“Vision 2030”

Natural Gas Infrastructure in India

Report by Industry Group

For

Petroleum & Natural Gas Regulatory Board

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Acknowledgements

The report on “Vision 2030” – Natural Gas Infrastructure in India was commissioned by the Petroleum and Natural Gas Regulatory Board (“PNGRB”). The report has benefited tremendously from the experience of a team of gas sector experts (nominated by entities on request from PNGRB) who invested their valuable time and also received support from their respective organizations.

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Objective of the study and sub-group participants

The PNGRB in its meeting on 22nd November 2011 decided to form a Industry-group for formulating a Vision 2030 - Natural Gas Infrastructure in India and nominated the companies listed below on the committee. The key terms for the group included projecting the infrastructure required for development of gas sector in India, keeping in view the demand and supply of gas, and existing infrastructure in the country. The terms also included providing suggestions on policy measures to be taken by Government of India / PNGRB to meet the stated objective of development of gas grid in the country.

The sub-group, chaired by BG India, finalized its report in April 2013 and submitted it to PNGRB in May 2013.

List of nominated member companies / organizations and their representatives

- **BG India - Akhil Mehrotra (Chairman)**
- BPCL - Shri Vijay Duggal
- CEA - Shri V K Singh
- Directorate General of Hydrocarbons - Shri Sudhir Kumar
- GSPL - Shri Devendra Agarwal
- GAIL - Shri Ajay Kumar Porwal, Shri Anant Khobragade
- HPCL – Shri Deepak Hota, Shri A V Sarma,
- IOCL – Shri D S Nanaware
- Kribhco /NFL – Shri R K Agarwal , Ms Ritu Goswami
- ONGC – Ms Tinku Nischal
- Planning Commission – Shri Rajnath Ram
- PLL - Shri Man Mohan Ahuja
- Reliance – Shri Neeraj Pasricha , Shri Manoj Pandey
- Shell – Shri Anindya Chowdhury

Disclaimer

This report has been prepared collectively by the committee formed by PNGRB. The contents of the report do not represent the views, strategy, outlook or circumstances of any of the individual committee member companies or their representatives. No representation or warranty, express or implied, is or will be made in relation to the accuracy or completeness of the information in this report and no responsibility or liability is or will be accepted by any of the companies listed as committee member or any of their respective subsidiaries, affiliates and associated companies (or by any of their respective officers, employees or agents) in relation to it.

1 Executive Summary

The Indian economy presently is believed to have established itself on a healthy growth path and this would increase going forward the energy consumption in the country. This increase in consumption is expected to be supplemented by an alteration in the primary energy mix of India on account of the substitution of oil by natural gas. The share of natural gas in the energy mix of India is expected to increase to 20% in 2025 as compared to 11% in 2010[1]. However, given that all the plans for expansion in natural gas supply in the country with the help of additional RLNG terminals, nation wide transmission pipeline network and transnational pipelines are expected to materialize by 2025, it is envisaged that the share of natural gas in the primary energy mix would reach 20% till 2030 if not more.

In recent years the demand for natural gas in India has increased significantly due to its higher availability, development of transmission and distribution infrastructure, the savings from the usage of natural gas in place of alternate fuels, the environment friendly characteristics of natural gas as a fuel and the overall favourable economics of supplying gas at reasonable prices to end consumers. Power and Fertilizer sector remain the two biggest contributors to natural gas demand in India and continue to account for more than 55% of gas consumption. India can be divided into six major regional natural gas markets namely Northern, Western, Central, Southern, Eastern and North-Eastern market, out of which the Western and Northern markets currently have the highest consumption due to better pipeline connectivity. However, with the increasing coverage and reach of natural gas infrastructure in India, this regional imbalance is expected to get corrected. ***In future, the natural gas demand is all set to grow significantly at a CAGR of 6.8% from 242.6 MMSCMD in 2012-13 to 746 MMSCMD in 2029-30.*** This demand represents the Realistic Demand[2] for natural gas in India. Gas based power generation is expected to contribute the highest, in the range of 36% to 47%, to this demand in the projected period (2012-13 to 2029-30). The share of fertilizer sector in the overall gas consumption in the country is expected to go down from 25% in FY 2013 to 15% in FY 2030 owing to higher growth in other sectors. The contribution to the overall demand from the CGD sector is set to increase from 6% to 11% during the projected period. The demand from CGD sector includes demand for combined heating and cooling power plants ("CCHP") from Industries. The consolidated demand for natural gas from 2012-13 to 2019-30 has been summarized in Table below.

[1] As per the 'Hydrocarbon Vision 2025' report

[2] Realistic demand means the demand estimated after considering limiting factors that are likely to restrict growth in demand.

***Table:* Consolidated segment wise demand for natural gas from 2012-13 to 2029-10**

MMSCMD	2012-13	2016-17	2021-22	2026-27	2029-30
Power	86.50	158.88	238.88	308.88	353.88
Fertilizer	59.86	96.85	107.85	110.05	110.05
City Gas	15.30	22.32	46.25	67.96	85.61
Industrial	20.00	27.00	37.00	52.06	63.91
Petchem/Refineries/Internal Cons.	54.0	65.01	81.99	103.41	118.85
Sponge Iron/Steel	7.00	8.00	10.00	12.19	13.73
Total Realistic Demand	**242.66**	**378.06**	**516.97**	**654.55**	**746.03**

The supply of natural gas is likely to increase in future with the help of increase in domestic gas production and imported LNG. However, the expected increase in domestic production at present is significantly lower than earlier projections due to a steady reduction in gas output from the KG D6 field. The capacity of RLNG terminals in India is expected to increase from 17.3 MMTPA in 2012-13 to 83 MMTPA in 2029-30 assuming all the existing and planned terminals in India would materialize. Natural gas availability through non-conventional sources like Shale Gas and Gas Hydrates has not been considered in gas supply projections in the absence of clarity on key variables like data as most of India remains unexplored/underexplored, regulatory policy and lack of domestic infrastructure. ***The total supply of natural gas is expected to grow at a CAGR of 7.2% from 2012 to 2030 reaching 400 MMSCMD by 2021-22 and 474 MMSCMD by 2029-30. The supply profile for the projected period has been provided in Table below.***

***Table:* Consolidated source wise supply of natural gas from 2012-13 to 2029-30**

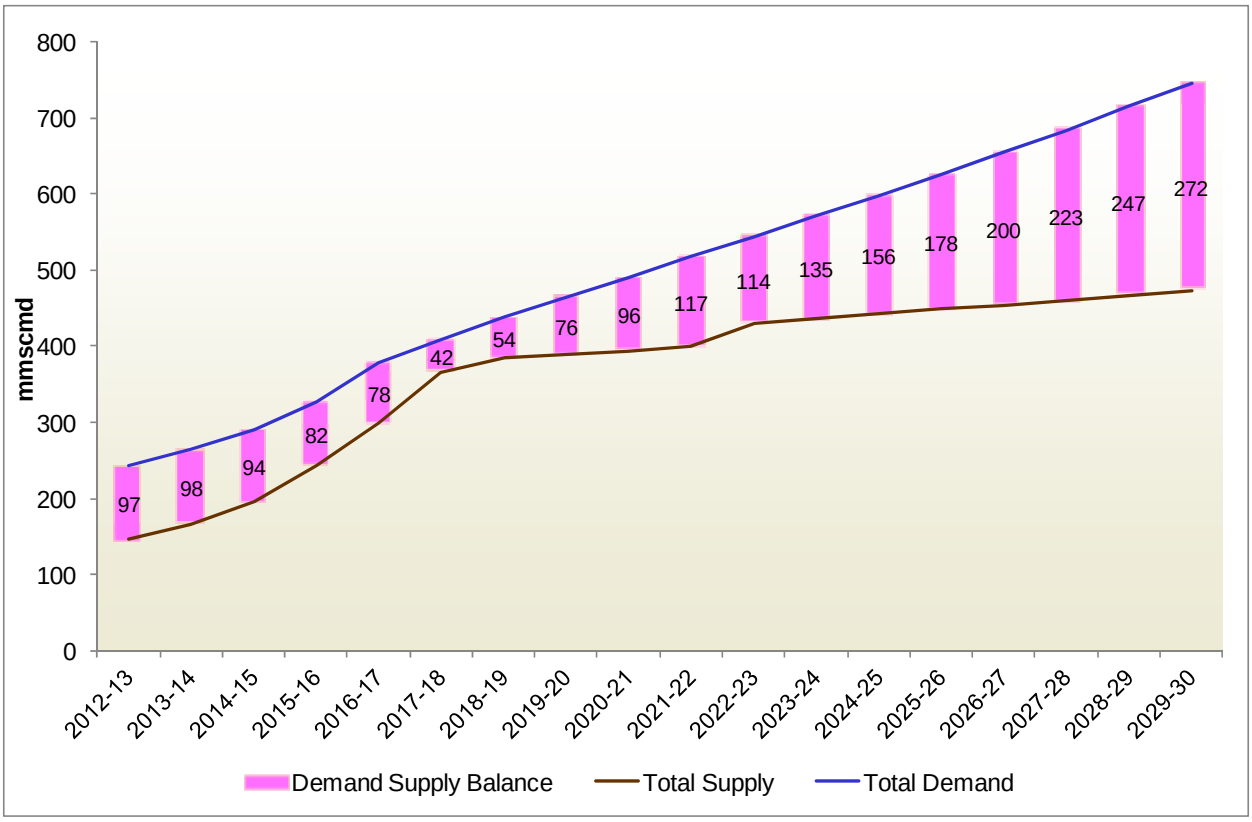
MMSCMD	2012-13	2016-17	2021-22	2026-27	2029-30
Domestic Sources	101.1	156.7	182	211	230
LNG Imports	44.6	143.0	188	214	214
Gas Imports (Cross border Pipelines)	0.0	0.0	30.0*	30.0	30.0
Total	**145.7**	**299.7**	**400**	**454**	**474**

* TAPI pipeline projected to get commissioned in 2017-18

The above projections for 2012-13 from domestic sources have gone down to circa 85mmscmd as of January 2013 primarily due to steady reduction in supply from KGD6 fields, which could get backfilled by other sources like RLNG in the interim.

The availability of natural gas in India is expected to fall short of the total natural gas demand by around 97 MMSCMD in 2012-13. However, this shortfall will reduce by 2017-18 due to substantial addition in regasification capacity and natural gas supply through cross border pipeline (TAPI). The demand-supply gap is likely to again increase post 2017-18 and reach about 272 MMSCMD by 2029-30 as increase in supply lag behind a steady increase in demand. The demand-supply gap that is likely to prevail over the projected period has been depicted in the graph below.

***Figure:* Demand Supply balance of natural gas from 2012-13 to 2029-30**



India, currently, has a network of about 13,000 km of natural gas transmission pipelines with a design capacity of around 337 MMSCMD. This pipeline network is expected to expand to around 28,000 Kms with a total design capacity of around 721 MMSCMD in next 5-6 years, putting in place most of the National Gas Grid that would connect all major demand and supply centre in India. This would ensure wider availability across all regions and also potentially help to achieve uniform economic and social progress. A summary of planned additions to the natural gas infrastructure in India during the projected period has been provided in the Table below.

***Table:* Summary of Planned additions to pipeline infrastructure**

Pipelines	Design Capacity (mmscmd)	Length (Kms)
Existing till 2012	306	12144
Expected addition in the 12th plan	416	15928
Expected addition in the 13th plan	60	3360
Capacity addition MBBVPL/MBPL/Surat Paradip/pipelines beyond 13th plan & till 2030	33	1295
Total	**815**	**32,727**

The design capacity of pipeline network in India is expected to reach 815 MMSCMD in 2029-30. However, considering the addition of capacity directly linked to the existing/planned sources of natural gas in the country, the gas grid capacity in India (pipeline emanating from source) is expected to reach 582 MMSCMD in 2029-30 from the present 274 MMSCMD. This capacity is expected to take care of the natural gas supply scenario in the projected period. In addition to the trunk lines regional gas pipelines, similar to the intra-state network of Gujarat, are recommended for highly industrialized states. It is expected that going forward the Southern and Northern part of India would catch-up with the Western part in terms of pipeline infrastructure while Eastern and North Eastern part of the country would lag behind and would require policy boost for industrial development to attract more investments.

Today, the natural gas sector is at the threshold of rapid growth in India supported by ever increasing demand for natural gas in the country, increased exploration efforts under NELP, commissioning of the LNG import terminals in the West Coast, projected upcoming LNG terminals and the Government's initiatives in the direction of development of a nation wide natural gas pipeline grid. However, there is a need to provide a proactive enabling environment to support the fast-paced development of natural gas infrastructure. An enabling environment includes providing desired policy support and the correct pricing signals for investment in the sector, reforming the present set of regulations to adopt to changing needs and making them more robust and addressing the distortions in the fiscal regime applicable for natural gas.

The Government of India ("GoI") currently allocates gas produced domestically as per Gas Utilization policy. This creates artificial demand and discourages new suppliers and hence need to be progressively removed. A free market without compromising the long term objectives of the nation would be a more prudent approach. The aim of the gas policy should be to attract investments and develop gas markets Policy initiative should be taken to facilitate development of a market for gas through initiatives like developing trading hubs and trading platform to discover prices and thereby creating sufficient depth in the Indian natural gas market. This would help more investment find its way into the hydrocarbon exploration and infrastructure sector and ensure efficient usage of the infrastructure.

To meet the growing demand for gas GoI need to achieve the objective of attracting investments in the upstream and midstream gas sector. Key to this would be sending the right price signals which could be achieved by reforms in the power and fertilizer sector (main consumers of gas) to increase their affordability. The government should also evaluate alternatives to the present differential tax regime for gas which is hindering free movement and swaps.

Certain regulatory reforms remain critical to the development and efficient usage of natural gas infrastructure In India. A fair and transparent access to the pipeline infrastructure is a key for movement of gas volumes. Currently the regulations provide for open access and have mandated accounting separation between transportation and marketing activities. To further develop the market the regulator should unbundle (legal unbundling) the marketing and transportation activities in next 2-3 years time. This would prevent restrictions imposed by pipeline companies through non-price measures on competition. Post legal unbundling the timing of ownership separation can be determined by the regulator based on factors like transparency adopted by transportation companies in dealing with their trading affiliates, number of shippers in the business and the choice exercised by consumers.

