in April 2015 (prior to the scheme) to a maximum level of 11.47 mcm/d in March 2016. But the government

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<sup>6</sup> Sen Anupama (2017).

<sup>7</sup> BEG/CEE (2017).

<sup>8</sup> Indian statistics are published in fiscal years. FY2015-16 extends from 1 April 2015 to 31 March 2016.

<sup>9</sup> BEG/CEE (2017).

<sup>10</sup> Nexant (2016).

<sup>11</sup> Sen Anupama (2017).



did not renew the subsidy in its 2017 federal budget. This may have contributed to the downturn in LNG imports by the power sector to only around 6 mcm/d in the first five months of 2017.<sup>12</sup>

**As government, not market prices, determine resource allocation, consumption distortions can occur.** The GoI recognizes that the current gas allocation policy restricts gas market development by making it difficult to identify the 'true' gas demand. The Roadmap for Reduction in Import Dependency in the Hydrocarbon Sector by 2030 recommends discontinuing the current system of gas allocation.<sup>13</sup>

#### *Regulated prices linked to international benchmarks*

Domestic gas prices are set by the federal government; LNG prices are determined by contract and spot prices. Following a major reform of gas pricing in October 2014, the price of domestically produced gas has been linked to a 12-month trailing, physical volume-weighted average of four international 'benchmark' prices: US Henry Hub, UK NBP, the Russian domestic gas price, and the Alberta reference price. The formula is adjusted biannually.<sup>14</sup> Prior to that date, the gas price paid to producers was \$4.20/million British thermal units (MBtu) from 2010 to November 2014. The Modi administration was concerned that prices were too low to spur upstream investment and has tried **to maintain a fine balance between the interest of gas producers and consuming sectors.** With the new formula, the resulting domestic gas price was \$5.05/MBtu (gross calorific value-GCV) from November 2014 to March 2015. However, benchmark prices have decreased sharply after the adoption of the reform and Indian domestic prices fell gradually to \$2.48 currently (Figure 3). The price is significantly below the cost of production of most fields and producers in India have claimed that their gas business has become unviable. State-owned ONGC, which is responsible for two thirds of national gas production, reported a loss of \$780 million in revenue on natural gas business, and about \$470 million in profit in 2016 because of cuts in gas prices.<sup>15</sup> The company is asking a floor price at least to the level of the earlier regulated price (\$4.20/MBtu). The cost of production of natural gas in the prolific Krishna Godavari basin is between \$4.99 and \$7.30/MBtu, and in a range of \$3.80 to \$6.59/MBtu in the other basins.<sup>16</sup> So far, the low prices for domestic gas have aggravated the supply-demand imbalance since they reinforce the shortage of gas by discouraging domestic production while enhancing demand for gas at artificially low prices.

Aware of the detrimental impact of low prices on upstream investments and gas production, the GoI has adopted a new **Hydrocarbon Exploration and Licensing Policy (HELP)** (see Section 3) and given pricing freedom for new gas production from Deepwater, Ultra Deepwater and High Pressure-High Temperature areas in March 2016, but has fixed a ceiling price based on alternative fuels (\$5.56 currently).

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<sup>12</sup> Petroleum Planning & Analysis Cell (PPAC), Monthly Report on Natural Gas.

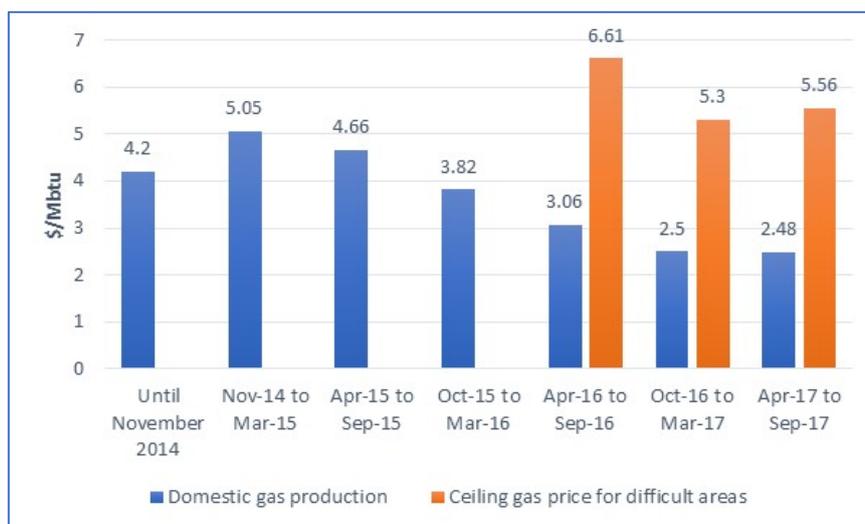
<sup>13</sup> Ministry of Petroleum and Natural Gas, Roadmap for Reduction in Import Dependency in the Hydrocarbon Sector by 2030, Government of India, September 2014, <http://www.taxindiaonline.com/RC2/pdfdocs/FinalReportKelkarCommittee2014.pdf>.

<sup>14</sup> Sen Anupama (2017).

<sup>15</sup> Press Trust of India, Natural Gas Production No Longer Profitable Business: ONGC, 27 May 2017, <http://profit.ndtv.com/news/corporates/article-natural-gas-production-no-longer-profitable-business-ongc-1704609>

<sup>16</sup> Lok Sabha, Natural Gas Production from KG Basin, Ministry of Petroleum and Natural Gas, 12 December 2016, <http://164.100.47.194/Loksabha/Questions/QResult15.aspx?qref=45035&lsno=16>

**Figure 3: Prices of domestically-produced gas**



Source: PPAC

The government does not control LNG import prices. Contract LNG prices have been around \$13-14/MBtu until the 2015 renegotiation of the Qatar RasGas - Petronet contract LNG price, which lowered the price by linking it to a three-month trailing average of Brent crude oil prices. In return for the price concession, Petronet agreed to increase contract volumes from 7.5 million tons per annum (Mtpa) to 8.5 Mtpa.<sup>17</sup> The new contract price is currently in the range of \$7-8/MBtu (first half 2017).<sup>18</sup> **Although the price competitiveness of LNG is improved, liquid fuels will continue to pose competition issues in the current oil price environment.**

## 2. Gas demand by sector

**Gas consumption in India is broadly driven by four sectors:** fertilizers (in which manufacturing and retail prices are regulated), power (in which end-user prices are regulated), city gas (in which prices are deregulated) and other industry, which comprises refineries, petrochemicals, iron and steel, and merchant/commercial consumers of gas (in which prices are deregulated).<sup>19</sup> Gas consumption is dominated by the fertilizer (34%), electric power (23%), refining (11%), CGD (11%), and petrochemical (8%) industries.

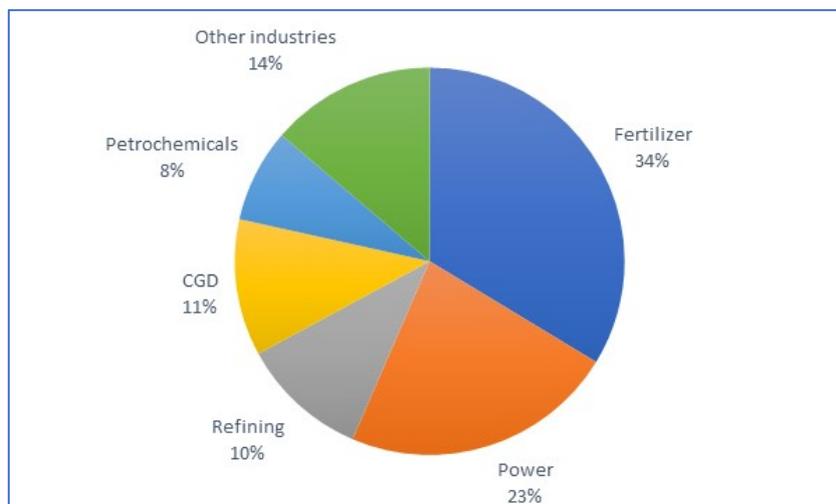
<sup>17</sup> BEG/CEE (2017).

<sup>18</sup> CEDIGAZ LNG Service

<sup>19</sup> Sen Anupama (2017).



Figure 4: Gas demand by sector in FY2015-16



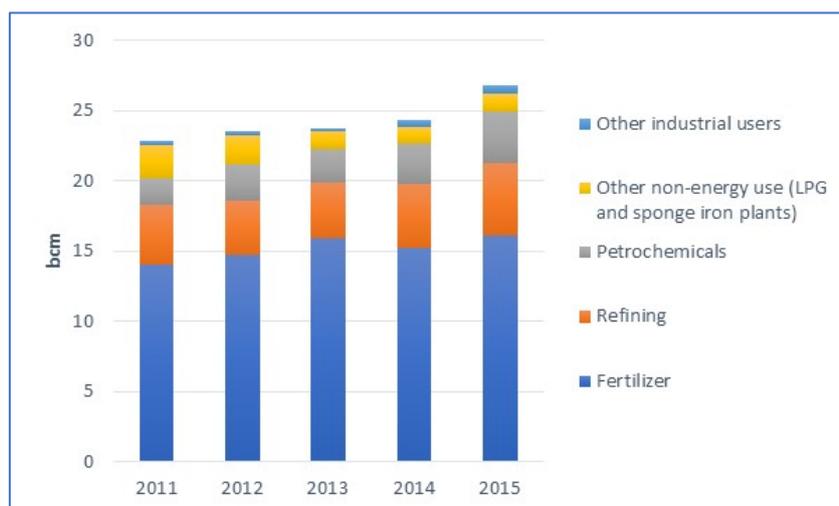
Source: Ministry of Petroleum and Natural Gas (MoPNG)

At present, **there is a strong regional imbalance regarding access to natural gas**. Few states like Gujarat, Maharashtra and Uttar Pradesh together consume more than 65% of the available gas, while a large number of states have no access to gas. This regional imbalance is mainly due to lack of pipeline infrastructure in many states like West Bengal, Bihar, Jharkhand, Odisha and Chhattisgarh.

### Industrial sector

**The largest consumer of gas is the industrial sector (including non-energy use).** With 27 bcm consumed in FY2015-16, the sector accounted for 56% of total gas use.<sup>20</sup> The fertilizer industry, which receives heavily subsidized natural gas in order to support the farmers in India, represented 60% of total industrial gas use. Refining, petrochemicals, and energy sector own use (primarily LPG shrinkage) followed at 19%, 14% and 5%, respectively, of total industrial gas use.

Figure 5: Industrial gas consumption by sector in India (2011-2015)



Source: MoPNG (fiscal years)

<sup>20</sup> Ministry of Petroleum and Natural Gas, Indian Petroleum and Natural Gas Statistics 2015-16 (IPNG Statistics 2015-16), Government of India, October 2016, <http://www.indiaenvironmentportal.org.in/files/file/pngstat%202015-16.pdf>



## Fertilizers

**The fertilizer production is an integral part of New Delhi's emphasis on food production security.** This explains why the fertilizer sector receives priority access to domestically-produced gas and subsidized prices through the 'Gas Pooling' policy of 2015. **Natural gas is the feedstock for 81% of urea capacity and gas use by urea plants increased from 14 bcm in 2011 to 16 bcm in 2015.** The gas requirements of the fertilizer industry are estimated at about 18 bcm per year, of which 11.5 bcm of domestic production has been allocated to the sector. However, due to gas shortages, the sector only gets 8 bcm per year of domestic gas, the balance is imported LNG given at pooled price. The fall in natural gas prices since the end of 2014 and the gas pooling policy have boosted gas demand to produce urea. The Gas Pooling scheme has been partly responsible for the surge in LNG imports in 2016.

**The government wants to make India self-sufficient in fertilizer production which will further boost gas demand by the sector.** India consumes about 31 Mtpa of urea (FY2015-16 estimate), of which 25 Mtpa is domestically produced (using gas or naphtha) and 6 Mtpa is imported.<sup>21</sup> Urea consumption is expected to reach 38 Mtpa by 2024.<sup>22</sup> So far, the inadequate availability of gas is one of the major limiting factors to the growth of urea industry in the country. Other factors which impeded growth in the sector are low profitability, delay in payment of subsidy and no favourable tax incentives for indigenous manufacturers. Notably, there is a huge backlog of government subsidies: the estimated unpaid fertilizer subsidy carried forward has been rising from less than \$2 billion in FY2011-12 to \$8 billion in FY2015-16.

In order to reduce India's urea import dependency, the Gol introduced a new urea policy in 2012, amended in 2015, to maximise domestic urea production and promote energy efficiency in urea units. The Gol has also taken new initiatives, such as the neem-coating of urea.<sup>23</sup> Since then, numerous projects and plans have been announced to re-open idled plants (expected incremental demand of 4 bcm per year), convert naphtha/fuel oil-based plants to gas (4.4 bcm), expand and revamp existing plants (7.8 bcm) and build new gas-based plants (6.7 bcm). All these projects would add 23 bcm per year of gas demand above the current 16 bcm.<sup>24</sup> The conversion of naphtha/fuel oil-based plants has started, but will not be completed until sufficient supply of gas either by pipeline or LNG is ensured.<sup>25</sup> In addition, in 2015 and 2016, the government approved the revival of five closed urea plants. The five plants (1.27 Mtpa each, one is coal-based) are expected to be reopened by 2020-21.<sup>26</sup> These plants will add 6.35 Mtpa of urea capacity (5.1 Mtpa based on gas), bringing Indian capacity to 31 Mtpa.

Investment in greenfield projects is more uncertain. Securing capital investment is a major hurdle and none of the dozen announced (gas and coal-based) greenfield plants have achieved financial closure so far. The backlog of unpaid fertilizer subsidy may deter private sector company investment

<sup>21</sup> BEG/CEE (2017).

<sup>22</sup> Sen Anupama (2017).

<sup>23</sup> Neem-coating increases nitrogen use efficiency. Neem oil basically acts as a 'nitrification inhibitor' when coated on urea. It therefore allows a reduction of urea consumption for the same farm production.

<sup>24</sup> BEG/CEE (2017), based on Vision 2030 (2013).

<sup>25</sup> Lok Sabha, Demand for grants 2017-18, Standing Committee on Chemicals and Fertilizers (2016-17), March 2017, [http://164.100.47.193/lssccommittee/Chemicals%20&%20Fertilizers/16\\_Chemicals\\_And\\_Fertilizers\\_31.pdf](http://164.100.47.193/lssccommittee/Chemicals%20&%20Fertilizers/16_Chemicals_And_Fertilizers_31.pdf)

<sup>26</sup> They include urea plants at Ramagundam in Telangana, Gorakhpur in Uttar Pradesh, Sindri in Jharkhand, Talcher (coal-based) in Odisha and Barauni in Bihar. The Ramagundam unit is expected to be completed by end-2018 and the four other plants are expected to start operation in 2020-21. hindustantimes.com, Cash-rich govt-run companies to revive 4 fertilizer plants, 27 April 2017, <http://www.hindustantimes.com/business-news/cash-rich-govt-run-companies-to-revive-4-fertilizer-plants/story-a4vdM59SpkI9kHfwdLNreP.html>



in the sector. Of the new projects under consideration, Chambal Fertilizers and Chemicals (CFCL) proposed gas-based ammonia-urea complex in Kota, Rajasthan, is in a fairly advanced stage.<sup>27</sup>

**Fuel switching, reopening of idle gas-based urea plants and the building of a new plant in Rajasthan could bring total urea production to 32.5 Mtpa and add about 10 bcm of incremental gas demand in the sector by 2025.** ICRA forecasts that urea sector gas demand will increase from 15 bcm in 2014 to 19, 23 and 26 bcm, respectively, in 2016, 2020 and 2025.<sup>28</sup> Based on investments announced in 2016-17, these levels of gas demand seem feasible, although with some delays. In the OIES report, a 'target case' estimates gas demand by the fertilizer industry at 24 bcm by 2024.

### Other industrial uses

The industrial sector, excluding fertilizer, is mainly composed of four main consumers: refineries, LPG plants, petrochemicals, and sponge iron and steel industries (see Figure 5).

India's **refining sector** gas use amounted to 5.08 bcm in FY2015-16. The sector has increased its gas use by less than 1 bcm over the past five years. As a Tier 2 natural gas consumer, LNG has been a significant component of the refining sector's supply estimated at about 45% in FY2012-13. In the refining sector, natural gas competes with naphtha, fuel oil and coal, and until the recent downturn in oil prices, this sector absorbed high-priced LNG imports as these were still cheaper when compared with higher priced fuel oil and naphtha.<sup>29</sup>

India has the fourth largest refining capacity in the world (4.62 mb/d) and the second largest in Asia (next to China). There are plans to expand refining capacity into the next decade. India turned from net importer to net exporter of refined products in the early 2010s. However, strong domestic demand for gasoline, diesel and LPG has led to a drop of exports, and larger amounts of refined products being diverted to the domestic market. Gasoline demand is driven by a rise in vehicle ownership, and diesel demand mainly by industrial use. Growth in LPG consumption is being driven by a programme to replace kerosene used for cooking in rural and semi-urban households with LPG.<sup>30</sup> According to BEG/CEE, **moderate gas demand growth from the sector is possible** and depends on adequate gas delivery capacity as well as the price competitiveness of gas (imported LNG) versus alternative fuels.

The **petrochemicals sector** consumed 3.73 bcm in FY2015-16 and has doubled its gas use since 2011. Growth in the petrochemicals sector is driven by growing demand from the textile, automobile and food packaging industries (polypropylene and polyethylene), and the main competing fuels to gas in this sector are naphtha, domestic coal and imported ethane.<sup>31</sup> According to BEG/CEE, it is difficult to see much near term natural gas demand growth in the sector because of the subdued level of forecast capacity additions in the Indian petrochemicals sector for the next 6-10 years (it takes at least 8 years to construct a new petrochemicals plant). There should be **moderate growth thereafter**

<sup>27</sup> Toyo Engineering has been awarded a contract to construct the large-scale fertilizer complex in Kota and CFCL has signed a gas supply agreement with GAIL. Process Worldwide, Toyo to Build Large-Scale Fertilizer Complex, 29 March 2016, <http://www.process-worldwide.com/toyo-to-build-large-scale-fertilizer-complex-a-527565/> and World Fertilizer, Chambal Fertilizers and Chemicals in supply contract with GAIL, 15 June 2017, <https://www.worldfertilizer.com/project-news/15062017/chambal-fertilizers-and-chemicals-in-supply-contract-with-gail/>

<sup>28</sup> BEG/CEE (2017), based on ICRA, Fertilizer Industry Report, Indian fertilizer sector; major policy initiatives for urea; gas pooling & comprehensive new urea policy 2015, July 2015, <http://www.icra.in/AllTypesOfReports.aspx?ReportCategory=Fertilizers>.

<sup>29</sup> BEG/CEE (2017).

<sup>30</sup> Sen Anupama (2017).

<sup>31</sup> Sen Anupama (2017).



depending on the success of improving the overall business environment in India and successful implementation of the clustering concept.<sup>32</sup>

Gas consumption in the **sponge iron and steel sector** has fallen from 1.3 bcm in FY2011-12 to 0.5 bcm in FY2015-16. Even though India was the only country amongst the world's top ten steel producers to report strong growth in steel production in 2015 and 2016, many industry observers are of the view that **future growth of gas consumption in the sponge iron and steel sector may be muted**, as the increasing use of blast furnaces for steelmaking no longer necessitates sponge iron as an input.<sup>33</sup>

In **other industrial sectors**, future gas demand relies on the success of the 'Make in India' policy, which aims at raising the manufacturing growth rate to 12–14% by 2025. Progress has been muted to date. However, if growth in manufacturing accelerates from current levels, there are **significant opportunities to increase gas demand in the non-energy intensive industries** such as textiles, food and beverages, transport equipment and electronics.