In addition to unbundling, in order to facilitate pipeline infrastructure sharing there is a need for a robust open access code for the natural gas pipelines. Establishment of a market for natural gas transportation would promote transparent and fair pricing of transportation service. A switch to a suitable tariff system like the 'Entry Exit system or a hybrid system, which encourages competition in the market as well as provide services to the customers at the reasonable tariff, particularly to customers at geographically disadvantageous locations, with due customization keeping in view the multi-ownership, tax systems, etc from the present Zonal tariff system should be considered. The development and usage of bulletin boards would facilitate gas trading and pipeline capacity trading by providing system and market information. Constituting a independent Pipeline System Operator (PSO) once major pipelines are build is expected to streamline tariff-sharing among various pipeline system owners.

Overall the gas sector in India has shown modest growth in the past. Substantial investment in infrastructure relating to import of LNG and transportation of domestic gas across India is planned for the next 5-6 years. The current planned investments along with incremental investments in future would be sufficient to meet the growing demand for gas from various consumers segments. In order to ensure the projects get implemented on a fast tract basis, GoI and PNGRB need to take various policy and regulatory measures as suggested in the report. This would help sustain higher investments in the gas chain including exploration leading to a sustained and healthy growth of the sector, ensuring that the share of gas is at least 20% in the primary energy mix by 2030.

2 Natural Gas – Demand/ Supply Dynamics

The Indian economy has been projected to achieve an average real GDP growth of 6.4% during 2008-2035[3]. Energy availability is key to economic growth and therefore, going forward high economic growth would lead to increase in the energy consumption of the country. The primary energy mix of India is also set to alter on account of the substitution of oil by natural gas. The share of natural gas in the energy mix is expected to increase to 20% in 2025 and beyond as compared to 11% in 2010[4]. The expected change in the primary energy basket for India in 2010 and 2025 has been presented in Table 1. Based on the plans for expansion in natural gas supply in the country with the help of additional RLNG terminals, nation wide transmission pipeline network and transnational pipelines expected to materialize in next 5 to 10 years, it is envisaged that the share of natural gas in the primary energy mix would reach 20% till 2030. However to achieve a 20% share of natural gas in the primary energy it is required to attract and sustain investments in the gas infrastructure including the cross country pipelines.

Table 1 Primary energy mix for India

Source	2010	2025
Coal	53%	50%
Oil	30%	25%
Gas	11%	20%
Hydro	5%	2%
Nuclear	1%	3%
	100%	100%

Historically, natural gas was significantly cheaper than alternate fuels like motor spirit, naphtha, diesel and LSHS/FO. Although the price of natural gas is steadily increasing (especially of imported gas), newer technology and larger plants have now made it possible to ensure efficiency and economies of scale enabling increase in usage of natural gas. Therefore natural gas has now become the preferred fuel for fertilizers, petrochemicals and has made inroads into power generation segment. Further, planned investments in the power, fertilizer, petrochemical and other areas including City Gas Distribution suggest a sustained increase in the level of natural gas consumption in the country.

2.1 Present Demand Scenario

Natural Gas demand has increased significantly in recent years due to the increase in the availability of gas, development of transmission and distribution infrastructure, the savings from the usage of natural

[3] As per International Energy Agency (IEA) –world energy outlook 2010 report
[4] As per Hydrocarbon Vision 2025 report

gas in place of alternate fuels and the overall favourable economics of supplying gas at reasonable prices to end consumers. It has become easier for the power, fertilizer and CGD sectors, as well as industrial and commercial establishments, to switch over to natural gas for their energy requirements. In the near future power and fertilizer sectors are expected to remain the anchor segments for natural gas demand in India. Going forward though, with the additional supply of gas significant demand for natural gas is also expected to come from the industrial (usage both in process and power generation - cogeneration) and CGD segments.

The total consumption of natural gas was 127 mmscmd (January 2013) with power and fertilizer sectors consuming 36 and 39 mmscmd of gas respectively. While power sector consumption accounted for 28% of the total natural gas consumption in India, the fertilizer sector consumption accounted for 31% of the total consumption. The sector wise consumption has been presented in Table 2.

Table 2 Sector wise natural gas consumption in India (January 2013)

Sector	Domestic Gas	RLNG	Total Consumption	% of total supply
Power	30.36	5.80	36.2	28%
Fertilizers	31.02	8.37	39.4	31%
CGD/CNG	6.69	7.28	14.0	11%
Court Mandated Customers	0.98	2.89	3.9	3%
Shrinkage for liquid extraction - LPG etc.	6.02	0.37	6.4	5%
Refineries	2.07	8.62	10.7	8%
Petrochemicals	3.5	1.37	4.9	4%
Sponge Iron/Steel	1.11	3.49	4.6	4%
Small consumers (<50,000 scmd)	2.38	0.01	2.4	2%
Other users	0.75	3.29	4.0	3%
Internal Consumption in pipelines	1.45	0	1.5	1%
Total	**86.33**	**41.49**	**127.8**	100.0%

India can be divided into six major regional natural gas markets namely Northern, Western, Central, Southern, Eastern and North-Eastern market. Out of these, the Western market accounts for the highest consumption of natural gas with more than 50% of the total gas consumption in the country. This is followed by the Northern market that consumes ~25% of the overall consumption. The Eastern market accounts for the lowest consumption in the country among all the gas markets. The major Indian gas markets and their share of natural gas consumption have been provided in Table 3.

Table 3 Regional gas markets in India

Region	% of consumption	States with infrastructure and consuming gas	States lacking pipeline infrastructure
Western	53%	Gujarat, Maharashtra	Goa
Northern	26%	Delhi, UP, Haryana, Rajasthan	Punjab, J&K, Himachal Pradesh, Uttarakhand
Central	3%	Madhya Pradesh	Chattisgarh
Southern	14%	Tamil Nadu, Andhra Pradesh	Kerala, Karnataka
Eastern	NIL	-	Bihar, West Bengal, Jharkhand, Orissa
North Eastern	4%	Assam, Tripura	Meghalaya, Sikkim, Arunachal Pradesh, Mizoram, Manipur, Nagaland

Source - Saumitra Chaudhuri report on Policy for pooling of natural gas prices and pool operating guidelines

At present, natural gas markets remain mostly limited to the states where gas sources have been found. States closer to the gas source or having pipeline infrastructure (HVJ pipeline) have had the benefits of higher availability of gas and local development of gas market e.g. Gujarat, Maharashtra, Northern markets, Andhra Pradesh, etc. Other states like Punjab, Haryana, Jharkhand, Uttarakhand, Karnataka, Kerala, Bihar, Chattishgarh, etc. have not been able to utilize benefits of gas due to lower gas availability and inadequate pipeline infrastructure.

2.2 Demand Projections

The Power, Fertilizer, Industrial and CGD segments are expected to contribute to the bulk of future growth of natural gas demand in India. Natural gas demand from the power sector is expected to be driven, not only by the shortage of domestic coal supply and the rising cost of its substitute i.e. imported coal but also by increased domestic gas supply and power sector reforms. Fertilizer industry is the only industry that uses chemical and thermal heat of gas for its production and remains a major contributor to the natural gas demand in the country. A higher emphasis on food security in India and increasing import price of urea are expected to drive the demand from the fertilizer sector. Rising price of crude oil/Naptha was one of the drivers for the rising gas demand from Fertilizer units and is also expected to remain one of the drivers from Industrial users as the price of the alternate fuels (Naphtha/FO) used by them is linked to crude oil. Focus on the reduction of subsidy burden by GoI is further expected to pull the demand from the Fertilizer units in the country. The process of addressing environmental concerns is expected to drive the demand of natural gas from the industrial users as well as Compressed Natural Gas (CNG) users in the CGD segment. Factors like availability of domestic gas, import of LNG and development of requisite infrastructure are also expected to push the growth of natural gas demand from the CGD user segment. The key demand drivers for key user segments have been summarized in Table 4.

Table 4 Demand drivers for various end user segments

Sector	Demand Drivers
Power Sector	✓ Rising cost of imported coal ✓ Constrained domestic coal supply ✓ Supply of domestic gas ✓ Power sector reforms ✓ Fast-growing economy
Fertilizer Sector	✓ Greater emphasis on Food Security ✓ Increase in import price of Urea ✓ Rising price of crude oil ✓ Subsidy burden ✓ Conducive Govt. Policy for new investment in urea manufacturing units
Industrial User Segment	✓ Rising price of crude oil ✓ Environmental concerns
City Gas Distribution	✓ Environmental concerns ✓ Subsidy burden ✓ Enabling policy framework ✓ Supply of domestic gas ✓ Availability of affordable RLNG ✓ Requisite infrastructure ✓ GDP / Household income

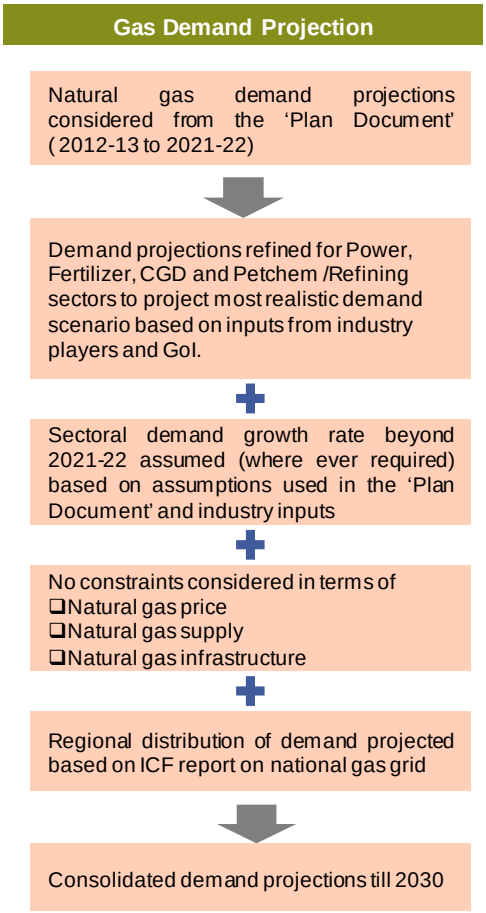
In terms of the sensitivity of demand to natural gas price the demand arising from the power and fertilizer sectors is expected to remain highly sensitive to the price at which the entities in these sectors are able to procure gas due to the issues around affordability by end consumers of basic food products and electricity. However, the demand from other consuming sectors is expected to remain relatively resistant to the price levels at which gas becomes available.

2.2.1 Approach & Methodology

Demand projection has been done from the year 2012-13 to 2029-30 using the 'Plan Document' as the main reference. Projection of potential demand for different consumer categories provided in the Plan Document from 2012-13 to 2021-22 have been analyzed and then refined (based on current and planned investment in the user segments), where ever required, in order to project the most likely demand scenario till the end of the 13th five year plan. These refined projections have then been used to project demand from 2022-23 till 2029-30 with the help of assumptions derived from various inputs from industry. The natural gas demand projected from 2012-13 to 2029-30 represents **'Realistic Demand'** of natural gas that takes into account the restrictions posed by the limiting factors including the delayed commissioning of end use infrastructure e.g. power and fertilizer plants, the lack of policy directives in end user segments, slow pace of regulatory reforms in natural gas sector as well as consumer segments and unviable economics of end use projects.

The approach and methodology adopted for projecting demand from 2012-13 and 2029-30 has been summarized in Figure 1.

Figure 1 Demand Projection Methodology



The sectoral demand projected till 2030 as per the above methodology has been discussed in detail in the following sub sections.

2.2.2 Power Sector Demand

Power sector has been the biggest consumer of natural gas in India in the past and is expected to remain so going into the future. However, the future demand for natural gas from the sector is likely to be constrained by the ability of the power plants to pay for a higher fuel expense, reduced availability of domestic gas supply and power sector reforms.

Gas contributes to about 10% of power generation in India. Gas based power generation is constrained by the higher cost of gas as a fuel and its availability across all the regions. In recent years the Plant Load Factor (PLF) of gas based power plants has dropped to around 50% due to lack of natural gas availability at affordable prices. Natural gas demand for gas based power generation remains highly price sensitive and it is expected to fall drastically at a price in excess of $8-$9/MMBTU. In future, the ability of power sector to absorb higher priced RLNG is likely to increase with the help of power sector reforms linked to periodic tariff revisions, peaking power regulation, time-of-day tariff, robust open access norms etc. The shortage in natural gas supply has hampered the capacity addition and performance of the existing plants. Allocation of domestic gas to power sector will remain constrained due to competing demand pressures from the fertilizer and petrochemical sectors.

Power sector consumed around 36.2 MMSCMD of gas (January 2013) which was 28% of total gas consumption in India. The total Installed Generation Capacity in the country by the end of 11th Plan (as on 31.03.2012) is 1,99,877 MW comprising 38,990 MW Hydro, 1,31,603 MW Thermal (including 18,381 MW from gas), 4,780 MW nuclear based power plants and 24,503 MW from renewable energy sources including wind. The region-wise and fuel-wise details of installed capacity in India as on 31st March 2012 is provided in Table 5:

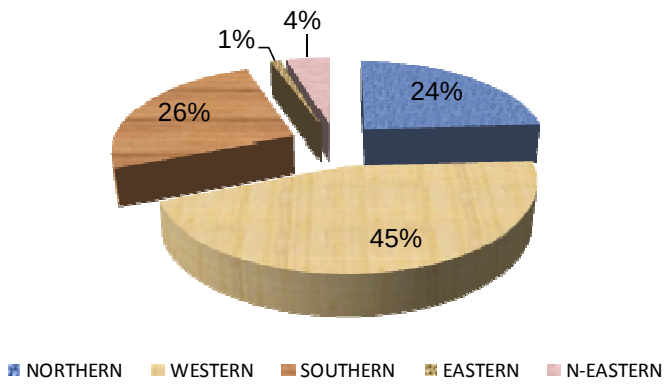
Table 5 SUMMARY OF INSTALLED CAPACITY AS ON 31.03.2012

REGION	Hydro	Thermal				Nuc-lear	Rest	Total
		Steam *	Gas	Diesel	Total			
NORTHERN	15,123	28,358	4,421	13	32792	1,620	4,391	53,926
WESTERN	7,447	38,924	8,255	18	47,197	1,840	7,910	64,394
SOUTHERN	11,338	22,882	4,691	939	28,513	1,320	11,569	52,740
EASTERN	3,882	21,798	190	17	22,005	-	399	26,286
N-EASTERN	1,220	60	824	142	1,026	-	228	2,454
ISLANDS	0	-	-	70	70	-	6	76
ALL INDIA	**38,990**	**1,12,022**	**18,381**	**1,200**	**1,31,603**	**4,780**	**24,503**	**1,99,877**
% OF TOTAL	**19.4**	**56.4**	**9.1**	**0.5**	**66.0**	**2.4**	**12.1**	**100**

* Generated with coal as fuel

The power generation capacity based on gas in India stands highly concentrated in the western region. The region accounts for 45% of the total gas based power capacity. Northern and Southern regions of the country contribute about 25% to the total power generation based on gas. The region wise break up of total gas based power generation capacity in India as of 31 March, 2012 has been provided in Figure 2.