### Future gas demand by the industrial sector

If growth in manufacturing accelerates from current levels, forecasters see significant expansion of the traditional energy-intensive industries alongside continued growth in non-energy intensive industries. However, most forecasters see coal as the dominant fuel in the industrial sector. According to the IEA, coal's share of industrial total energy use will expand from 50% currently to 57% by 2040. India's environmental goals and commitments will be met with renewables rather than significant industrial fuel switching from coal to gas.

According to BEG/CEE, industrial gas demand growth will be muted due to infrastructure and supply impediments; limited duration of current low LNG import prices; limited progress in the push for manufacturing growth to date; constrained access to affordable capital for investment as well as overall impediments to industrial activity.

Altogether, **gas demand by the industrial sector, including fertilizers, could add about 20 bcm to 30 bcm of gas demand by 2025 above the 27 bcm consumed in FY2015-16. OIES target case estimates industrial gas demand at 45 bcm in 2024.**

### CGDs

**The CGD sector includes PNG customers (residential/commercial and small industrial customers) and CNG (transport).** City gas is a relatively new and expanding sector, primarily limited to urban areas. Households and the transport segment across the country are top priority customers and the GoI is meeting 100% of their gas requirement through domestically-produced gas. Guidelines in this regard have been issued in February 2014. This decision has brought down the price of CNG and PNG for households across the nation and has led to an increase in gas demand. **The CGD sector consumed 5.46 bcm in FY2015-16 and an estimated 7.31 bcm in FY2016-17.**<sup>34</sup> Gujarat state accounts for the majority of CGD customers.

### PNG connections

Gas demand in the residential sector is limited. More than 70% of Indian household energy use is for cooking and solid biomass still accounts for about 85% and 25% of rural and urban cooking fuel,

<sup>32</sup> The central government has a cluster initiative, the Petroleum, Chemicals and Petrochemical Investment Regions, and has approved four locations but only one project has made any significant progress because of "excessive interference and control by the state and failure to actively involve the private sector". BEG/CEE (2017).

<sup>33</sup> BEG/CEE (2017).

<sup>34</sup> PPAC, Monthly Report on Natural Gas.



respectively.<sup>35</sup> In urban areas, subsidized LPG is a major competitor and is displacing kerosene and biomass as a cooking fuel. This competition was eased somewhat as CGD residential customers were allocated more inexpensive domestic gas supplies, a result of their improved Tier 1 status and the LPG subsidy was discontinued for higher income customers. As a result, by December 2015, PNG was competitive with subsidized LPG and 33% cheaper than unsubsidized LPG.<sup>36</sup>

**By 2019, the GoI is planning to connect 10 million households to the PNG network. Currently 59 cities in India are covered by CGD networks, with 3.7 million customers as of March 2017.**<sup>37</sup> The Petroleum & Natural Gas Regulatory Board (PNGRB), established in 2007 under the PNGRB Act of 2006, grants authorization to gas distribution entities for developing a CGD network and natural gas pipeline infrastructure through a competitive bidding process. The PNGRB has already authorized 81 geographical areas (GAs) across the country for the development of CGD network and identified 228 GAs to be included in future bidding rounds in a phased manner depending upon the availability of natural gas and techno-commercial viability of the area.<sup>38</sup>

### CNG

CNG established its market share primarily through the enforcement of environmental legislation in the early 2000s to curb air pollution in city-wide transportation systems. CNG is now prevalent in around 11 (out of 29) Indian states, with many cities mandating its use in public transport (taxis, auto-rickshaws and buses).<sup>39</sup> Growth in this sector is severely constrained by infrastructure – there are roughly 3 million CNG vehicles but only 1,233 CNG filling stations. CNG infrastructure is also disproportionately skewed towards three states: the National Capital Territory of Delhi (421 stations), Gujarat (396 stations), and Maharashtra (245 stations).<sup>40</sup>

India's CNG consumption has been growing at about 6% per year in recent years but needs considerably more infrastructure for the sector to take off. Sales of CNG in FY2016-17 grew by 9.7% over FY2015-16.<sup>41</sup> The Indian Supreme Court gave the sector a boost when in late 2015 it mandated that all Delhi taxis must convert to CNG and registration of new diesel vehicles in the city will no longer be allowed. If similar measures are enacted in other heavily polluted cities, it would encourage sector growth.

### Future CGD demand

Gas consumption will continue to grow in the city gas sector; at the same time, this growth is strongly dependent on the extension of CGD infrastructure, which has historically been slow. There are plans to develop one hundred 'smart cities' through the expansion of city gas infrastructure to semi-urban areas.

The Energy Information Administration (EIA) forecasts 14 bcm, 25 bcm of CGD gas use respectively in 2025 and 2030.<sup>42</sup> Most of the growth occurs in the transport sector which accounts for 17 bcm of the 25 bcm in 2030. The International Energy Agency (IEA) expects more modest growth in CGD gas demand with gas use increasing to 8 bcm in 2025 and 11 bcm in 2030.<sup>43</sup> The IEA expects diesel to

<sup>35</sup> BEG/CEE (2017).

<sup>36</sup> BEG/CEE (2017).

<sup>37</sup> PPAC, Monthly Report on Natural Gas.

<sup>38</sup> Lok Sabha, Ministry of Petroleum and Gas, PNG consumption, 24 July 2017, <http://164.100.47.194/Loksabha/Questions/QResult15.aspx?qref=54400&lsno=16>

<sup>39</sup> Sen Anupama (2017).

<sup>40</sup> BEG/CEE (2017), updated with PPAC data of March 2017.

<sup>41</sup> PPAC, Monthly Report on Natural Gas.

<sup>42</sup> EIA, International Energy Outlook 2016 (IEO 2016).

<sup>43</sup> IEA, World Energy Outlook 2016 (WEO 2016).

continue dominating transport sector fuel use and residential/commercial gas demand growth to be tempered by competition from alternatives. OIES also projects limited growth in the sector (10 bcm of total consumption in 2024).

Based on recent data and initiatives, it can be expected that the higher EIA forecasts are achieved, and **incremental gas demand by the sector would be 7 bcm by 2025 and 18 bcm by 2030.**

## Power

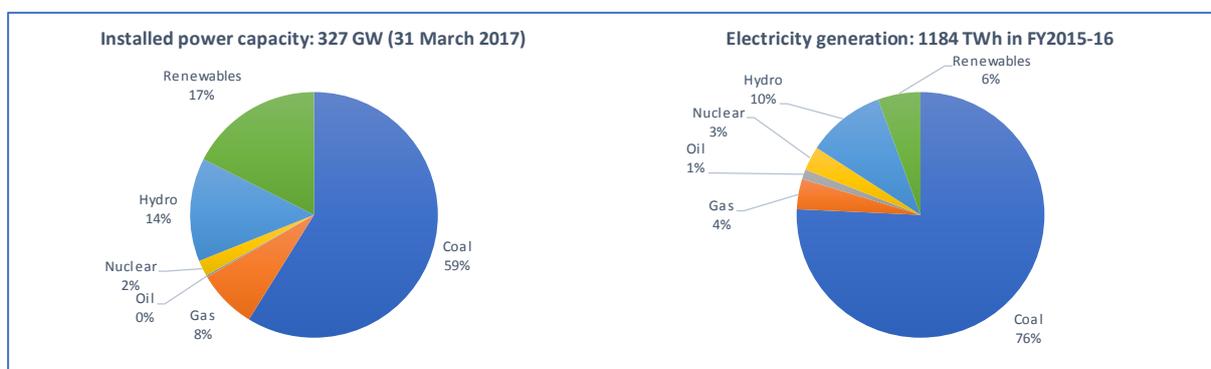
Of all gas consuming sectors, **the power sector is the one presenting the largest range of uncertainty.** Gas demand by the sector is difficult to project as, not only, it depends on economic and physical factors (price of gas, including LNG imports, availability of domestic gas), but also on policies and initiatives taken by the GoI to alter the structure of the power mix.

### Electricity generation and capacity

Currently, **the power mix is dominated by coal.** Of the total installed capacity of 327 GW at the end of March 2017, coal represented 59%, while **natural gas, with 25 GW<sup>44</sup>, accounted for only 8%.**<sup>45</sup> In addition, a gas-based capacity of 4.3 GW is ready for commissioning/under construction but due to acute shortage of natural gas, is not in a position to commission.

Electricity generation totalled 1,184 TWh in FY2015-16.<sup>46</sup> Gas generation was 47.3 TWh<sup>47</sup>, accounting for 4% of total electricity generation, while coal dominated with a share of 76%. Electricity generation has increased by about 6.6% between 2006 and 2015, mirroring GDP growth. Despite this increase, India continues to suffer from inadequate electricity supply: **19% of the population has no access to electricity** (4% of urban and 26% of rural population).<sup>48</sup> The Modi administration has committed to provide '24/7 Power For All' (PFA) by 2019.

**Figure 6: Installed power capacity and electricity generation in FY2015-16**



Source: CEA Executive Summary and NEP 2016

Despite significant capacity addition during the past five years,<sup>49</sup> **India suffered from electricity shortages** due to inadequate coal and gas supplies, power transmission system constraints, high

<sup>44</sup> However, a capacity of 23 GW is monitored by the Central Electricity Authority (CEA). Out of the total monitored capacity, a capacity of 20.2 GW is connected with the gas grid and 2.9 GW is connected with isolated gas fields.

<sup>45</sup> This excludes captive plants. There is significant captive generation capacity in India (40.7 GW), which also depends on coal primarily but also has a larger use of natural gas.

<sup>46</sup> CEA, Power sector, Executive summary (based on monthly reports)

<sup>47</sup> NEP 2016.

<sup>48</sup> IEA, WEO2016 database, <http://www.worldenergyoutlook.org/resources/energydevelopment/energyaccessdatabase/>

<sup>49</sup> During the 12<sup>th</sup> Plan (2012-17), a capacity addition of about 99,209 MW against the target of 88,537 MW from conventional sources and about 29,462 MW against the target of 30,000 MW from renewable sources have been achieved.



transmission and distribution losses, and, above all, the inability of state Discoms to pay for electricity supplies. To achieve its commitment to provide PFA by 2019, the GoI has adopted several programmes, such as Deen Dayal Upadhyaya Gram Jyoti Yojana (DDUGJY) to electrify all villages<sup>50</sup>, Integrated Power Development Scheme (IPDS) to strengthen distribution networks and reduce line losses, and Ujjwal Discom Assurance Yojana (UDAY) to reduce local state Discoms debts and make the sector viable. The GoI has also taken several steps to promote energy conservation, energy efficiency and other demand side management measures.<sup>51</sup>

**Since then, the power supply situation has improved dramatically.** Already chronic electricity and coal shortages have been eliminated. There has also been considerable improvement in the reliability of power. Installed capacity is now adequate to meet electricity requirements and peak demand in connected areas. Adequate supply of domestic coal to power plants has been ensured. Village electrification is nearing completion with over 13,000 villages electrified in the last two years. Despite this positive momentum, India's per capita electricity consumption is low compared with that of developed countries and with China. India's per capita electricity consumption in FY2015-16 was 1,075 kWh, compared with 12,987 kWh in the United States, 7,820 in Japan, and 3,927 in China (2014 data).<sup>52</sup> Raising India's per capita consumption to Chinese levels alone would require power generation to more than triple. The inability of state Discoms to pay for electricity supplies is illustrated by the low PLF of thermal power plants recorded in recent years (less than 65%). Low PFL have undermined the financial performance of generating companies, many of which are unviable without power offtake agreements and cannot service their debt.

The increased coal production, reforms in the distribution sector and proposed investment in Transmission & Distribution are likely to improve the balance sheet of Discoms, PLFs of generators, and to some extent, the financial attractiveness of the power sector.

### Current gas demand in the power sector

**The power sector is the second largest gas consuming sector in India.** Its consumption totalled 10.9 bcm in FY2015-16 and an estimated 11.5 bcm in FY2016-17. **Gas consumption by the sector has declined since 2010 (when it reached 26 bcm) due to the non-availability of domestic gas.** The gas power capacity was built on projected rising production of the KG-D6 gas field. In 2009, the GoI allocated 23 bcm of KG-D6 gas to the power sector for FY2009-10. However, the gradual reduction in production from KG-D6 upset the gas-based capacity addition program. When the production from the field fell to 16 mcm/d in March 2013, the supplies to the power sector were reduced to zero and the power sector had to rely on other sources of gas supplies. Gas requirements to operate the existing power plants at 85% are estimated at about 40 bcm per year. However, as the gas production and supply to gas-based power stations have not kept pace with demand, existing gas-based power plants are operating at very low PLF of about 23% in FY2015-16, and this, despite the temporary subsidy scheme put in place in 2015. Currently, 14.3 GW of gas-based power capacity is stranded due to non-availability of domestic gas. According to the Ministry of Power (MoP), domestic natural gas supply to the power sector can improve only in case production levels increase in the future.<sup>53</sup>

<sup>50</sup> DDUGJY: The scheme was launched in 2014 with the objective to achieve 100% village electrification by 2019 (18,500 un-electrified villages to be connected) and provide electricity connection to 42 million households.

<sup>51</sup> Lok Sabha, Power deficit, Ministry of Power, 20 July 2017,

<http://164.100.47.194/Loksabha/Questions/QResult15.aspx?qref=53935&lsno=16>

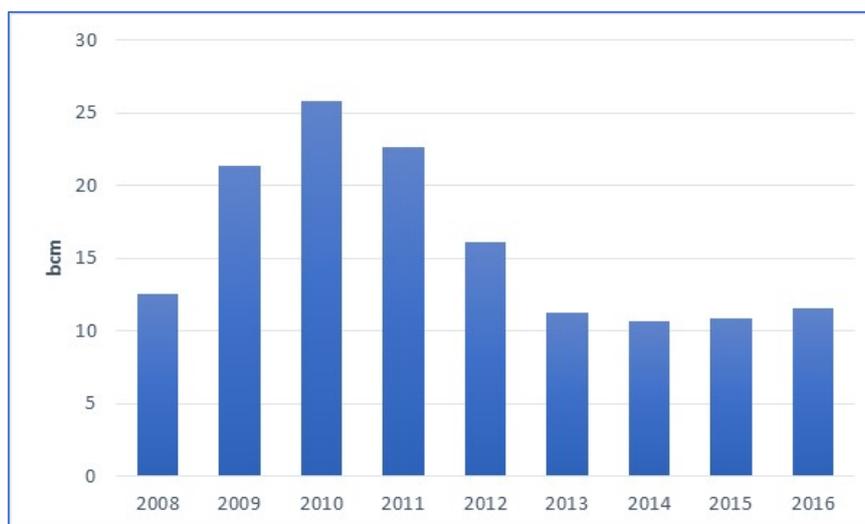
<sup>52</sup> World Bank, Electric power consumption, <http://data.worldbank.org/indicator/EG.USE.ELEC.KH.PC>

<sup>53</sup> Lok Sabha, Gas-fired generation capacity, Ministry of Power, 20 July 2017,

<http://164.100.47.194/Loksabha/Questions/QResult15.aspx?qref=53924&lsno=16>



**Figure 7: Gas consumption by the power sector (2009-2016)**



Source: MoPNG (fiscal years)

### Future gas demand by the power sector

India's electricity consumption is expected to grow through 2030 driven by a growing economy, urbanization and demographic trends, and Prime Minister Modi's commitment to provide PFA by the end of this decade. The IEA projects electricity generation to reach 2,275 TWh by 2025 and 2,896 TWh by 2030. Total power capacity is projected at 617 GW in 2025 and 785 GW in 2030.

Past forecasts expected the largest increase in future gas demand to occur in the power sector driven by environmental considerations. However, there are impediments to increased gas use in power generation, such as the price competitiveness of natural gas with coal and, to a lesser extent, renewables; the limitations of gas infrastructure and domestic gas supplies, and concerns regarding import dependence (see Section 3). Due to these obstacles, international and Indian forecasters have revised their projections downward.

In the New Policies Scenario (NPS) of the IEA WEO 2016, gas demand by the sector is now projected at 31 Mtoe (37 bcm) and 46 Mtoe (49 bcm) respectively in 2025 and 2030, compared with 46 Mtoe and 72 Mtoe for the same years in WEO 2011. The IEA does not expect gas-fired generation to produce base-load power in India. Instead gas-fired plants will perform a peaking/load balancing role which is essential in reducing the large peak day deficits and will drive the increase in sector gas demand. Gas's share of power sector energy consumption will increase from 5% in 2014 to 9% by 2030. Coal will remain the dominant fuel in the power sector although its share of total fuel use drops from 75% in 2014 to 59% in 2030.<sup>54</sup>

The EIA has also significantly lowered its projections for electricity sector gas use in India from the 2013 edition of the IEO in the latest edition in 2016. The IEO 2016 Reference scenario now projects gas demand by the sector at 14 bcm and 22 bcm respectively in 2025 and 2030.<sup>55</sup>

**According to BEG/CEE, if low LNG prices persist, power sector demand will increase enough to have adequate utilization of existing gas-fired generation capacity.** However, given the limitations of India's gas infrastructure natural gas is not likely to play a baseload power role in the future or increase its share in total generation significantly. Given the uncertainties surrounding potential

<sup>54</sup> BEG/CEE (2017), IEA, World Energy Outlook 2016.

<sup>55</sup> BEG/CEE (2017), EIA, International Energy Outlook 2016.



increases in domestic gas production, and the inability of the sector to tolerate high LNG prices, BEG/CEE outlook for power sector demand is on the low end of various forecasts.

The draft National Electricity Plan 2016 (NEP 2016), published by the Central Electricity Authority (CEA) in December 2016, provides an assessment of future electricity requirements and supplies by FY2021-22 and FY2026-27, based on different assumptions for the contribution of renewable power. India has set an aspirational target of 175 GW renewables capacity by 2022, of which 100 GW from solar and 60 GW from wind.<sup>56</sup> Over the past four years, renewables capacity (excluding large hydro) has doubled from 28 GW in January 2013 to 57 GW in March 2017. For the first time in FY2016-17, growth in renewables capacity addition (about 14 GW) exceeded thermal capacity addition (11.7 GW). To meet the 175 GW-target by 2022, more than 20 GW of renewables capacity should be added in each of the next five years, the majority from solar. Although NEP 2016 asserts that the high 175 GW target will be met by 2022, it also posits a 'moderate' (150 GW) and 'low' (125 GW) target achievement for purposes of comparison.

NEP 2016 assesses the minimum gas requirements to effectively run existing gas-based capacity. NEP 2016 considers that gas plants ready for commissioning/under construction (4.3 GW) are available during the period 2017-22. But, as the availability of gas is uncertain, no additional gas-based projects are considered during the period 2017-22, nor in the period 2022-27. However, in case the availability of natural gas improves, NEP 2016 states that preference may be given to gas-based power plants owing to their advantage in efficiently helping in balancing the grid and reducing emissions.

As the role of gas-based plants during evening is vital for the Indian grid, NEP 2016 proposes to run gas-based power stations at 85% PLF during the 6 hours in the evening. This requires about 20 mcm/d (7.3 bcm per year) additional gas over and above 28.3 mcm/d (10.3 bcm per year) already being supplied to gas-based power stations. NEP 2016 also proposes a gas-based capacity of 2,000 MW to be used during peak hours to meet intermittence of renewable generation. Gas requirements for this capacity to run at 50% PLF would be about 5.3 mcm/d (about 2 bcm per year). **NEP 2016 therefore assesses minimum gas requirements at 53.56 mcm/d (around 20 bcm per year) to ensure an effective utilisation of existing gas based plants.**

These projections are quite different from that published by the previous Indian administration. The Gol's Vision 2030,<sup>57</sup> published in 2013, projected a gas-based capacity of 43 GW at the end of the 12<sup>th</sup> Plan (2012-2017). Given the low carbon growth strategy of the country, about 20 GW of new capacity were added during each 13<sup>th</sup>, 14<sup>th</sup> & 15<sup>th</sup> Plans. Gas demand by the power sector was expected to reach 58 bcm by FY2016-17 and an incremental demand of about 27 bcm was assumed during each Plan beyond the 12<sup>th</sup> Plan until 2030, when demand was expected to reach 129 bcm. But the Vision 2030 was based on the assumption that coal production would not be adequate to supply coal-fired power plants. Since this publication, the Modi administration has adopted a series of measures aimed at raising domestic coal production which have allowed adequate domestic coal supplies to power plants. The Vision 2030 also did not take into account the renewable target of 175 GW by 2022 set by the Modi administration in 2014. These policy goals have altered the possible role of natural gas in the power sector, which is not required anymore for baseload power but rather for meeting peak demand and balancing renewables intermittency.