Figure 2 Region wise gas based power generation capacity (%)



The total gas demand for existing (as on 31st March 2012) gas based generating capacity of 18381 MW ***(Annexure I)*** at 90% PLF works out to be about 88 MMSCMD [5]. However, average gas supply/consumption during 2011-12 for these power projects was only about 56 MMSCMD (including RLNG), primarily due to lesser production/availability of gas in the country. In light of the reduced production of KG basin and the likely availability of gas during 12th Plan from other sources, it may be difficult to make available gas to power projects for operation at 90% PLF and therefore natural gas supply for the capacity existing in the country has been considered at 68.4 MMSCMD (70-75% PLF) in this report.

In order to meet the increasing demand for electricity and to reduce the CO_2 emissions, a substantial gas based capacity is desirable. Besides being environmentally benign, the gas projects have high efficiency, have benefit of low gestation period, and require less land and water. Coal based stations have a long gestation period and also the domestic coal production is not keeping pace with the requirements of the power sector. Thus, promotion of gas based generating capacity in the country is essential. Keeping in view the requirement and the increasing shortage of coal during the 12th plan period, there is an urgent need to plan for additional gas based capacity to the tune of 25000 MW. This additional Gas Turbine (GT) capacity will help in reduction of our Greenhouse Gas (GHG) emissions and meeting the shortfall which is expected due to delay in commissioning of the ongoing thermal and hydro projects. Central Electricity Authority (CEA) has received applications for allocation of gas for about 1,30,000 MW capacity from

[5] Assuming 4.8MMSCMD for 100 MW at 90% PLF

various states, Central Public Sector Undertaking's(CPSU's) and Independent Power Producers (IPPS) for which about 600 MMSCMD gas is required. Out of these proposed projects, many projects can be commissioned within next 2-3 years provided gas is made available. However, considering ground reality of reduced gas availability in the country, it is difficult to presently plan for 25,000 MW gas based generation capacity addition during the 12th Plan.

In view of above, during the 12th plan period gas capacity of only 2539 MW (comprising 1452 MW slipped capacity from 11th Plan and 1087 MW for which gas is proposed from local sources) has been considered. The gas requirement for these projects ***(Annexure II-(A))*** is expected to be 9.47 MMSCMD. In addition to above, many gas based power projects in private sector are under advance stage of construction and awaiting gas supply for testing/commissioning and commercial operation. Some of these projects were expected to be commissioning during the 11th Plan, if timely gas was made available. However, these projects can be commissioned during 2013-14 if gas is made available. All these projects ***(Annexure II-(B))*** would require 28.56 MMSCMD. There are a few other projects for which orders have been placed and are under construction/ construction delayed due to uncertainty of gas availability. These projects ***(Annexure II-(C))*** can also be commissioned during 12th Plan if gas availability is ensured and would require around 16 MMSCMD gas. Ministry of Power has also recommended for allocation of gas to certain projects ***(Annexure II-(D))*** in State Sector, targeted for commissioning during 12th Plan, if gas availability is assured. A gas requirement of about 24 MMSCMD exists on account of these projects.

Also, it is proposed that during the 12th plan period at least 2000 MW gas based peaking power plants and 2000 MW CCHP plants having higher efficiency above 70 % should be promoted. The combined requirement of these plants would be about 12 MMSCMD (4 MMSCMD for peaking plants & 8 MMSCMD for CCHP plants). These plants can be commissioned within a short span of about 2-3 year subject to gas availability & policy reforms to promote peaking and CCHP plants.

Considering the gas requirement for power sector discussed above, the total gas demand of power projects by the end of 12th Plan (2016-17) works out to be about 199 MMSCMD (corresponding to 90% PLF) and 159 MMSCMD if gas is made available at lower PLF of 75%/70% for projects. Keeping in view the reduced production of KG basin and likely availability of gas during 12th Plan from other sources, it is felt that it may be difficult to make available gas to power projects for operation at 90% PLF. Therefore a demand of 157 MMSCMD at 75% PLF in 2016-17, which appears to be more realistic for power sector, has been considered in this report. The break up of demand for natural gas for power sector in the 12^{th} five year plan has been provided in the Table 6.

Table 6 Gas Demand for Power Projects by End of 12th Plan (2016-17)

S.No	Project Category	Capacity (MW)	Gas Demand at 90% PLF (MMSCMD)	Gas Demand at 75%/70% PLF
				(MMSCMD)
1	**Existing Projects**	**18381.05**	**88.00**	**68.4**
	(end of 11th Plan as on 31.03.2012)			
2	Incremental Demand for 12th Plan Projects			
	A: Planned Projects for 12th Plan (Under Construction/ Partly commissioned)	2538.60	12.20	9.47
	B: Projects Under Advanced Stage of Construction (Ready for commissioning)	7346.5	35.34	28.57
	C: Projects with delayed construction due to non availability of gas	4201	20.16	16.18
	D: Gas Requirement of power projects Recommended by Ministry of Power	6450	30.96	24.26
	E: Gas Requirement for Peaking & CCHP plants **	4000	12	12
	Sub-Total (12th Plan Demand)	**24536.1**	**110.66**	**90.48**
3	**Total (End of 12th plan i.e 2016-17)**	**42917**	**198.66**	**158.88**

** Considering daily operation of peaking plants for 5-6 hrs and CCHP operation at 75% PLF

The additional requirement in the generation capacity beyond 12th Plan is yet to be ascertained, however keeping in view the growing demand for power in the country, it may be assumed that about 90,000 - 1, 00,000 MW incremental capacity would be required during each Five year plan beyond 12th Plan out of which about 20,000 MW would be gas based capacity (given the low carbon growth strategy of the country), during each 13th, 14th & 15th Plans. An incremental gas demand of about 75 MMSCMD corresponding to 20,000 MW capacity has thus been assumed during each Plan beyond 12th plan till year 2030. It should be noted however that actual demand of natural gas for power sector would depend upon gas pricing, gas availability, power sector reforms and actual gas based capacity addition planned during each subsequent plan.

Natural gas demand for gas based power generation projected for the period 2012-13 to 2029-30 has been provided in Table 7 and Table 8. The demand for gas for gas based power generation is expected to grow at a CAGR of 8.6% over the projection period i.e. from 2012-13 to 2029-30.

Table 7 Power Sector Gas Demand - 12th and 13th five year plan

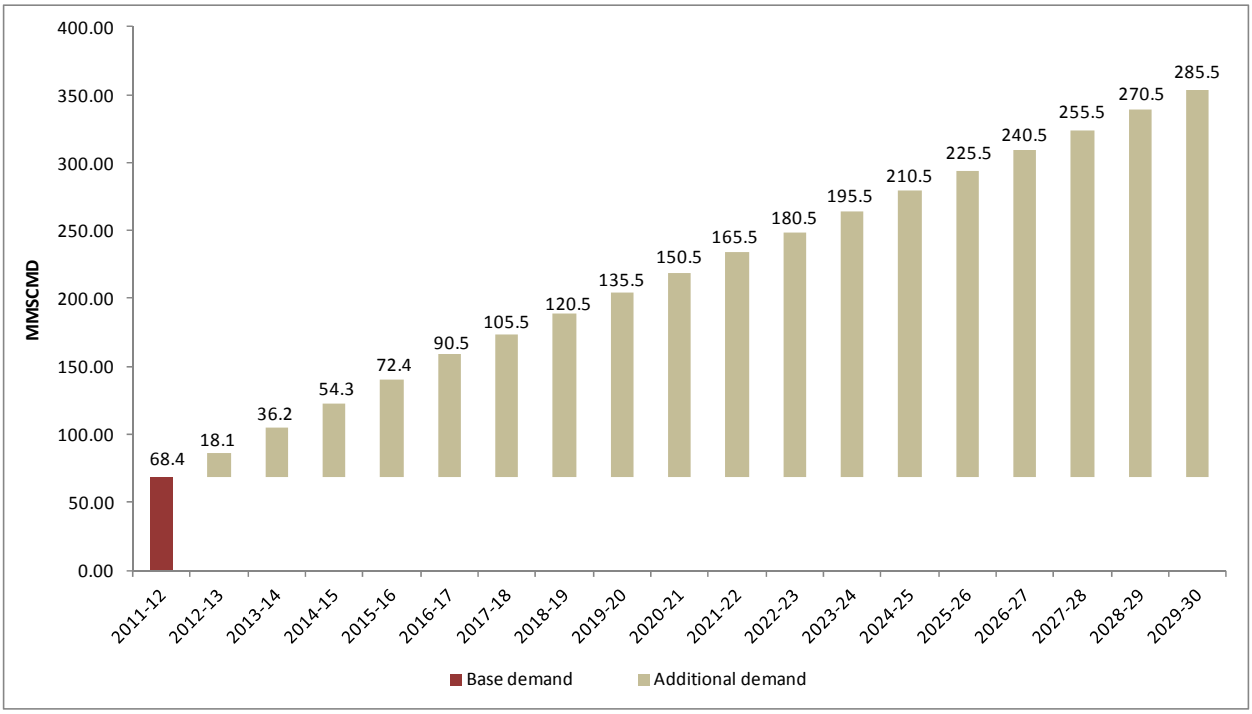
	12th plan					13th plan				
MMSCMD	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Power sector demand	**86.50**	**104.59**	**122.69**	**140.78**	**158.88**	**173.88**	**188.88**	**203.88**	**218.88**	**233.88**

Table 8 Power Sector Gas Demand - 2023 to 2030

MMSCMD	**2022-23**	**2023-24**	**2024-25**	**2025-26**	**2026-27**	**2027-28**	**2028-29**	**2029-30**
Power sector demand	**248.88**	**263.88**	**278.88**	**293.88**	**308.88**	**323.88**	**338.88**	**353.88**

The year-on-year addition in natural gas demand for power sector has also been shown in Figure 3. An overall addition of 285 MMSCMD is expected to happen over the projection period, taking the total demand to 353.8 MMSCMD in 2029-30.

Figure 3 Gas demand for power sector from 2012-13 to 2029-30



2.2.3 Fertilizer Sector Demand

Fertilizer sector currently is the top priority gas user segment under the domestic gas allocation policy. The sector consumed around 31% of total gas consumption in the country which is the highest in the list of the biggest gas consuming sectors.

The fertilizer industry (Nitrogen based plants that consume gas) is regulated by the Ministry of Fertilizer, GoI and its policies administer the production as well as price of fertilizer. Today, there are around 31 plants in India engaged in the manufacturing of urea. These plants have been categorized on the basis of usage of various feed stocks used in urea production like natural gas, naphtha and fuel oil / LSHS. In 2010-11 the total gas requirement of urea plants **(Annexure - III)** in the country stood at 43 MMSCMD. Switch over of plants **(Annexure – IV (A))** based on substitute feedstock to natural gas is estimated to generate an additional annual demand of 10-15 MMSCMD [out of which circa 4 mmscmd arising out of switchover of fuel oil based plants is urgently required as huge investments have already been made for these projects and these projects cannot shift to fuel oil /LSHS once converted to gas] and the revival of closed urea units **(Annexure – IV (B))** is expected to require annually another 14-15 MMSCMD , from 2012-13 to 2029-30. Planned expansions **(Annexure – IV(C))** of existing urea units and Greenfield urea projects **(Annexure – IV (D))** that are at various stages of implementation and are awaiting favourable fertilizer policy are also expected to contribute to the natural gas demand in future.

For projecting demand from 2012-13 to 2029-30, the gas requirement of 43 MMSCMD in 2010-11 has been considered as the base demand. Annual addition in demand over and above this demand has been estimated based on the gas requirement for the list of Revamp projects **(Annexure – IV(E))**, Naphtha based plants, Fuel oil plants, planned expansions, closed units and Greenfield projects as provided in the 'Plan Document'. However, the phasing of gas requirement against the revival of closed units, expansion units and Greenfield projects has been adjusted to account for the 'on-the-ground' progress of revival, expansion or commissioning of plants. It is important to note here that for the estimation of annual addition in demand, constraints linked to affordable pricing, gas infrastructure and gas supply have not been taken into consideration. The demand for this user segment is highly price sensitive in nature and would depend on the affordable gas price as per the new fertilizer policy of Government of India.

In the long term, demand for fertilizer sector is expected to reach 97 MMSCMD by 2016-17 and 108 MMSCMD by 2021-2022. Future gas demand projection for fertilizer sector is provided in Table 9 and Table10.