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<sup>56</sup> India's intended nationally determined contribution, 2015, India INDC to UNFCCC report,

<http://www4.unfccc.int/submissions/INDC/Published%20Documents/India/1/INDIA%20INDC%20TO%20UNFCCC.pdf>

<sup>57</sup> Government of India, Vision 2030: Natural gas infrastructure in India, Industry Group Report for the Petroleum & Natural Gas Regulatory Board of India, May 2013, <http://www.pngrb.gov.in/Hindi-Website/pdf/vision-NGPV-2030-06092013.pdf>.



**OIES offers three contrasted scenarios according to energy and environmental policies adopted by the GoI.** The first scenario (*Outlook 1 – A continuation of the status quo to 2024, underpinned by sector-specific growth targets*), gives a projection for gas demand by the fertilizer, industry and CGD sectors, underpinned by a continuation of current policy targets. This outlook sees gas demand in these sectors growing by around 40% from 2015 levels, to about 55 bcm in 2024. The main constraint to this outlook is infrastructure.

The second and third scenarios are centred on the power sector and assess possible levels of gas demand according to the contribution of renewables and coal in the power sector. In the second scenario (*Outlook 2 – Renewables targets are not met; potential for gas to fill the gap by 2027*), where India fails to meet the 175 GW renewables target by 2022, the role of gas in the power sector is central in balancing intermittency as well as bridging any ensuing power deficit. In this scenario, gas demand by the power sector could increase by 35 bcm by 2022 and higher thereafter (by about 100 bcm by 2027). In this scenario, the role of gas is constrained by prices, infrastructure, renewables policy and coal policy. In the third scenario<sup>58</sup> (*Outlook 3- Coal is actively discouraged in the power sector, opening an important and immediate role for gas in the power sector to 2027 and beyond*), the role of gas is predicated on an active policy to discourage the use of coal through fiscal disincentives, and induce a large-scale switching from coal to gas, which would also serve to create demand and encourage the development of infrastructure. This scenario could lead to a substantial and anchoring role for gas in the power sector, but would require a nearly fivefold increase in the coal tax (now \$6/t) and a potential 30% increase in associated electricity tariffs, which also makes this a highly improbable outlook. The outlook is also constrained by renewables policy and policy on coal and air pollution (see Section 3).

The OIES report concludes that a likely outcome is some combination of the first two outlook cases, which translates into gas demand by the power sector comprised between 20 bcm and 46 bcm by 2022. However, as stated in the report, even in a case where the renewable capacity target is not met, the role of gas is also highly uncertain. Indeed, in that case, the current low PLF of coal-fired power plants creates a buffer as they could easily increase their production without any investment.<sup>59</sup> This is also the conclusion of NEP 2016. NEP 2016 considers that the balance capacity (after considering the committed capacity addition from hydro, nuclear, gas and renewables) to meet the projected electricity demand is met from coal-based power plants. Even when the renewables target is not met, NEP 2016 states that coal-based capacity is sufficient and no new coal plants are required beyond the 50 GW already under construction, beyond at least 2027.

In conclusion, **beyond the minimum gas requirements assessed in NEP 2016 (20 bcm per year)**, additional gas demand by the power sector is highly dependent on the availability of additional gas production and/or the price of imported LNG as gas-based generation in India can easily be challenged by other sources of power production.

### ***Conclusion: outlook for future gas demand***

**All forecasts for total India gas consumption, but the GoI Vision 2030 and the OIES outlook 2, are in the same range: 70 bcm in 2020, 90 bcm in 2025 and 115 bcm in 2030.** The industrial sector, including fertilizers, leads the growth. Under current energy and environmental policy, the power sector is not expected to drive a surge in gas demand. These outlooks require continued low prices as

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<sup>58</sup> Future gas demand is not quantified in this outlook.

<sup>59</sup> See NEP 2016 for a discussion on the possible contribution of coal generation according to coal plants PLF.



well as a significant increase in domestic production, gas pipeline additions and government financial support for the fertilizer and power sectors.

*Table 1: Comparison of India gas demand forecasts*

bcm	FY2015-16	2020	2025	2030
<b>Industrial (incl. Fertilizers)</b>				
<b>Current demand</b>	26.8			
IEA NPS		37	46	55
EIA Ref		48	56	67
GOI Vision 2030		63	84	111
OIES (Outlook 1)			45 (a)	
<b>Power</b>				
<b>Current demand</b>	10.89			
IEA NPS		20	37	49
EIA Ref		11	14	22
GOI Vision 2030		58	80	129
OIES (Outlook 2)			46 (b)	111 (c)
<b>City Gas Distribution</b>				
<b>Current demand</b>	5.46			
IEA NPS		7	8	11
EIA Ref		9	14	25
GOI Vision 2030		8	15	31
OIES (Outlook 1)			10 (a)	
<b>TOTAL (d)</b>				
<b>Current demand</b>	47.85			
IEA NPS		64	90	114
EIA Ref		70	87	112
GOI Vision 2030		138	179	272
OIES			101 (e)	

(a) 2024; (b) by 2022; (c) by 2027; (d) includes 'Other uses' (e) by 2024

Source: IEA, EIA, GoI, OIES

### 3. Main drivers and obstacles to increased gas demand

Due to its environmental advantages and greater efficiency, gas is expected to play a larger role in the Indian energy mix. However, despite several initiatives taken towards a gas-based economy, there are some challenges, which needs to be addressed effectively.

#### *Sustainability*

**India's move to promote gas usage is in line with the commitment made at the Paris meeting on climate change**, which aims to reduce the country's carbon emission intensity by up to 35% from 2005 levels by 2030 and producing 40% of the power from non-fossil fuel sources by 2030. India's CO<sub>2</sub> emissions stood at 2,271 Mt in 2016, up from 1,209 Mt in 2005, making India the world's third-biggest emitter. However, its per capita emissions are a fraction of many other nations', at just 1.59



ton a year, compared with 7.55 for China and 16.39 for the US.<sup>60</sup> About half of Indian CO<sub>2</sub> emissions is estimated to be generated from the power sector. The other major contributors of CO<sub>2</sub> emissions are the transport and industrial sectors. Natural gas is a good fit for decarbonizing India's energy system, as it plays a dual role in both replacing carbon-intensive fuels and facilitating the development of renewable power.<sup>61</sup>

The increasing use of gas in non-power sectors will allow to reduce CO<sub>2</sub> emissions and improve air quality as gas will replace (or complement) higher-emitting oil products: fuel oil/naphtha and petcoke in the industrial sector, diesel in transportation and traditional biomass, LPG and kerosene in the residential/commercial sectors. In addition, oil-to-gas switching will allow to reduce oil dependency.

In the power sector, despite the advantage of natural gas compared with coal, so far, Indian policies seem to be geared towards renewables and high-efficiency coal rather than renewables and natural gas. India has already built a large fleet of coal-based power plants sufficient to meet its power needs until FY2026-27 according to NEP 2016. In addition, the country is working towards steam coal independency and is increasing its coal production and supply to thermal power plants.<sup>62</sup> Unlike China, India's coal-fired generation fleet is not of advanced design: 80% use subcritical technology and their efficiency of 35% is below that of China. Their poor efficiency is exacerbated by high ash content coal and high ambient temperatures. Improving the efficiency of coal-based power plants is one of the effective methods to reduce CO<sub>2</sub> emissions which is being achieved by various schemes introduced by the GoI. Notably, the GoI has mandated supercritical technology for all coal-based power plants commissioned from 2017 onwards, in addition to an existing 34.9 GW of existing supercritical plants as of March 2016 (representing roughly 20% of the coal fleet). Also, efficiency improvement measures through renovation and modernization (R&M) of old and inefficient units is undertaken and units in which R&M is not possible are being considered for retirement. Furthermore, the GoI has mandated the use of washed coal with a reduced ash content of 34% (or lower) in power plants located beyond 500 km from their coal source, or based in urban, eco-sensitive, or other critically polluted areas.

But above all, thrust is being given for increasing the share of non-fossil fuel based generation in the energy mix to reduce CO<sub>2</sub> emissions from the power sector. Under current policies, with the targeted 175 GW of renewable power capacity by 2022, India is already set to overachieve its 2030 carbon emissions intensity target. The likely continued expansion of renewables after 2022 would result in India also overshooting the 2030 non-fossil capacity target set in its National Determined Contribution (NDC). If the NEP 2016 is implemented, India will achieve its NDC's 2030 40% non-fossil capacity target before 2022, and will reach 57% by 2027.<sup>63</sup>

Improvement of air quality will be more difficult to achieve. Beyond coal burning in the power sector, the sources of India's air pollution are many: indoor cook stoves, road traffic – including the ubiquitous auto-rickshaws that use a toxic mix of kerosene and diesel – industrial plants that burn coal and oil and open burning of waste. The GoI adopted new emissions standards in December 2015 for coal-based power plants in order to improve air quality. Existing plants were given two years to comply, whereas all new plants beginning operations after 1 January 2017 have had to comply from the outset. The rules require coal plants to reduce particulate emissions by about 25%, sulphur

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<sup>60</sup> BP (2017).

<sup>61</sup> OGFJ, India wants a gas-based economy, 17 April 2017, <http://www.ogfj.com/articles/print/volume-14/issue-4/features/india-wants-a-gas-based-economy.html>

<sup>62</sup> See Cornot-Gandolphe Sylvie (2016).