Table 9 Fertilizer Sector Gas Demand - 12th and 13th five year plan

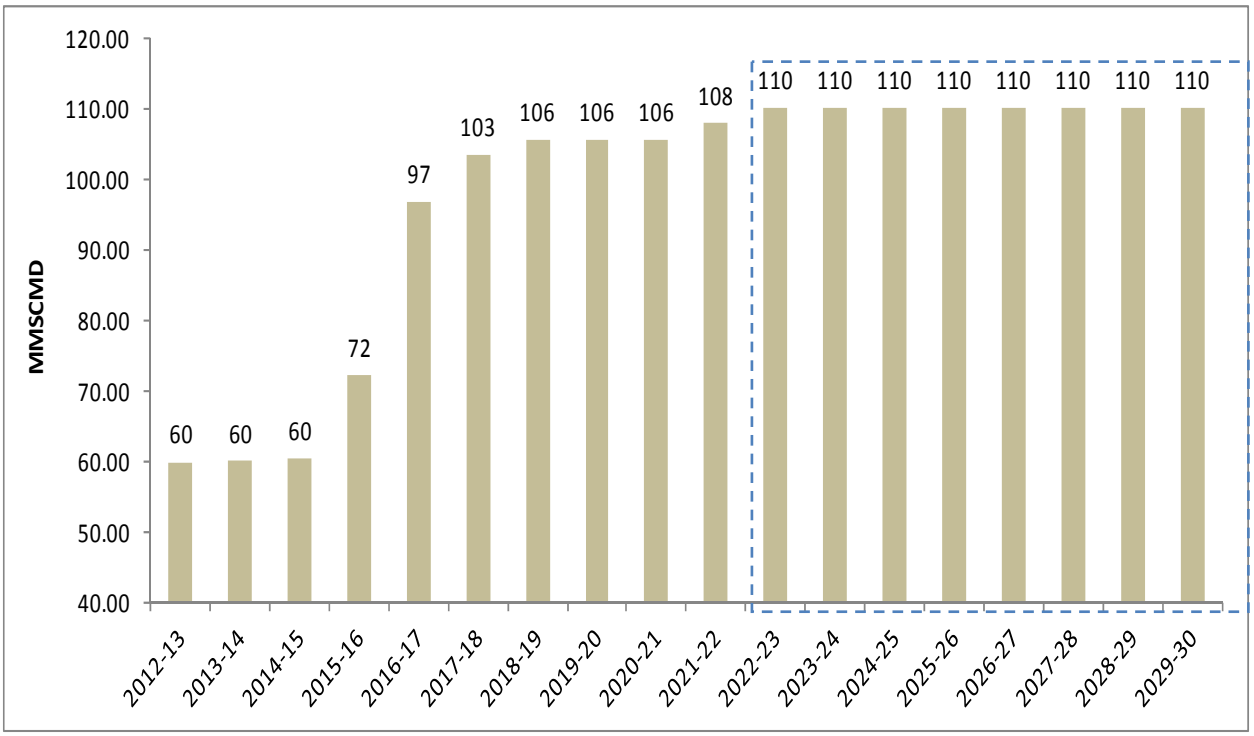
	12th plan					13th plan				
MMSCMD	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Fertilizer sector demand	**59.86**	**59.96**	**60.39**	**72.09**	**96.85**	**103.45**	**105.65**	**105.65**	**105.65**	**107.85**

Table 10 Fertilizer Sector Gas Demand - 2023 to 2030

MMSCMD	**2022-23**	**2023-24**	**2024-25**	**2025-26**	**2026-27**	**2027-28**	**2028-29**	**2029-30**
Fertilizer sector demand	**110.05**	**110.05**	**110.05**	**110.05**	**110.05**	**110.05**	**110.05**	**110.05**

Post 2022-23, no further addition in demand is anticipated till 2030, but the same may change based upon the drivers elaborated in Table 4.

Figure 4 Gas demand from fertilizer sector: 2012-13 to 2029-30



2.2.4 CGD Sector Demand

City Gas Distribution (CGD) sector in India has seen rapid growth in recent years and consumes approx. 13.6 MMSCMD ***(Annexure – V)*** of natural gas. There are 15.22 lakh domestic connections, 10,631 commercial customers and 2974 industrial customers at present in India. In the City Transport Sector, there are presently around 588 CNG filling stations servicing around 1.2 million vehicles[6].

CGD sector has relatively high affordability and has the capacity to absorb prices of gas higher than power and fertilizer sectors. Usage of natural gas has proved to be economical vis-a-vis competing fuels for most of the user segments within the CGD space. Natural gas demand for CGD sector is expected to rise steadily due to the addition of gas networks in new cities, price advantage of CNG and increased use of PNG in domestic, industrial and commercial sectors. Environmental concerns will further push the use of natural gas especially in the automotive and industrial segment (coal replacement).

For projecting the natural gas demand for this user segment a base demand of 13.6 MMSCMD has been considered in 2010-11 which takes into account the gas consumption by all the existing CGD entities in India. The cumulative sales volumes for three major CGD players IGL, MGL and GGCL grew at around 8%-9% form 2007 to 2011. However, this rate of growth is expected to slow down as the existing businesses become mature on higher base effect. Therefore, the natural gas demand from the existing CGD entities has been assumed to grow at a rate 20%-30% lower than their growth rate in the past five years till the end of 13th five year plan.

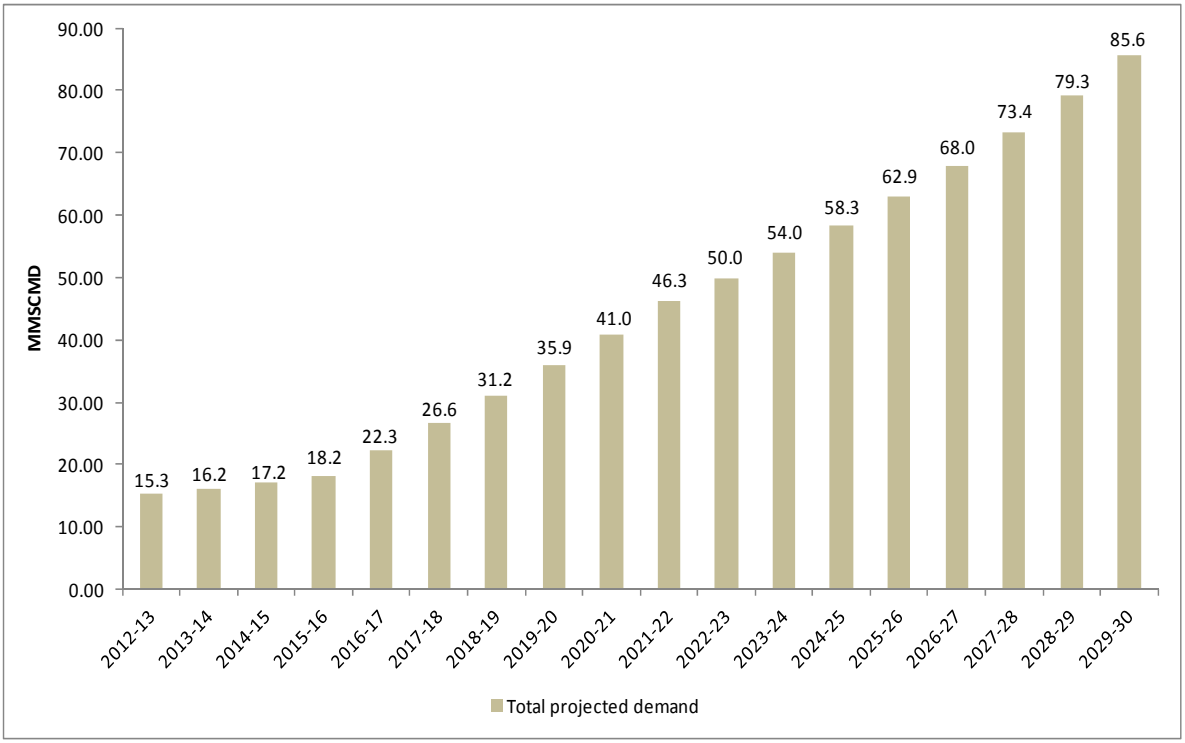
Additional CGD network has been assumed to be set up in ten Geographical Areas (GA) **(Annexure – VI)** every year from 2016-17 till the end of the 13th five year plan, considering that out of more than 240 GA's that are planned to have a CGD network, the most feasible 60 GA's would have a CGD network by 2021-22. The feasibility of a GA has been broadly assessed based on its population (more than 0.2 million) and its proximity to an existing or a planned transmission pipeline. Natural gas demand of 0.3 MMSCMD has been assumed for each of the 60 GAs in the first year of operation based on the experience of the existing CGD networks. This demand has been assumed to grow at an annual rate of 5% considering that the new CGD networks would have significantly lower demand to capture (due to high cost RLNG to be used by CGD's) when compared to the already established CGD.

Post 13th five year plan it has been assumed that the total demand for the CGD sector i.e. the demand considering the CGD networks that exist today as well as those that would be setup till the end of 13th five year plan, assumed to grow at a rate of 8% annually. The total demand from CGD sector is expected to grow from 15.3 MMSCMD in 2012-13 to 85.6 MMSCMD in 2029-30 at a CAGR of 10.7%.

[6] All figures as per Plan Document

The cumulative year on year demand from 2012-13 to 2029-30 from CGD segment has been shown in Figure 5.

Figure 5 Gas demand from CGD sector: 2012-13 to 2029-30



The above demand from the CGD sector includes demand from the Combined Heat and Power plants which contract gas from the city gas companies operating in their area. Efforts are required to encourage generation of power through these CCHP which are more efficient than centralized CCGT's due to higher efficiency (as high as 85%), low transmission losses, lower physical vulnerability and low gestation period.

2.2.5 Other Consumer Sectors' Demand

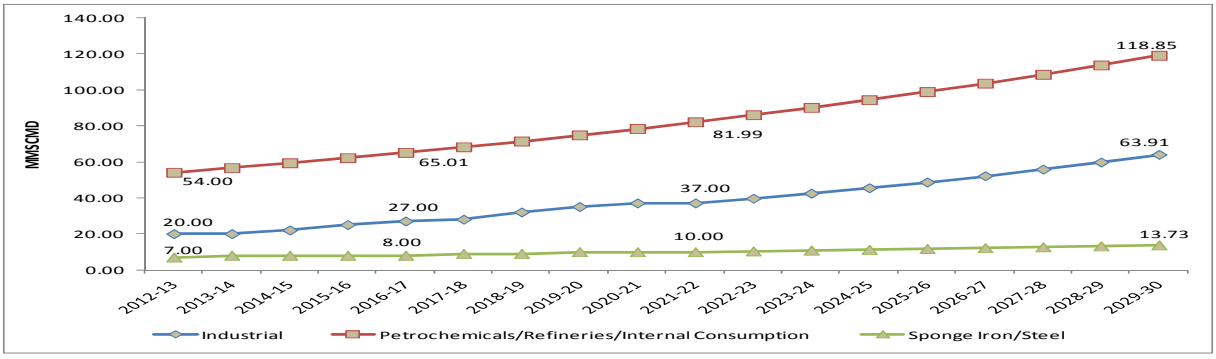
The industrial sector remains crucial for the development of natural gas market in India due to its high affordability. It is expected that a major portion of the incremental future demand for natural gas would come from the industrial sector. The demand projection for this user segment till 2030 has been based on the demand projections provided in the Plan Document. A demand of 20 MMSCMD has been considered in 2012-13 which has been assumed to grow at a CAGR of 7% till 2029-30.

Petrochemical industry in India is expected to continue its growth given the robust growth in domestic demand. As per the Plan Document the demand of natural gas for petrochemical sector will be around 27 MMSCMD by 2016-17. Refineries typically use costly alterative, viz., crude oil/fuel oil for processing & using naphtha for hydrogen production and look to switch to natural gas due to high cost of naphtha. Expansion of refining capacity is presently constrained due to environmental concerns and the usage of gas is also expected to help refineries in meeting environmental norms. Refinery sector in India consumes around 10-14 MMSCMD of gas at present and the demand from this segment is set to grow in future. For projecting demand from these user segments, gas demand as per plan document has been considered as the base demand which has been assumed to grow at a CAGR of 5.0% till 2029-30 in line with the projections as per the Plan Document.

For the sponge iron/steel sector, demand projections provided in the Plan Document have been considered. This report has projected gas demand for this user segment based on the report of the sub-group on demand estimates for petroleum products for 12th and 13th five year plan.

The demand profiles for the above mentioned user segments have been depicted in Figure 6. The demand from Industrial sector is expected to grow from 20.0 MMSCMD to 63.9 MMSCMD over the projection period. Natural gas demand for the Petrochemicals/Refining/Internal consumption segment is set to increase from 54 MMSCMD to 118 MMSCMD over the same period. The demand from Sponge Iron/steel segment is expected to almost double from 7 MMSCMD in 2012-13 to 13.7 MMSCMD in 2029-30.

Figure 6 Gas demand from other consuming sectors: 2012-13 to 2029-30



2.2.6 Consolidated demand

The consolidated **Realistic Demand** for natural gas from 2012-13 to 2029-30 has been provided in Table 11 and Table 12.

Table 11 Total Realistic Demand - 12th and 13th five year plan

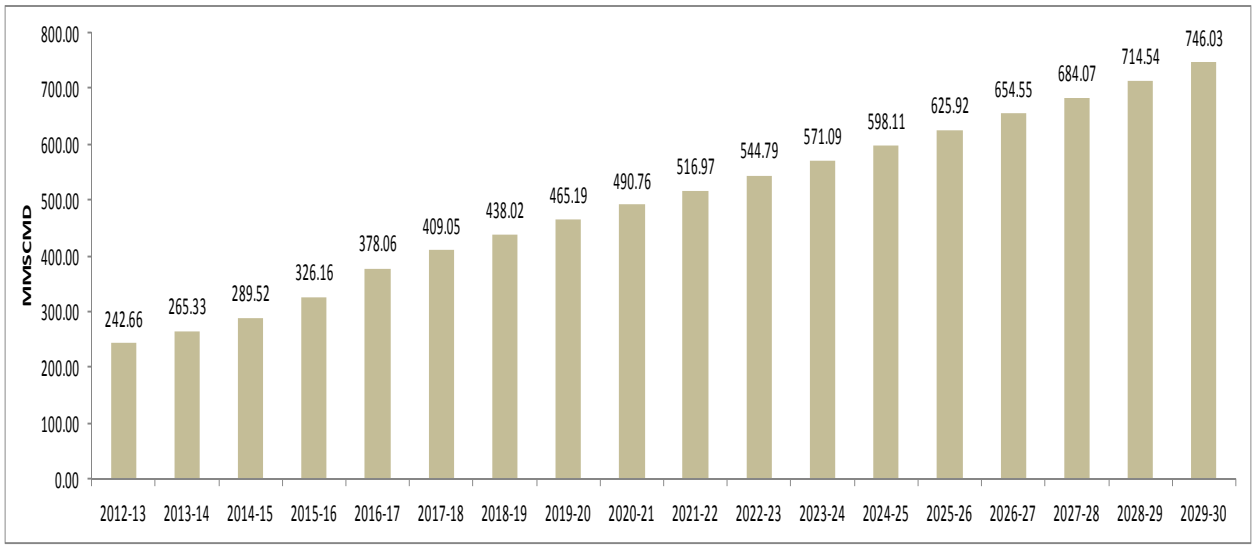
	12th plan					13th plan				
MMSCMD	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Power	86.50	104.59	122.69	140.78	158.88	173.88	188.88	203.88	218.88	233.88
Fertilizer	59.86	59.96	60.39	72.09	96.85	103.45	105.65	105.65	105.65	107.85
City Gas	15.30	16.22	17.19	18.22	22.32	26.62	31.16	35.94	40.96	46.25
Industrial	20.00	20.00	22.00	25.00	27.00	28.00	32.00	35.00	37.00	37.00
Petchem/Refineries/Internal Cons.	54.00	56.57	59.25	62.07	65.01	68.10	71.34	74.73	78.28	81.99
Sponge Iron/Steel	7.00	8.00	8.00	8.00	8.00	9.00	9.00	10.00	10.00	10.00
Total Realistic Demand	**242.66**	**265.33**	**289.52**	**326.16**	**378.06**	**409.05**	**438.02**	**465.19**	**490.76**	**516.97**

Table 12 Total Realistic Demand - 2023 to 2030

MMSCMD	**2022-23**	**2023-24**	**2024-25**	**2025-26**	**2026-27**	**2027-28**	**2028-29**	**2029-30**
Power	248.88	263.88	278.88	293.88	308.88	323.88	338.88	353.88
Fertilizer	110.05	110.05	110.05	110.05	110.05	110.05	110.05	110.05
City Gas	49.96	53.95	58.27	62.93	67.96	73.40	79.27	85.61
Industrial	39.62	42.42	45.42	48.63	52.06	55.75	59.69	63.91
Petchem/Refineries/Internal Cons.	85.89	89.97	94.24	98.72	103.41	108.32	113.46	118.85
Sponge Iron/Steel	10.40	10.82	11.26	11.72	12.19	12.68	13.19	13.73
Total Realistic Demand	**544.79**	**571.09**	**598.11**	**625.92**	**654.55**	**684.07**	**714.54**	**746.03**

The total realistic natural gas demand is likely to grow from 242.66 MMSCMD in 2012-13 to 746 MMSCMD in 2029-30 (CAGR of 6.83%) over the projection period. The trajectory of growth in demand has been depicted in Figure 7.

Figure 7 Consolidated demand growth trajectory



The contribution of power sector to the overall demand is expected to increase from 36% to about 47% over the projection period. The demand for fertilizer sector is expected to decrease from 25% of the total demand in 2012-13 to about 15% of the total demand by 2029-30 (due to higher rate of absolute growth in power sector). The share of natural gas demand for CGD sector in the total gas demand is expected to increase significantly over the projection period from 6% in 2012-13 to about 11% in 2029-30. The breakup of sectoral demand is illustrated in Figure 8 and Figure 9.

Figure 8 Consolidated Demand - Break up in 2012-13 and 2016-17

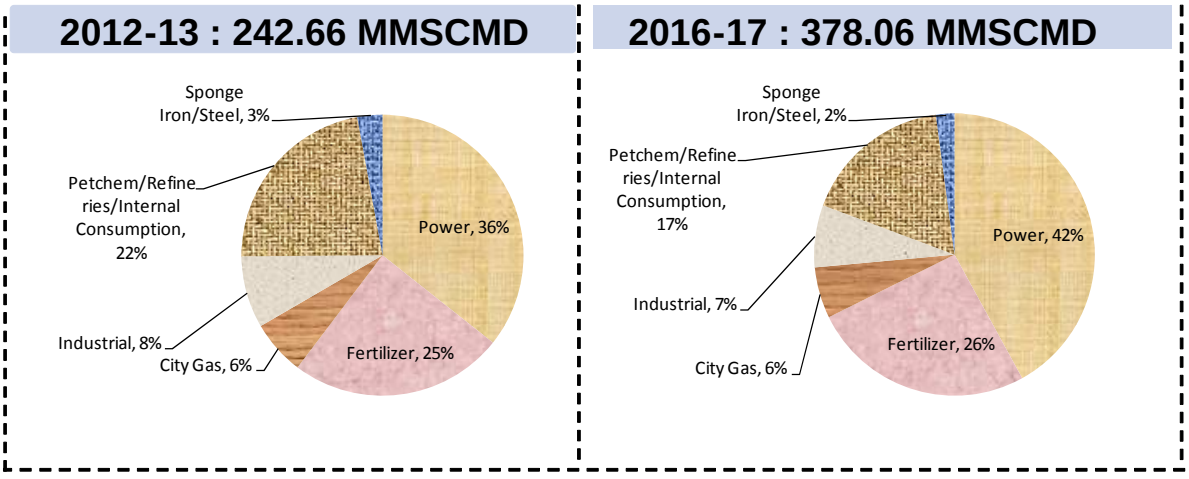
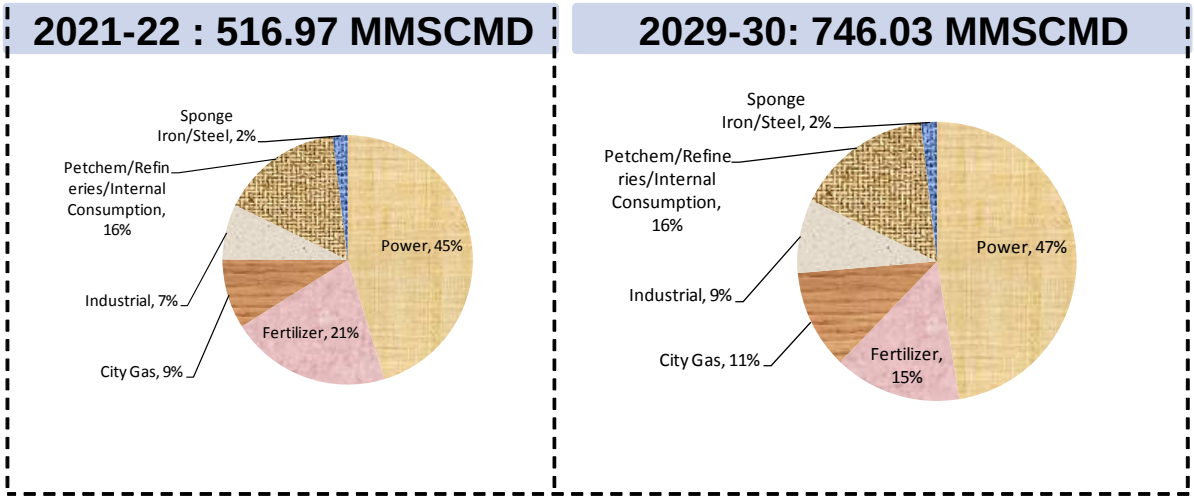


Figure 9 Consolidated Demand - Break up in 2021-22 and 2029-30

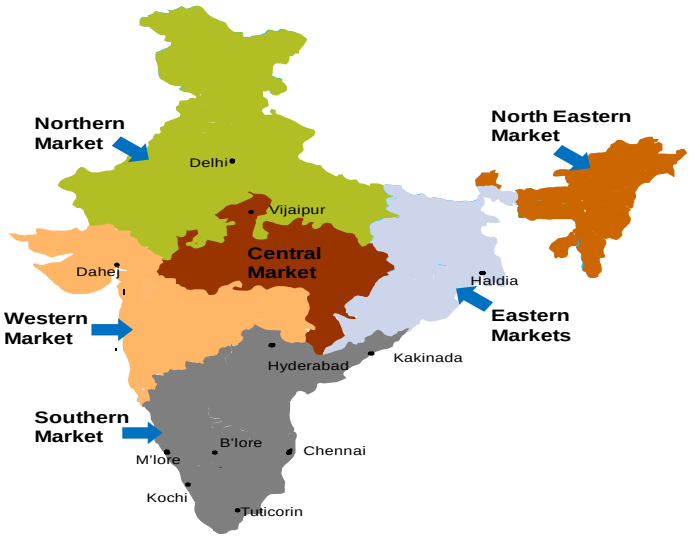


Natural gas demand in India is expected to register a healthy growth in the years to come. However, the growth in demand could be much more rapid than expected if the constraints linked to availability of natural gas and infrastructure used for its transport are addressed in future.

2.2.7 Regional distribution of demand

Natural gas market in India could be divided into six regions based on geographic location. These areas have been shown in Figure 10.

Figure 10 Regional markets in India



The constituent states of these regional markets have been provided in the Table 13 below.

Table 13 Regional Markets – Constituent States

Market region	Constituent states
North	Uttar Pradesh, Uttaranchal, J&K, Haryana, Punjab, Delhi, Himachal Pradesh, Rajasthan
East	West Bengal, Bihar, Jharkhand, Orissa
West	Maharashtra, Gujarat, Goa
North East	Assam, Arunachal Pradesh, Manipur, Meghalaya, Nagaland, Tripura, Mizoram, Sikkim
South	Tamil Nadu, Kerala, Karnataka, Andhra Pradesh
Central	Madhya Pradesh, Chhattisgarh

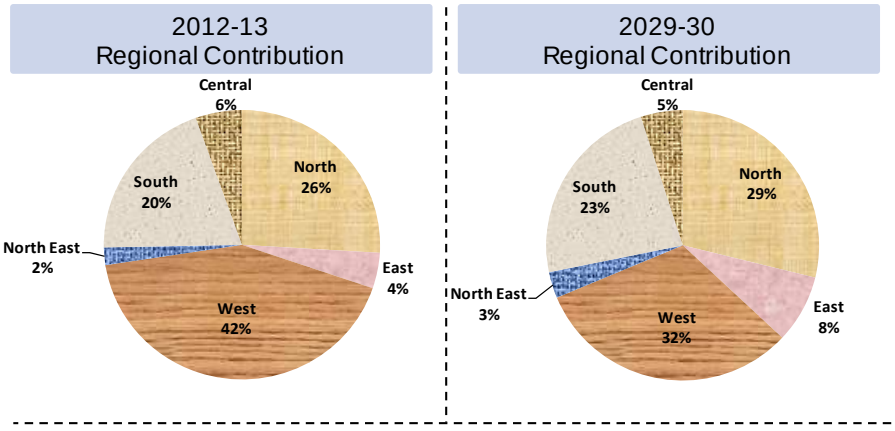
The share of each region in the total demand from 2012-13 to 2029-30 has been worked out based on proportion of the state wise demand as projected in the ICF report "Technical Assistance for the India National Gas Grid Study" submitted to PPAC in July 2011. The estimated region wise demand projections have been given below.

Table 14 Regional Demand Distribution

MMSCMD	2012-13	2016-17	2021-22	2026-27	2029-30
North	62.98	88.40	144.66	188.74	215.11
East	10.35	21.66	31.03	53.24	60.68
West	102.80	165.13	191.78	207.50	236.50
North East	5.13	5.29	10.47	20.67	23.56
South	48.20	81.28	116.71	151.89	173.11
Central	13.21	16.29	22.33	32.52	37.07
Total	**242.66**	**378.06**	**516.97**	**654.55**	**746.0**

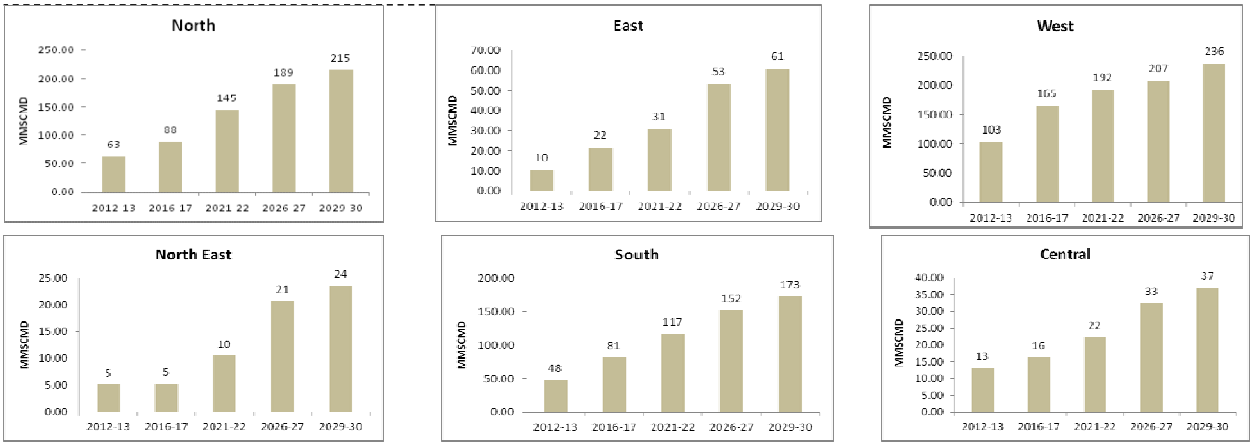
The natural gas consumption of western region is expected to reduce from 42% in 2012-13 to 32% in 2029-30. Increase in consumption is expected in the Northern, Southern and Eastern markets due to better infrastructure connectivity. The regional contribution to the overall demand has been presented in Figure 11.

Figure 11 Regional contributions to demand



The demand profile for each region for the projection period has been shown in Figure 12.

Figure 12 Regional demand growth profiles



Natural gas demand from the Eastern region is expected to increase over six times over the projection period while the North Eastern region demand is likely to more than quadruple over the same period with demand rising from 5 MMSCMD in 2012-13 to 24 MSMCMD in 2029-30. Northern and Southern regions are also expected to register significant increase in natural gas demand from 2012-13 to 2029-30. Western and Central regional markets are likely to register a modest growth in demand as compared to other regional markets during the projected period due to higher base demand.