<sup>63</sup> Carbon Action Tracker, India, 15 May 2017, <http://climateactiontracker.org/countries/india.html>



dioxide (SO<sub>2</sub>) emissions by 90%, nitrogen oxide (NO<sub>x</sub>) emissions by 70% and mercury emissions by 75%. The new norms require the introduction of technologies like Flue Gas Desulfurization (FGDs) for SO<sub>2</sub> reduction and Selective Catalyst Reduction (SCRs) for NO<sub>x</sub> reductions. Coal-based power plants operators have reportedly been finding it challenging to apply these emissions standards, due to the high associated costs and even more so, a lack of clarity over whether these costs would be passed through into tariffs. This has resulted in India's Power Minister recently admitting that there would be delays in implementation. However, Indian policymakers appear to be banking heavily on the renewables target to mitigate any increased requirements for (and negative externalities from) coal, rather than considering gas as a transition fuel.<sup>64</sup>

### ***Security of supply considerations***

As domestic energy production has lagged demand growth, India's import dependence has increased. Consequently, concerns about India's energy security have been rising. India imported over a third of its energy needs and spent almost 40% of its total export earnings in FY2016-17 as a result of the stagnant domestic production.<sup>65</sup> India spent \$6 billion in LNG imports in FY2016-17. Although small compared with the crude oil bill (about \$100 billion), increasing imports and fluctuating prices continue to pose risks. The GoI wants to reduce oil and gas import dependence by 10% between 2014 and 2022.<sup>66</sup> To improve the country's oil and gas supply security, increasing domestic production is an important step. Notably, **increasing domestic gas production is critical to build a gas-based economy**. India has significant gas reserves: 1.4 tcm in 2016.<sup>67</sup> However, due to low domestic gas prices and lack of incentives, marketed gas production has fallen by more than 20 bcm between 2010 and 2016. To reverse this trend, **the Government has taken several steps to enhance domestic natural gas production through several policy initiatives**.

To incentivize gas production from difficult areas, the GoI has granted marketing, including pricing, freedom for the gas produced from difficult areas. Marketing freedom has also been provided under Discovered Small Field (DSF) bidding round as well as under the new Hydrocarbon Exploration and Licensing Policy (HELP) of March 2016 under which acreages are now provided. The implementation of these policy initiatives and other reform initiatives is expected to make upstream investments more attractive and to enhance domestic oil and natural gas production. In particular, **HELP has the potential to positively alter the dynamics of India's E&P of hydrocarbons**. HELP has four key features: first, a single or 'uniform' licencing policy (ULP) for the exploration and extraction of all conventional and unconventional hydrocarbons from an entire contract area – with the aim of reducing administrative costs. Second, 'open acreage licensing' policy (OALP), which permits public and private sector exploration companies (international and domestic) to identify and bid for acreage all year round, rather than limiting this to periodic government-administered bidding rounds (that often end up being delayed) for acreage. A third feature is the replacement of the Production (profit) Sharing Contract (PSC) with a Revenue Sharing Contract (RSC) under which the government will receive a share of revenues, rather than a share of profits, from production. Finally, under HELP, companies have commercial freedom to sell their production at market-oriented prices within the

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<sup>64</sup> Sen Anupama (2017).

<sup>65</sup> Department of Commerce, Export Import Data Bank, <http://commerce.nic.in/eidb/ecom2.asp>

<sup>66</sup> Ministry of Petroleum & Natural Gas, Import dependence in Oil & Gas will be reduced by 10%, says the Petroleum Minister; Government taking steps to boost gas exploration and production, 22 March 2016, <http://pib.nic.in/newsite/PrintRelease.aspx?relid=138249>

<sup>67</sup> CEDIGAZ database



domestic economy.<sup>68</sup> Lastly, to attract investors, the government has kept royalty rates for deepwater and ultra-deepwater blocks at zero for the first seven years and 5% and 2%, respectively, after seven years.<sup>69</sup>

**The GoI launched its first bidding round on 1 July 2017 under HELP.** Investors can access data related to India's hydrocarbon reserves and submit bids for any basins, which the oil ministry will review for awarding to successful bidders before the next round from January 2018. India has 26 sedimentary basins over 3.14 million sq. km, and crude oil and natural gas are being produced in seven basins. In the new rounds, 2.7 million sq. km will be on offer, comprising 1.5 million sq. km of onshore and 1.2 million sq. km of offshore areas.<sup>70</sup>

The new upstream policy seems attractive for national producers. Despite declining production and profits from its gas business due to current low domestic gas prices, state-owned ONGC projects a 66% rise in its natural gas production by March 2022. ONGC's gas output is projected to rise from 25 bcm in FY2017-18 to 41.5 bcm in FY2021-22.<sup>71</sup>

**The success of the new upstream policy and a higher gas production would help the GoI to achieve a gas-based economy as security of supply considerations would restrain a rising contribution of natural gas in the energy mix, especially in the strategic power sector,** where domestic energy sources are favoured over imports. Although security of supply may not be the primary driver of the development of wind, solar and nuclear, these energy sources are domestically-controlled resources and do not have the security disadvantage associated with imports.<sup>72</sup> However, since it is not likely that India would be self-sufficient through domestic production in the foreseeable future, the country will have to rely on imports to meet its demand.

### **Affordability**

**The level and direction of domestic and international gas prices will shape future gas demand in India** where all sectors, and notably the fertilizer and power sectors, remain price-sensitive. Natural gas in the power sector mostly competes with coal. At current domestic coal prices (about \$0.7/MBtu)<sup>73</sup>, and without additional tax on coal burning, natural gas is unable to compete with domestic (or imported) gas for baseload power.

The LNG market oversupply in the coming years is expected to keep LNG imports affordable for India's non-power sectors until the beginning of the 2020s. However, low LNG prices could cause widespread investment delays in new liquefaction capacity and sow the seeds for a period of sharp price increases in the next decade when the market tightens again. The rebalancing of the global LNG market could reduce the attractiveness of LNG and make oil products more competitive, especially if oil prices remain low.

<sup>68</sup> See Sen Anupama (2016).

<sup>69</sup> OGFJ, India wants a gas-based economy, 17 April 2017, <http://www.ogfj.com/articles/print/volume-14/issue-4/features/india-wants-a-gas-based-economy.html>

<sup>70</sup> Business Standard, Govt to kick off new energy exploration round on July 1, 27 June 2017, [http://www.business-standard.com/article/economy-policy/govt-to-kick-off-new-energy-exploration-round-on-july-1-117062601003\\_1.html](http://www.business-standard.com/article/economy-policy/govt-to-kick-off-new-energy-exploration-round-on-july-1-117062601003_1.html)

<sup>71</sup> Press Trust of India, ONGC Eyes 17% Jump In Crude Output, 66% In Natural Gas By 2022 April 2017, <http://profit.ndtv.com/news/energy/article-ongc-eyes-17-jump-in-crude-output-66-in-natural-gas-by-2022-1677181>

<sup>72</sup> BEG/CEE (2017).

<sup>73</sup> Coal India Limited (CIL), the state-owned company, sells nearly 85% of coal through regulated channel to power plants where prices are fixed annually. The remaining is sold through electronic auction where price follows international trend. In 2016, CIL increased its coal prices by 6.3% in May from an average INR 1,193/t (about \$18.5/t) to INR 1,268/t (\$19.7).



An important step to move to a gas-based economy would be **to create a comprehensive market-based pricing mechanism for natural gas across all sectors of the economy**. The new upstream policy has made some progress in that direction. But under the new upstream policy, marketing pricing and freedom to the contractors is restricted to new gas production. Even the new production from difficult areas remains subject to a price ceiling (\$5.56/MBtu currently) which is not commensurate with the risk involved and is below the price of LNG imports, that these fields are expected to replace.<sup>74</sup> Over time, as domestic gas prices rise to reflect market prices, these reforms could stimulate further upstream investments and encourage the entry of private players to the Indian natural gas market.

On the demand side, to prevent major shocks to the economy, several policy and fiscal reforms need to be taken in the interim period leading up to market-determined prices. In order to promote efficient gas usage and stimulate domestic supply, the current system of gas allocation that mandates producers to sell to a particular category of consumers should be discontinued. Instead, the government could institute a policy of transparent consumer or producer subsidies to prioritize usage of gas for important sectors like fertilizer manufacturing and power generation.

### ***Development of gas infrastructure***

Due to the nascent stage of the gas market in India, **development of gas infrastructure is the most critical enabler for transition to a gas-based economy and pipeline and LNG infrastructure has to be created 'ahead of the market'** to act as a facilitator for market development and to ensure wider availability of gas across all regions.

#### ***A doubling of the transmission grid***

Since a National Gas Grid (NGG) was conceptualized in 2000, India has built **more than 16,000-km of gas pipeline network with a design capacity of approximately 384 mcm/d** (see Annex 1). However, the pipeline network has been developed mostly in the northern and western regions. A large part of the country lacks transmission infrastructure and access to gas (see Map 1, Annex 1). Today, many potential and solvent gas consumers are unable to access the gas because of a lack of regional infrastructure.

The GoI is planning to develop a NGG having multiple entry/exit points. The proposed gas grid would connect the gas sources to major demand centres such as industrial clusters, big cities, etc. It was expected that India's existing trunk pipeline network would be expanded to around 28,000 km, with a total design capacity of around 721 mcm/d by 2017.<sup>75</sup> However, this target has been postponed due to lack of financing. Currently 13,800 km are under construction and expected to start operation by 2018-19 (see Annex 1). The development of new pipeline networks is market driven (i.e. it can be initiated by any interested public or private entity) and bid-based. The GoI normally does not provide any financial support for laying pipeline infrastructure. However, recognizing the strategic role of infrastructure development, it has started to invest into transmission lines to help the creation of a NGG, providing a capital grant of about \$800 million (i.e. 40% of the estimated capital cost) to Gas Authority of India Limited (GAIL) for development of the Jagdishpur-Haldia/Bokaro-Dhamra Gas Pipeline (JHBDPL) project to connect the eastern part of the country with the NGG.