2.3 Present Supply Scenario

India has seen an increase in the supply of domestic natural in the recent years on the back of sustained efforts of the government to push domestic gas production. Since the introduction of New Exploration Licensing Policy (NELP) in 1999, nine bidding rounds have been completed so far resulting into E&P activity that covers approx. 70% of the country's sedimentary basins. The government is planning to bring out the new Open Acreage Licensing policy which may include among other things flexibility of bidding for E&P blocks throughout the year.

The present supply of natural gas in India is mainly from the nominated blocks, operated by ONGC and OIL, private and joint venture fields like Panna-Mukta &Tapti (PMT) and from the fields awarded under NELP like RIL's KG D-6. The total availability of natural gas as on June 2011 has been presented in Table 15.

Table 15 Natural gas availability by source in India

Source	Supply (June 2011) in MMSCMD
ONGC	50.8
OIL	6.6
Panna-Mukta-Tapti (PMT)	11.9
Other JV's	3.4
Long term RLNG	25.1
Spot R-LNG	21.2
KG-D6 #	47.2
Total	**166.2**

Source: Plan Document/ # KG D6 production has now dropped to circa 20mmscmd

The significance of continuous efforts to push domestic gas production has increased even more after the recent decline in KG D6 production.

2.4 Supply Projections

On the supply side, India's domestic gas production is expected to increase in next 3-6 years with the development of gas discoveries made by ONGC and private players in the previous decade. A supply boost is also expected from the development of CBM blocks. The Government may also look to explore and develop other unconventional resources, such as shale gas, which have a significant potential for enhancing the domestic gas production.

Apart from domestic sources, a significant contribution in gas supply is expected from LNG imports, with plan to augment and add capacities both on the west and east coast of India. Transnational pipelines although dependent on geopolitical consideration may also add significant capacity in the future.

2.4.1 Approach & Methodology

The natural gas availability projections from 2012-13 to 2029-30 has been based on the Plan Document as the main reference source. The domestic gas supply projections provided in this document against different gas sources from 2012-13 to 2016-17 have been analyzed and then refined (based on current pronouncements), where ever required, in order to project the most likely gas supply scenario till the end of the 12th five year plan. Similarly, the natural gas availability by the way of LNG import projected in the document from 2012-13 till the end of the 13th five year plan has also been analyzed and refined wherever required. These refined projections have then been used to project supply till 2029-30 under these two heads with the help of suitable assumptions based on various inputs and industry experience. The projected gas supply through transnational gas pipeline projects estimated in the Plan Document has been considered.

The approach and methodology adopted for projecting gas availability from 2012-13 and 2029-30 has been summarized in Figure 13.

Figure 13 Gas supply projection methodology

The supply projected till 2030, from different supply sources, as per the methodology provided in Figure 13 has been discussed in detail in the following sub sections. Non-Conventional sources of natural gas have also been discussed in the following sub sections but the potential availability of gas from such sources has not been considered in the overall supply estimation process.

2.4.2 Domestic Production

Indigenous gas production in India can be classified on regulatory & contractual basis as follows, nominated fields awarded to National Oil Companies (NOC), Small size & Medium size fields awarded to private parties, pre-NELP discovered fields, NELP fields and CBM blocks.

For projecting the natural gas supply from the domestic sources for the period 2012-13 to 2029-30, the gas supply projections provided in the Plan Document have been considered as reference. However, these projections have been further refined on the basis of information obtained from DGH and ONGC as provided in Table 16.

Table 16 Domestic Supply Projections (MMSCMD)

Year	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
ONGC	54.0	55.0	57.6	61.8	91.1
OIL	7.6	9.4	9.9	10.1	10.4
Private JV's	39.5	38.1	43.4	48.5	55.2
Total	**101.1**	**102.5**	**110.9**	**120.4**	**156.7**

Gas availability post 12th five year plan till 2029-30 has been projected considering an annual growth rate of 3% from the gas supply projections in 2016-17 as gas availability projections were not furnished by ONGC, OIL and DGH for this period. There is a likelihood that a significant discovery in future may alter the growth rate, but in absence of any such data at present it was assumed prudent enough to go ahead with modest growth rate.

The domestic supply projections from 2012-13 to 2029-30 have been provided in Table 17 and Table 18.

Table 17 Domestic gas availability - 12th and 13th five year plan

	12th plan					13th plan				
MMSCMD	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Domestic Sources	101	102.5	110.9	120.4	156.7	161	166	171	176	182

Table 18 Domestic gas availability - 2023 to 2030

MMSCMD	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
Domestic Sources	187	193	198	204	211	217	223	230

2.4.3 Imports of LNG

Currently the natural gas demand far exceeds domestic supply in India and the situation is likely to prevail in future as well. Given that there are very few new domestic sources available, additional demand is likely to be catered through RLNG in future or through transnational pipelines in absence of any large domestic discoveries.

As on date, LNG re-gasification capacity in the country is 13.60mtpa (10 mtpa at PLL's terminal at Dahej and 3.60 mtpa at Shell's terminal at Hazira). Capacity of Dahej is expected to reach to 12.5 mtpa by 2013-14 and 15.0 MMTPA by 2015-16 after expansion. The capacity of HLPL Hazira is also likely to be expanded to 5.0 mtpa by 2013-14 and 10.0 mtpa by 2016-17. In addition to these terminals, PLL is adding another 5.0 mtpa terminal at Kochi and RGPPL is commissioning the 5.0 mtpa terminal at Dabhol. PLL's Kochi terminal with a capacity of 2.5 mtpa is expected to become operational from 2013. The initial capacity of Dhabol terminal is expected to stand at 1.2 mtpa after commissioning without breakwater facility in 2013. However, after completion of breakwater facilities by 2014, the terminal will be in a position to handle 5.0 mtpa of natural gas. Further into future, GSPC-Adani plans to add a 5.0 mtpa terminal at Mundra, and IOCL plans to add a 5.0 mtpa terminal at Ennore by the end of the 12th five year plan period in 2016-17. An FSRU based terminal at Kakinada and another terminal at Gangavaram, both on the east coast of the country, are also expected to become operational in the second half of the 12th five year plan.

In addition to the existing and planned RLNG terminals discussed above, regasification capacity addition of 10.0 MMTPA each on the east and the west coast of the country post 13th five year plan period has also been considered based on various inputs from the industry. The capacity utilization of regasification terminals has been assumed at 70% for the purpose of supply projections, in line with the average utilization of terminals across various geographies.

Projection of the natural gas supply by the way of imported LNG has been provided in Table 19 and Table 20.

Table 19 Imported LNG - 12th and 13th five year plans

	12th plan					13th plan				
MMTPA	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Dahej	10	10	12.5	15	15	15	15	15	15	15
HLPL Hazira	3.6	5	5	5	10	10	10	10	10	10
Dabhol	1.2	5	5	5	5	5	5	5	5	5
Kochi	2.5	5	5	5	5	10	10	10	10	10
Ennore	0	0	0	5	5	5	5	5	5	5
Mundra	0	0	0	5	5	10	10	10	10	10
Kakinada (FSRU)	0	0	2.5	5	5	5	5	5	5	5
Gangavaram	0	0	3	3	3	3	3	3	3	3
East Coast terminals(1)	0	0	0	0	2.5	2.5	5	5	5	5
West Coast terminal (1)	0	0	0	0	0	2.5	5	5	5	5
Total capacity (mtpa)	**17.3**	**25.0**	**33.0**	**48.0**	**55.5**	**68.0**	**73.0**	**73.0**	**73.0**	**73.0**
Total capacity (mmscmd)	63.7	92.0	121.4	176.6	204.2	250.2	268.6	268.6	268.6	268.6
Gas availability (PLF@70%) (mmscmd)	**44.6**	**64.4**	**85.0**	**123.6**	**143.0**	**175.2**	**188.0**	**188.0**	**188.0**	**188.0**

Table 20 Imported LNG - 2023 to 2030

MMTPA	**2022-23**	**2023-24**	**2024-25**	**2025-26**	**2026-27**	**2027-28**	**2028-29**	**2029-30**
Dahej	15	15	15	15	15	15	15	15
HLPL Hazira	10	10	10	10	10	10	10	10
Dabhol	5	5	5	5	5	5	5	5
Kochi	10	10	10	10	10	10	10	10
Ennore	5	5	5	5	5	5	5	5
Mundra	10	10	10	10	10	10	10	10
Kakinada (FSRU)	5	5	5	5	5	5	5	5
Gangavaram	3	3	3	3	3	3	3	3
East Coast terminals(1)	10	10	10	10	10	10	10	10
West Coast terminal (1)	10	10	10	10	10	10	10	10
Total capacity (mtpa)	**83.0**	**83.0**	**83.0**	**83.0**	**83.0**	**83.0**	**83.0**	**83.0**
Total capacity (mmscmd)	305.4	305.4	305.4	305.4	305.4	305.4	305.4	305.4
Gas availability (PLF@70%) (mmscmd)	**213.8**	**213.8**	**213.8**	**213.8**	**213.8**	**213.8**	**213.8**	**213.8**

2.4.4 Gas Imports through Cross Border Pipelines

India has remained interested in sourcing gas though cross border pipelines from countries like Turkmenistan, Iran and other Middle-East countries for a long time. The Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline is proposed for transporting Caspian Sea natural gas from Turkmenistan through Afghanistan into Pakistan and then to India covering approximate 1680 km. The four partners (Turkmenistan, Afghanistan, Pakistan and India) are likely to constitute a consortium that would build and operate the pipeline and the project is likely to be completed by 2017-18. India plans to import 30-40 mmscmd of natural gas from Turkmenistan through this pipeline and negotiations are under way with Afghanistan and Pakistan over transit fee and other related matters.

MoPNG has projected a natural gas availability of 30 mmscmd through TAPI pipeline from 2017-18 to 2021-22 in the Plan Document. The same has been assumed for projecting natural gas supply through transnational pipelines and given that no other firm cross border pipeline proposal is under active considerations at present, this supply of 30 MMSCMD through TAPI pipeline has been further assumed to continue till 2029-30. The natural gas supply projections through trans-national pipelines have been presented in Table 21 and Table 22.

Table 21 Gas availability (cross border pipelines) - 12th and 13th five year plans

	12th plan					13th plan				
MMSCMD	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Gas Imports	0	0	0	0	0	30	30	30	30	30

Table 22 Gas availability (cross border pipelines) - 2023 to 2030

MMSCMD	**2022-23**	**2023-24**	**2024-25**	**2025-26**	**2026-27**	**2027-28**	**2028-29**	**2029-30**
Gas Imports	30	30	30	30	30	30	30	30

2.4.5 Non Conventional Sources

2.4.5.1 Coal Bed Methane (CBM)

Coal bed Methane (CBM), is an eco-friendly natural gas, stored in coal seams, generated during the process of the coalification. CBM holds potential as a source of natural gas for India due to high coal reserves (sixth largest coal reserves in the world) in the country with projected CBM reserves of about 92 TCF. In order to exploit these reserves, the Government formulated a Policy for Coal Bed Methane in

1997. However, after four bidding rounds for CBM blocks, CBM production in India is about 0.3 mmscmd and is expected to exceed 4mmscmd by 2016-17.

CBM production in India faces several challenges. These include technical challenges relating to assessment of potential, inferior grade of coal present in India and low production from wells due to low porosity and permeability, regulatory challenges related to delineation of blocks for mining and CBM exploitation, environmental challenges linked to higher requirement of land and disposal of water, logistic challenges associated with the requirement to drill large number of wells at low cost and political challenges as most of the prospective coal mines lie in areas affected by insurgency and face a serious threat to safe operations.

2.4.5.2 Shale Gas

Shale gas remains adsorbed in the laminations, fractures and pore spaces of shale that act as the source, reservoir and cap rock for the gas. Shale gas is produced by applying technology of horizontal wells and multi-stage hydraulic fracturing.

In India, although the potential of shale oil and gas has been recognized to some extent no credible estimates of the actual reserves are available. EIA, USA in April 2011 estimated a Gas-In-Place (GIP) concentration of 1170 TCF in 4 basins namely Cambay, Krishna-Godavari, Cauvery and Damodar. Taking into account various projections by different agencies the resource potential in India varies upto 2100 TCF of shale gas with potential also for shale oil. There have been field experiments for evaluating the shale gas potential on shales in the Gondwana basin and the initial results have been encouraging. It is estimated that India possesses shale deposits across Gujarat, Jharkhand, West Bengal, Andhra Pradesh, Tamil Nadu, Assam, Rajasthan and a few other areas. Studies are in progress in DGH to fine tune the resource assessment of shale gas and shale oil in the country.

With the growing demand for natural gas in India and the fact that existing gas fields are in decline, shale gas could contribute towards bridging the demand – supply gap in the future. In order to achieve this, the Indian Government is finalizing the prospective locations in terms of shale gas deposits and is planning to come up with a policy dealing with the exploration and development of shale gas and oil. A MoU has been signed between MoPNG and Department of state, USA towards resource assessment, regulatory framework, training and investment promotion. Further to this, ONGC has been given special permission for drilling R&D wells in the Damodar Valley.

Shale gas exploration is relatively new in India, but it is rapidly gaining the attention of the government as well as the industry players. MoPNG has put DGH in charge of scouting for shale gas potential and developing regulation. Meanwhile Indian companies have acquired acreages in the US shale play Marcellus, in order to gain experience that could be transferred to Indian shale gas deposits, but challenges in India could be of entirely different nature.

2.4.5.3 Gas Hydrates

Natural Gas Hydrates are a combination of gas and water in solid phase at low temperatures. These hydrates are a potential source of natural gas. As per the Ministry of Petroleum & Natural Gas, among the locations showing evidence of in-situ hydrates, there are indications of either probable occurrence in and around India in the Indian Ocean region. Studies are being undertaken in the Indian Ocean region to establish the potential natural gas hydrates.

The global reserves of gas hydrates are estimated to be twice the known oil & gas reserves of the world. Compared to this, the conventional natural gas accumulations for the world are estimated at approximately 440 trillion cubic meters. India has an estimated 1894 trillion cubic meters of prognosticated resources of gas hydrates off the country's east coast found in Krishna Godavari, Mahanadi and Andaman offshore waters. However, there are several technical challenges in the recovery of natural gas from hydrate. Although countries like USA & Japan are at advanced stages of R&D, no country has been able to commercially exploit gas hydrates so far. Pilot tests have been done by Canada for extracting gas from hydrates and efforts have been going on in Germany to dissociate methane from gas hydrates with injection of carbon dioxide.

In India, National Gas Hydrate Program (NGHP) was launched by Ministry of Petroleum & Natural Gas which is a consortium of National E&P companies - ONGC, GAIL and OIL and National Research Institutes (National Institute of Oceanography, National Geophysical Research Institute and National Institute of Ocean Technology). Its expeditions so far, have been aimed at physical verification of gas hydrates in deep waters and identification of site wherein hydrates could be found in sand facies for carrying out pilot production testing. Actual core evidences of the presence of Gas Hydrates in Indian Deep Waters have been established with the help of these expeditions. Another expedition aimed at carrying out pilot production testing of at least one site in the Indian Deep Water environment is planned.

Non conventional sources of natural gas like Coal Bed Methane (CBM), Shale Gas and Gas Hydrates are being pursued internationally including India in the wake of depleting conventional sources of gas. However, there remain some issues in the development of unconventional gas sources like lack of data as most of India remains moderately explored, pricing (including taxes and royalties) regulatory policy, lack of domestic infrastructure and expertise. Therefore, for projecting natural gas supply till 2029-30, natural gas availability through these non-conventional sources viz shale gas and Gas hydrates has not been considered.

2.4.6 Consolidated supply projections

The consolidated natural gas supply projections for the period 2012-13 to 2029-30 have been presented in Table 23 and Table 24.

Table 23 Total gas availability - 12th and 13th five year plan

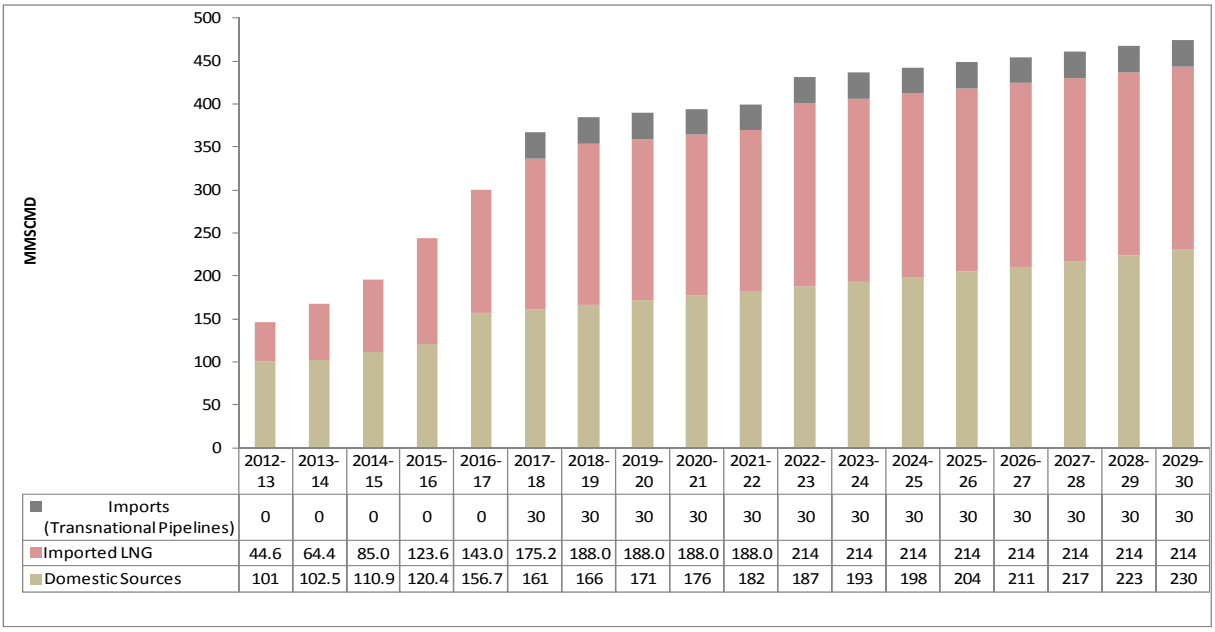
	12th plan					13th plan				
MMSCMD	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**	**2017-18**	**2018-19**	**2019-20**	**2020-21**	**2021-22**
Domestic Sources	101.1	102.5	110.9	120.4	156.7	161.4	166.2	171.2	176.4	181.6
LNG Imports	44.6	64.4	85.0	123.6	143.0	188	188	188	188	188
Gas Imports (Cross border Pipelines)	0.00	0.00	0.00	0.00	0.00	30.00	30.00	30.00	30.00	30.00
Total	**145.7**	**166.9**	**195.9**	**244.1**	**299.7**	**367**	**384**	**389**	**394**	**400**

Table 24 Total gas availability - 2023 to 2030

MMSCMD	**2022-23**	**2023-24**	**2024-25**	**2025-26**	**2026-27**	**2027-28**	**2028-29**	**2029-30**
Domestic Sources	187.1	192.7	198.5	204.4	210.6	216.9	223.4	230.1
LNG Imports	214	214	214	214	214	214	214	214
Gas Imports (Cross border Pipelines)	30.00	30.00	30.00	30.00	30.00	30.00	30.00	30.00
Total	**431**	**437**	**442**	**448**	**454**	**461**	**467**	**474**

The total availability of natural gas is expected to grow at a CAGR of 7.2% from 2012 to 2030 reaching 400 MMSCMD by 2021-22 and 474 MMSCMD by 2029-30. The supply growth profile from 2012-13 to 2029-30 has been shown in Figure 14.

Figure 14 Natural Gas Supply Growth Profile

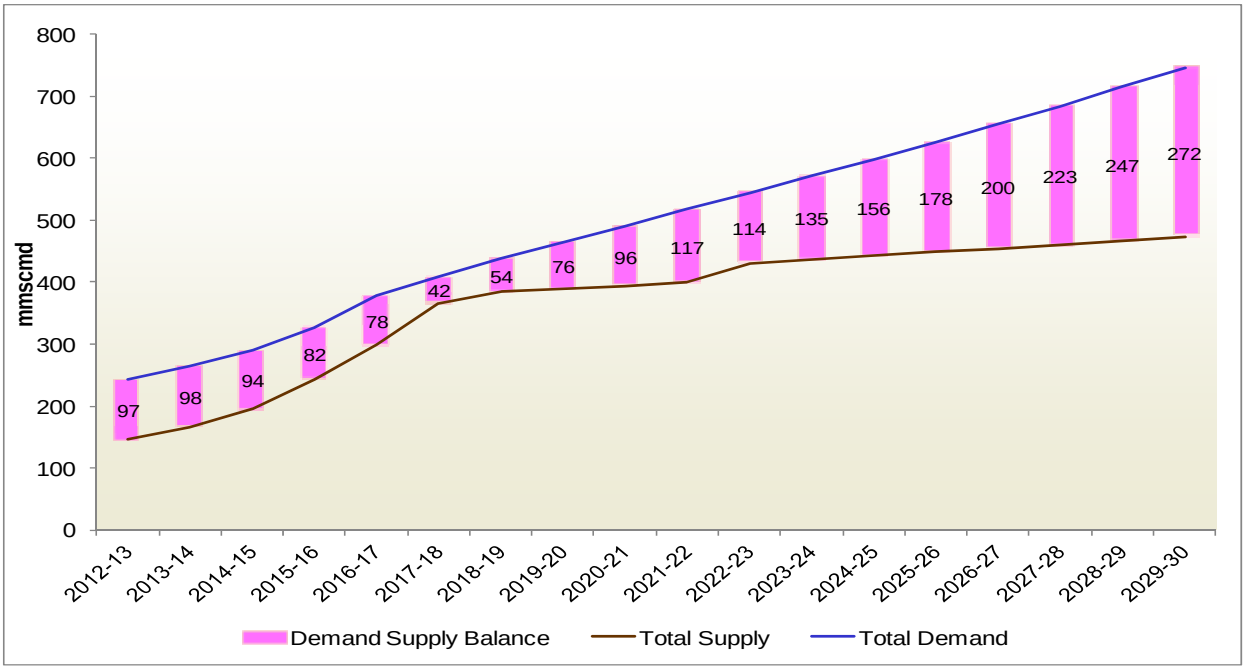


LNG imports are expected to contribute about 45% to the total gas availability by 2029-30 as compared to 30% in 2012-13. Natural gas availability from domestic sources is expected to account for 48.5% of the total natural gas supply in 2029-30 as against a high 70% in 2012-13.

2.5 Demand Supply Balance

The demand for natural gas in India is expected to get more than triple in the period 2012-13 (243 MMSCMD) to 2029-30 (746 MMSCMD) indicating a steep rise in natural gas consumption in the country. On the supply side it is certain that over the next several years, exploration and production efforts will result in an increase in the availability of natural gas in the country. However, even in the most optimistic scenario it is not possible to visualize a situation where increase in domestic gas production will be able to completely meet incremental domestic demand for natural gas in the years going forward. With requisite natural gas infrastructure in place and availability of RLNG at affordable price the supply of natural gas should not fall way behind the demand in the country. The projected demand supply balance has been shown in Figure 15.

Figure 15 Projected Demand Supply Gap



The availability of natural gas is expected to be short of the total natural gas realistic demand in the country by around 97 MMSCMD in 2013. This shortfall is expected to decline by 2017-18 on account of a

substantial addition expected in the regasification capacity of the country and supply by the way of cross border pipeline (TAPI). However, the demand-supply gap is further expected to expand post 2017-18 to about 272 MMSCMD by 2029-30 as increase in supplies is expected to lag behind a consistent increase in demand. However the demand supply gap can be bridged to some extend if RLNG at affordable price for end user segments like power and fertilizers is available which could be imported through additional available capacity (assumed in this report to operate at 70%PLF) at RLNG terminals.

3 Natural Gas Infrastructure

India has a relatively under-developed gas pipeline infrastructure when compared to some developed countries. However, it is growing rapidly in tune with increasing demand and growing natural gas supplies. India, currently, has a network of ~13,000 km of natural gas transmission pipelines with a design capacity of around 337 mmscmd. This network is expected to expand to around 28,000 Kms of pipelines with a total design capacity of around 721 MMSCMD in next 5-6 years taking the country close to the formation of a National Gas Grid connecting all major demand and supply centers in India. This will ensure wider and uniform availability of gas across all regions for economic and social progress.

3.1 Present state of Infrastructure

GAIL India ("GAIL") owns the largest network of the natural gas transmission infrastructure present in the country. The company currently owns and operates 9,000km (approx.) of high-pressure natural gas pipelines with a transmission capacity of more than 160mmscmd. At around 3,750 km in length, GAIL's Hazira-Vijaipur-Jagdishpur (HVJ) pipeline is the longest natural gas pipeline network in the country operating at 100% capacity. With no free capacity, this network has been unable to meet the increase in domestic natural gas supplies stemming from the commencement of production at the KG D6 field and the increase in India's overall RLNG capacity. To overcome this problem, GAIL has done expansion and upgradation of its network. The rest of the country's natural gas trunk pipelines network is owned by Gujarat State Petronet Limited (GSPL) and Reliance Gas Transportation Infrastructure Limited (RGTIL) with a small network owned by Gujarat Gas Company Limited (GGCL) and Assam Gas Company Limited (AGCL). Although the gas pipeline coverage has increased, it is still inadequate to channelize the gas supply to demand centers in the country. The present state of natural gas transmission infrastructure in the country has been summarized in the Table 25.

Table 25 Natural gas transmission infrastructure in India

Name of pipeline	Name of Entity	Length	Design Capacity
		Kms	MMSCMD
HVJ+GREP+DVPL	GAIL	4222	53.0
DVPL-GREP Upgradation	GAIL	1280	54.0
Dahej-Uran-Panvel-Dabhol	GAIL	815	19.9
Agartala P/L network	GAIL	61	2.3
Mumbai regional P/L network	GAIL	129	7.0
Assam regional P/L network	GAIL	8	2.5
KG Basin regional P/L network	GAIL	878	16.0
Gujarat regional P/L network	GAIL	760	3.9
Cauvery regional P/L network	GAIL	271	3.9
EWPL	RGTIL	1460	80.0

Name of pipeline	Name of Entity	Length	Design Capacity
Gujarat Gas Grid network (HP & LP)	GSPL	1950	43
Hazira- Ankleshwar	GGCL	73	5.0
Assam network	AGCL	105	6.0
Dadri-Panipat	IOCL	132	9.5
Dadri – Bawana- Nangal	GAIL	886	31
Total		**13030**	**337**

Source: PNGRB

The pipelines existing in the country as of today includes GAIL's Hazira-Vijaipur-Jagdishpur (HVJ) pipeline and recent upgradations in the pipeline, Dahej-Uran-Dabhol pipeline (DUPL/DPPL), 1460 Kms long East West Pipeline (EWPL) laid by RGTIL that connects the east coast of the country to the west, Vijaypur-Kota pipeline and regional pipeline networks of GAIL, GSPL, GGCL and AGCL/OIL. However, the geographical distribution of these pipelines has remained uneven as the states closer to the gas source have had the benefits of higher utilization of gas and local development of gas market e.g. Gujarat, Maharashtra, Andhra Pradesh, etc. Other states/under developed have not been able to utilize benefits of gas due to less gas availability and inadequate pipeline infrastructure e.g. Punjab, Haryana, Jharkhand, Uttrakhand, Karnataka, Kerala, Bihar, Chattisgarh, etc. The distribution of current pipeline network present in the country has been presented in Table 26.