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<sup>74</sup> OGFJ, India wants a gas-based economy, 17 April 2017, <http://www.ogfj.com/articles/print/volume-14/issue-4/features/india-wants-a-gas-based-economy.html>

<sup>75</sup> Roadmap for Reduction in Import Dependency in the Hydrocarbon Sector by 2030, Final Report, Ministry of Petroleum and Natural Gas, Government of India, September 2014, <http://www.taxindiaonline.com/RC2/pdfdocs/FinalReportKelkarCommittee2014.pdf>



### LNG playing a bigger role

**India's vision for a gas-based economy also includes increasing LNG imports.** As of 2017, India has four operational LNG terminals, giving it an annual import capacity of 36.7 bcm (see Annex 2). Four new terminals and one expansion are under construction adding 33.5 bcm per year of import capacity (Annex 2). India's LNG import capacity could reach 70 bcm per year (52.5 Mtpa) early in the next decade. This development will drastically improve access to natural gas along India's eastern seaboard and is in line with the Government's intention to more than double the annual LNG import capacity in the coming years. In addition, there are many proposed new terminals and expansions at different stages of planning (potential and speculative), with some planned floating storage regasification units (FSRUs) at an advanced stage (e.g. H-Gas LNG Gateway). Should all these proposed LNG terminals be built, they would add an import capacity of 100 bcm per year.

India's LNG imports are already on a higher trajectory. Net imports jumped by 6.2 bcm (+33.7%) to 24.6 bcm in 2016. LNG imports rose again in the first four months of 2017: +13.9% compared to the same period in 2016.<sup>76</sup> Most imported LNG comes from Qatar (62% of total imports in 2016), and is delivered under long-term contracts between Petronet and Rasgas. However, India is also increasing its purchases of flexible LNG to take advantage of lower prices. Spot and short-term imports amounted to 9.9 Mt in 2016, accounting for more than half of total LNG imports.<sup>77</sup> India has also started to diversify its sources of supply and signed long-term contracts with the United States and Australia, in addition to its contracts with portfolio aggregators (see Annex 3). If all current Memorandum of Understanding (MoU) and Heads of Agreements (HoA) were turned into firm contracts, Indian LNG imports under term contracts could rise to 30.5 Mtpa (40 bcm per year).

To encourage LNG imports in the country, the custom duty on LNG has been reduced to 2.5% from the earlier 5% in the federal budget 2017.<sup>78</sup> However, government effort to make LNG more affordable has been scuttled by the withdrawal of tax benefits by the state of Gujarat, through which 90% of the LNG used in India passes.<sup>79</sup> According to Petronet LNG, levies across the country add about 40% to the delivered price of LNG by the time it reaches the end user, making LNG too expensive to compete with alternative fuels. These diverging measures are one illustration of the lack of a coherent view on the role of natural gas/LNG in the country. Due to the price sensitivity of LNG consumers, the Gujarat measure is likely to restrain the growth in LNG imports in the short term.

### International gas pipelines under consideration, but no progress

India is also considering gas imports by pipeline. At this stage, however, despite some discussion of pipelines from Turkmenistan, Iran, and Russia, major political, security, and economic challenges must be overcome before becoming a viable option for India.<sup>80</sup>

There are four import pipeline projects at different stages of development: the Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline, the Iran-Pakistan-India pipeline (IPI) and the more recent Iran-Oman-India and Russia-India pipeline projects. Pursuit of these alternatives included the signing, in May 2012, of a gas sale and purchase agreement between GAIL and TurkmenGas for gas deliveries

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<sup>76</sup> CEDIGAZ LNG Service, Monthly Bulletin, July 2017

<sup>77</sup> GIIGNL (2017).

<sup>78</sup> India.com, Energy Budget 2017: Focus on making India 'Gas-based economy', Custom duty on LNG halved to 2.5 per cent, 1 February 2017, <http://www.india.com/news/india/energy-budget-2017-focus-on-making-india-gas-based-economy-custom-duty-on-lng-halved-to-2-5-per-cent-1801648/>

<sup>79</sup> The withdrawal of the tax credit in November 2016 has resulted in an effective value-added tax rate of 15% from 4% earlier. Bloomberg, LNG Fights a Losing Battle in India as Taxes Weigh on Demand, 17 February 2017,

<https://www.bloomberg.com/news/articles/2017-02-17/lng-fights-a-losing-battle-in-india-as-taxes-weigh-on-demand>

<sup>80</sup> Based on CSR (2017).



through the TAPI pipeline. Though a ground-breaking ceremony for the project took place in Turkmenistan in 2015, there are still significant political and commercial obstacles to overcome, such as transiting Pakistan, if it is to be completed by its target date of 2019. With the loosening of sanctions on Iran's oil and gas industry, the prospects for the IPI pipeline were expected to improve. This renewed optimism was seemingly put to rest in 2016 when Iran's ambassador to India declared the project to be dead. Instead, the two countries are studying a 1,400-km offshore pipeline that would take natural gas from southern Iran via Oman Sea and the Indian Ocean to Gujarat state. In October 2016, India and Russia agreed to build a 4,500 km to 6,000 km-long pipeline from Siberia estimated to cost \$25 billion. However, due to the cost to transport Russia's natural gas to India, the two countries are now exploring an alternative gas swapping scheme involving China and Burma.

## Conclusion: Gas demand in India is the wild card of the global gas market

Government projections of future gas demand have tended to be over-optimistic, and international assessments by multilateral institutions seem very cautious. In other words, India is a wildcard in the global gas market. The OIES and BEG/CEE reports provide an in-depth review of gas demand by sector to make an informed assessment of future demand. OIES provides both quantitative and qualitative assessments, while BEG/CEE provides a qualitative assessment of published forecasts. Both reports also underline the main drivers and challenges to increase gas demand in India. The OIES report emphasizes the highly dynamic nature of the Indian market post-COP21, making the point that the long-term determinants of gas demand could effectively evolve as the Indian gas market develops towards meeting India's key climate policy goals.

Based on these reports and further analysis, five main concluding remarks can be drawn:

1. **Gas demand in India is highly determined by policy.** The view today is an increasing share of gas in the energy mix, although some enabling factors are still missing. Should this view be reinforced by a coherent holistic approach, the gas market in India could expand significantly as there are plenty of opportunities to substitute less environmental friendly fuels (coal in the power sector, fuel oil in industry, gasoil in transportation and traditional biomass in residential/commercial sectors). An integrated national-level energy policy that defines—and clearly demarcates—the role of natural gas in India's energy mix is still missing.
2. Under current policies, gas demand in India is expected to grow from 55 bcm in 2016 to **70 bcm in 2020, 90 bcm in 2025 and 115 bcm in 2030**. Additional growth, notably in the power sector, is conditional to new policies to alter the electricity mix, which have a low probability as of today. In other words, natural gas today is more a substitute to oil products in the non-power sector than a substitute to coal in the power sector.
3. Building a gas-based economy has shown marginal progress over the last few years with gas accounting for only 6% of the energy mix, but **2016 could be a turning point with the first increase in gas consumption in the past five years**. India has undertaken several initiatives and policy interventions across the natural gas value chain, which can shape the nation's natural gas future. Notably, the new upstream policy can go a long way in enhancing domestic production of natural gas by making investments in E&P more attractive.
4. **Gas demand by the main consuming sectors in India is price-sensitive.** The biggest risk for future gas demand is the affordability of gas in the key demand sectors, such as power and fertilizers. Domestic production is highly unlikely to keep up with the demand and the country has to rely on



imports to meet its demand. As long as low-priced LNG is available on the global market, LNG can increase its share of total supplies. However, should the LNG market rebalance at a much higher price, the growth in LNG imports could stop.

5. Increased gas demand in India will depend primarily on the **availability of domestic gas and adequate infrastructure** to facilitate its flow to both existing and prospective markets.

## Annex 1: Gas transmission network in India

The main transport system comprises the inland cross-country pipelines Hazira-Vijaipur-Jagdishpur pipeline, Dahej-Vijaipur pipeline and Dejuan pipeline. Gas Authority of India Limited (GAIL) is the quasi-monopoly operator of cross-national pipelines with a network of almost 11,000 km. State-owned Oil and Natural Gas Corporation (ONGC) also owns a small proportion of the network, and only a small number of pipelines are owned by the private sector (joint ventures).

**Table 2: Gas Pipeline Network as of 31 March 2017**

Network/Region	Entity	Length (Kms)	Design Capacity (mcm/d)	Pipeline Size	Average flow (FY2016-17)	% Capacity utilisation (FY2016-17)
Hazira- Vijaipur- Jagdishpur Pipeline /Gas Rehabilitation & Expansion Projects pipeline/Dahej-Vijaipur Pipeline & Spur / Vijaipur- Dadri Pipeline	GAIL	4659.00	53.00	36"	33.16	62.57
DVPL-GREP Upgradation (DVPL-2 & VDPL)	GAIL	1119.00	54.00	48"	28.26	52.33
*Chhainsa- Jhajjar -Hissar Pipeline (CJPL) (including Spur lines) commissioned up to Sultanpur, Jhajjar-Hissar under hold (111 Km).	GAIL	265.00	5.00	36"/16"	0.97	19.34
Dahej-Uran-Panvel Pipeline (DUPL/ DPPL) including Spur Lines	GAIL	875.00	19.90	30"/18"	12.62	63.41
*Dadri- Bawana- Nangal Pipeline (DBPL), Dadri-Bawana:106Km, Bawana - Nangal:501 KM, Spur Line of BNPL : 196 Km.	GAIL	834.80	31.00	36"/30"/24"/18"	4.66	15.03
Dabhol -Bangaluru Pipeline (including spur)	GAIL	1097.00	16.00	36"-4"	1.17	7.32
Kochi-Koottanad-Bengaluru- Mangalore (Phase-1)	GAIL	48.00	6.00	16"-4"	1.03	17.08
Assam (Lakwa)	GAIL	8.00	2.50	24"	0.37	14.80
Tripura (Agartala)	GAIL	61.00	2.30	12"	1.44	62.61
Ahmedabad	GAIL	133.00	2.91	12"	0.26	8.93
Rajasthan (Focus Energy)	GAIL	151.40	2.35	12"	1.44	61.28
Bharuch, Vadodara (Undera) including RLNG+ RIL	GAIL	538.00	15.42	24"/16"	4.08	26.47
Mumbai	GAIL	129.00	7.03	26"	6.31	89.76
KG Basin (including RLNG+ RIL)	GAIL	881.00	16.00	18"	5.31	33.19
Cauvery Basin	GAIL	278.00	8.66	18"	2.65	30.59
East- West Pipeline (RGTL)	Reliance	1480.00	80.00	48"	17.00	21.25
Gujarat State Petronet Ltd.(GSPL) Network including	GSPL	2612.00	43.00	Assorted	25.33	58.91
Assam Regional Network	AGCL, DNPL	816.80	3.24	16" and others	2.25	69.44
Dadri -Panipat	IOCL	140.41	9.50	30"/10"	4.34	45.70
Uran -Trombay	ONGC	24.00	6.00	20"	3.80	63.33
<b>Total</b>		<b>16150.41</b>	<b>383.81</b>		<b>156.44</b>	

Source: PPAC

**Table 3: Gas Pipeline under Execution / Construction as of 31 March 2017**

NETWORK/REGION	Entity	Length in Kms	Design Capacity (mmcmd)	Pipeline Size	Status of Pipeline laid (Km)
Kochi - Koottanad - Bangaluru - Mangalore	GAIL(India) Ltd.	1063	16.00	24"/18"/12"	55.45
Dabhol -Bengaluru (DBPL)	GAIL(India) Ltd.	315	16.00	36"/30"/24"/18"	77.27
Surat - Paradip*	GAIL(India) Ltd.	2112	74.81	36"/24"/18"	0
Jagdishpur- Haldia-Bokaro-Dhamra (JHBDPL) (Phase-1 (755 KM), 7.44 MMSCMD capacity	GAIL(India) Ltd.	2539	16.00	30"/24"/18"/12"/8"/4"	86.6
Mallavaram - Bhilwada*	GSPC India Transco Ltd.	2042	78.25	42"/36"/30"/24"/18"/12'	0
Mehsana - Bhatinda *	GSPC India Gasnet Ltd.	2052	77.11	36"/24"/18"/12"	0
Bhatinda -Srinagar*	GSPC India Gasnet Ltd.	725	42.42	24"/18"/16"/12"/8"/6"	0
Kakinada -Vizag- Srikakulam *	A P Gas Distribution Corporation	391	90.00	24"/18	0
Shadol-Phulpur *	Reliance Gas Pipelines Ltd.	312	3.50	16"	304
Ennore- Nellore*	Gas Transmission India Pvt. Ltd.	250	36.00	24"/18"	0
Ennore- Thiruvallur-Bengaluru-Puducherry-Nagapattinam-Madurai-Tuticorin*	Indian Oil Corporation Ltd.	1385	84.67	28"/24"/16"/12"/10"	0
Jaigarh-Manglore*	H-Energy Pvt. Ltd.	635	17.00	24"	0
<b>Total</b>		<b>13821</b>			

Source: PPAC



**Map 1: Select Indian Natural Gas Fields and Infrastructure**



Source: CSR (2017)

## Annex 2: LNG import terminals

*Table 4: Existing, under construction and proposed LNG import terminals*

Plant	Location	Operator / Project Proponent	Start-up	Type	mmtpa	bcm per year	Storage ('000 cm)	Number of Tanks
<b>OPERATING</b>								
Dabhol LNG	Dabhol, Maharashtra	Gail	2013	Onshore	5	6.7	480	3
Dahej LNG	Dahej, Gujarat	Petronet LNG	2004	Onshore	10	13.3	592	4
Hazira LNG	Hazira, Gujarat	Hazira LNG	2005	Onshore	5	6.7	320	2
Kochi LNG	Kochi, Kerala	Petronet LNG	2013	Onshore	5	6.7	310	2
Kochi LNG (expansion)	Kochi, Kerala	Petronet LNG	2015	Onshore	2.5	3.3		
				<b>TOTAL</b>	<b>27.5</b>	<b>36.7</b>	<b>1702</b>	<b>11</b>
<b>UNDER CONSTRUCTION</b>								
Dahej LNG (expansion)	Dahej, Gujarat	Petronet LNG	2017	Onshore	5	6.7	340	2
Dhamra LNG	Dhamra, Odisha	Gail / Indian Oil Corp. / Adani Group	2021	Onshore	5	6.7		
Ennore LNG	Chennai, Tamil Nadu	Indian Oil Corp.	2019	Onshore	5	6.7		
GSPC LNG	Mundra, Gujarat	GSPC LNG	2018	Onshore	5	6.7		2
Jafrabad FSRU	Jafrabad, Gujarat	Swan Energy / Exmar	2019	FSRU	5	6.7		
				<b>TOTAL</b>	<b>25</b>	<b>33.5</b>		
<b>POTENTIAL</b>								
Dabhol LNG (expansion)	Dabhol, Maharashtra	Gail	2017	Onshore	2	2.7		
Dahej LNG (expansion)	Dahej, Gujarat	Petronet LNG	2020	Onshore	2.5	3.3		
Kakinada FSRU	Kakinada, Andhra Pradesh	Gail	2018	FSRU	3.5	4.7		
Mumbai FSRU	Mumbai, Maharashtra	Mumbai Port Trust	2018	FSRU	5	6.7		
				<b>TOTAL</b>	<b>13</b>	<b>17.4</b>		
<b>SPECULATIVE</b>								
Chhara LNG	Chhara, Gujarat	HPCL / Shapoorji						
Dighi FSRU	Dhamra, Odisha	Balaji Infra Projects	2017	FSRU	3.6	4.8		
Dighi LNG	Dhamra, Odisha	Balaji Infra Projects	2018	Onshore	5	6.7		2
Ennore LNG (expansion)	Chennai, Tamil Nadu	Indian Oil Corp.	2020	Onshore	5	6.7		
Fox Petroleum FSRU	Karnataka	Fox Petroleum		FSRU	7.7	10.3	330	
Gangavaram LNG	Visakhapatnam, Andhra Pradesh	Petronet LNG	2018	Onshore	5	6.7		
Gangavaram LNG (expansion)	Visakhapatnam, Andhra Pradesh	Petronet LNG	2020	Onshore	5	6.7		
GSPC LNG (expansion)	Mundra, Gujarat	GSPC LNG	2020	Onshore	5	6.7		
Hazira LNG	Hazira, Gujarat	Hazira LNG		Onshore	5	6.7		
Digha FSRU	Digha, West Bengal	H-Energy	2019	FSRU	6	8		
H-Gas LNG Gateway	Jaigad, Maharashtra	H-Energy	2018	FSRU	8	10.6	380	2
Jafrabad FSRU (expansion)	Jafrabad, Gujarat	Swan Energy / Exmar		FSRU	5	6.7		
Kolkata FSRU	Kolkata, West Bengal	H-Energy - Excelerate Energy	2019	FSRU	4	5.3		
Krishnapatnam LNG	Krishnapatnam, Andhra Pradesh	LNG Bharat						
Mangalore LNG	Mangalore, Karnatak	ONGC-Mitsui	2021	Onshore	3	4		
Mangalore LNG (expansion)	Mangalore, Karnatak	ONGC-Mitsui	2025	Onshore	3	4		
Nana Layja LNG	Nana Layja, Gujarat	IL&FS		Onshore	5	6.7		
				<b>TOTAL</b>	<b>75.3</b>	<b>100.6</b>		

Source: CEDIGAZ LNG Service, Regasification database



## Annex 3: Main LNG contracts

Table 5: Main LNG contracts

Export Country	Export Plant	Seller	Buyer	Type	Terms	Volume (mtpa)	Start	End
Qatar	RasGas 2	RasGas	Petronet LNG	SPA	FOB	5.00	2004	2029
Qatar	RasGas 3	RasGas	Petronet LNG	SPA	FOB	2.50	2009	2034
Qatar	RasGas 3	RasGas	Petronet LNG	SPA	FOB	1.00	2016	2028
Australia	Gorgon LNG	ExxonMobil	Petronet LNG	SPA		1.50	2016	2036
United States	Sabine Pass		Gail	SPA	FOB	3.50	2017	2037
United States	Cameron LNG	Mitsubishi Corp.	Indian Oil Corp.	HoA	DES	0.70	2019	2039
United States	Main Pass		Petronet LNG	HoA		4.00		
<b>Total 1</b>						<b>18.20</b>		
<b>PORTFOLIO SELLERS</b>								
		Gazprom	Gail			3.50	2016	2041
		Shell	Gujarat State Petroleum Co.		DES	1.30	2015	2035
		Gazprom	Gujarat State Petroleum Co.	MoU		2.50	2016	2041
		Gazprom	Indian Oil Corp.	MoU		2.50	2016	2041
		Gazprom	Petronet LNG	MoU		2.50	2016	2041
<b>Total 2</b>						<b>12.30</b>		
<b>TOTAL</b>						<b>30.50</b>		

Source: CEDIGAZ LNG Service, LNG database Contracts Q3 2017



## List of Tables, Figures and Boxes

### Tables

Table 1: Comparison of India gas demand forecasts .....	22
Table 2: Gas Pipeline Network as of 31 March 2017 .....	30
Table 3: Gas Pipeline under Execution / Construction as of 31 March 2017 .....	30
Table 4: Existing, under construction and proposed LNG import terminals.....	32
Table 5: Main LNG contracts .....	33

### Figures

Figure 1: India Primary Energy Supply, 2016.....	6
Figure 2: Natural gas production, consumption and LNG imports in India (2000-2016).....	7
Figure 3: Prices of domestically-produced gas.....	11
Figure 4: Gas demand by sector in FY2015-16 .....	12
Figure 5: Industrial gas consumption by sector in India (2011-2015).....	12
Figure 6: Installed power capacity and electricity generation in FY2015-16 .....	17
Figure 7: Gas consumption by the power sector (2009-2016).....	19

### Boxes

Box 1: Main government initiatives to promote natural gas .....	8
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