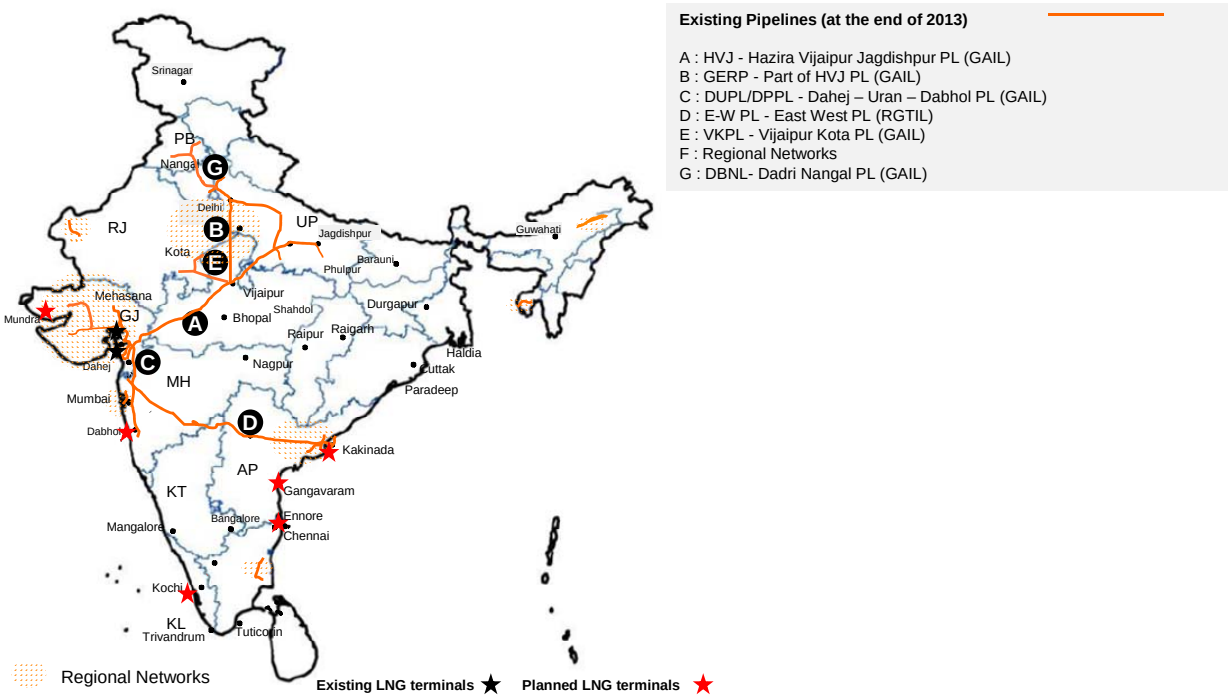
Table 26 Natural gas transmission infrastructure in India – Regional Distribution

Region	Approx. % of Total gas P/L network	% of consumption	States with infrastructure and consuming gas	States lacking pipeline infrastructure
Western	40%	53%	Gujarat, Maharashtra	Goa
Northern	20%	26%	Delhi, UP, Haryana, Rajasthan	Punjab, J&K, Himachal Pradesh, Uttarakhand
Central	13%	3%	Madhya Pradesh	Chattisgarh
Southern	16%	14%	Tamilnadu, Andhra Pradesh	Kerala, Karnataka
Eastern	0	NIL	-	Bihar, West Bengal, Jharkhand, Orissa
North Eastern	10%	4%	Assam, Tripura	Meghalaya, Sikkim, Arunachal Pradesh, Mizoram, Manipur, Nagaland

Source - Saumitra Chaudhuri report on Policy for pooling of natural gas prices and pool operating guidelines

The western region of India accounts for the highest proportion of the existing pipeline network of the country and also for the highest consumption of natural gas. At the same time the presence of pipeline network remains significantly low in the central, southern and eastern parts of the country. The existing gas transmission infrastructure in India is shown in Figure 16.

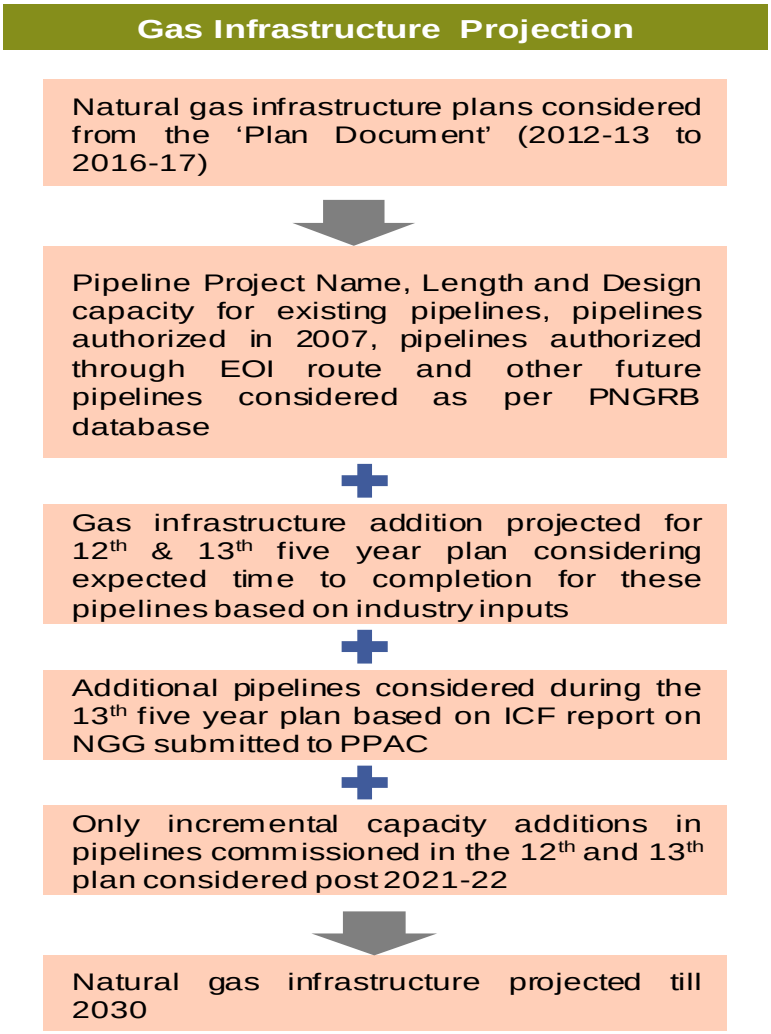
Figure 16 Existing gas transmission network in India



3.2 Infrastructure Projection – Approach & Methodology

The buildup of natural gas infrastructure in the country from 2012-13 to 2029-30 is projected based on the Plan Document. Gas infrastructure projects linked to the pipelines authorized in 2007 by the central government and those authorized later through bidding route by PNGRB (that are slated for completion in the next few years as well as the pipelines planned for future), have been considered in terms of the length and design capacities of the corresponding pipelines in this document. Other possible infrastructure additions as per the National Gas Grid (NGG) proposed by ICF in its report submitted to PPAC have also been considered for projecting natural gas infrastructure in India till 2030. Gaps identified post factoring all these planned pipelines have then been considered for completing the gas grid. The approach and methodology adopted for projecting gas infrastructure from 2012-13 and 2029-30 has been summarized in Figure 17.

Figure 17: **Gas infrastructure projection methodology**



The natural gas infrastructure expected to be in place in India by 2029-30 has been discussed in detail in the following sub sections.

3.3 Pipeline Infrastructure – Development Plans

To address the regional imbalance of pipeline networks present in the country, MoPNG in the year 2007 authorized to lay around 8400 Kms of pipelines as per Table 27.

Table 27 Pipeline authorizations by MoPNG in 2007

Name of pipeline	Length	Design Capacity	Commissioning period
	Kms	**MMSCMD**	
Dadri - Bawana – Nangal	886	31	Commissioned
Chainsa - Jhajjar – Hissar	455	35	2013 (partly commissioned)
Jagdishpur – Haldia	1860	32	2016
Dabhol - Bangalore	1414	16	2013
Kochi-kootanad-Bangalore-Mangalore	1104	16	2013
Kakinada-Vasudevpur-Haldia #	928	26.7	TBD *
Kakinada – Chennai #	577	26.7	TBD *
Chennai - Bangalore – Mangalore #	538	13.3	TBD *
Chennai – Tuticorin #	585	13.3	TBD *
Total (A) + (B)	**8347**	**210**	

*# The authorization to these pipelines is cancelled by MoPNG / * assumed in 2017*

Authorizations were also awarded by PNGRB through transparent bidding route to the winning bidders for the pipelines in the years 2009-12 as per Table 28.

Table 28 Pipeline Authorizations through EOI Route / Pending EOI's

Name of pipeline	Length	Design Capacity	Commissioning date
	Kms	**MMSCMD**	
Mallavaram - Bhopal - Bhilwara – Vijaypur	2042	76.25	2014
Mehsana – Bhatinda	2052	77.11	2014
Bhatinda - Jammu – Srinagar	725	42.42	2014
Surat – Paradip	2112	74.8	2015
Shahdol-Phulpur ##	350	3.5	2016
Ennore - Puducherry - Nagapattinam (with spur lines to Madurai, Tuticorn and Beglaluru) ##	1175	12.5	2016
Total	**8456**	**286.59**	

Source: PNGRB; ## Currently under bid process/ yet to be awarded

Chainsa-Jhajjar-Hisar pipeline of GAIL is partly commissioned till Jhajjar. The complete pipeline is expected to get commissioned in the FY 2013. All the other pipelines, listed above, are slated for completion during the 12th five year plan that shall end in 2017. These pipelines, once commissioned, would nearly **complete the integrated nation wide natural gas grid**. The list of the pipelines expected to get commissioned in the 12th five year plan has been presented in Table 29.

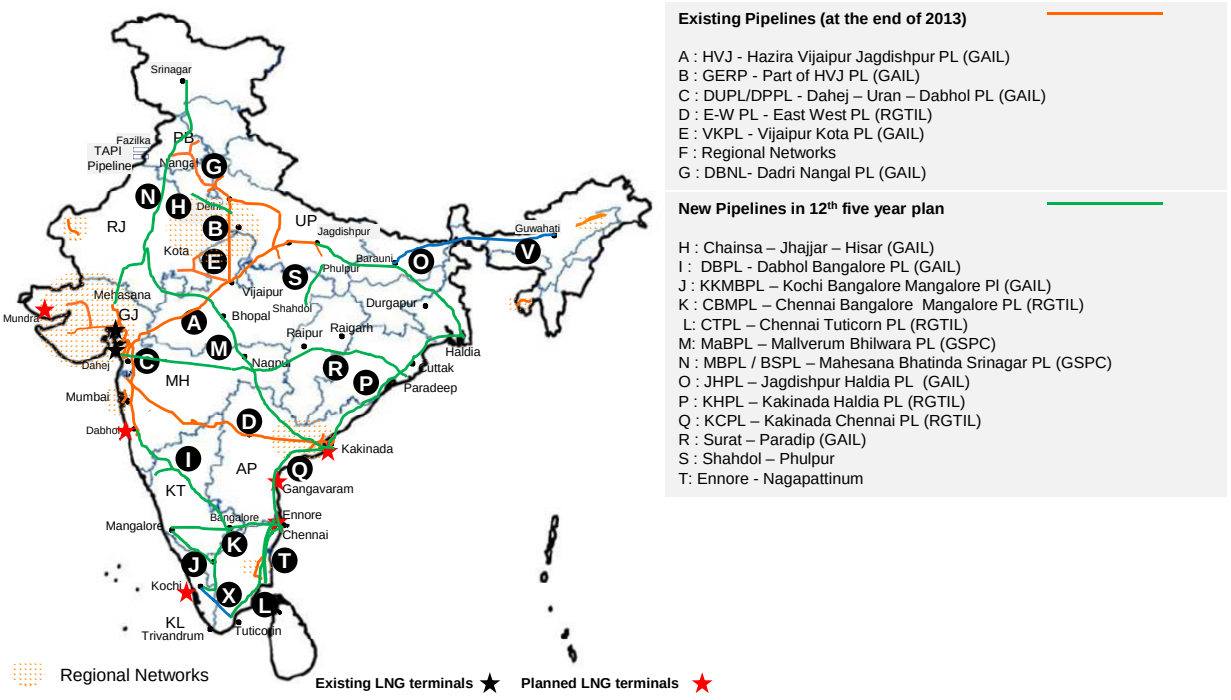
Table 29 Gas pipelines expected to be commissioned in the 12th five year plan

Name of pipeline	Length	Addition in Design Capacity	Completion Status
	Kms	**MMSCMD**	
Jagdishpur – Haldia	1860	32	2016
Kochi-Kanjirkkod-Bangalore-Mangalore	1156	16.0	2013
Dabhol - Bangalore	1414	16.0	2013
Kakinada-vasudevpur-Haldia	928	26.7	2016
Kakinada – Chennai	577	26.7	2016
Chennai – Tuticorin	585	13.3	2016
ChennaI - Bangalore – Mangalore	538	13.3	2016
GSPL Gujarat Grid (HP-Under construction/Under-development)	420	0.0	2013
Mallavaram - Bhopal - Bhilwara - Vijaypur	1688	52.9	2014
Mehsana – Bhatinda	1611	42.9	2014
Bhatinda - Jammu – Srinagar	512	33.9	2014
Surat-Paradip	1825	60.0	2015
Shahdol – Phulpur	350	3.5	2016
Ennore - Puducherry – Nagapattinam	1175	12.5	2016
Dadri – Bawana – Nangal	886	31	Commissioned
Chaisana – Jhajjar – Hissar	445	35	2013, Partly commissioned
Total	**15918**	**415**	

During the 12th five year plan period, an additional 15,918 kms of natural gas pipeline network is expected to be added to the existing 12,144 kms of pipeline network in the country increasing, in the process, the existing design capacity of 306 MMSCMD by another 415 MMSCMD.

The planned addition of pipelines during the 12th five year plan has been depicted on the Indian map in Figure 18.

Figure 18 Gas transmission network in India at the end of 12th five year plan



Also during the 12th five year plan GAIL is expected to upgrade the GREP/DVPL pipeline, GSPL is expected to upgrade the Gujarat network adding around 420 kms of pipeline and AGCL/OIL is expected to lay an additional pipeline infrastructure of 350 kms in Assam. Therefore at the end of the 12th five year plan a pipeline network of around 28,000 kms is expected to be in place in the country in the form of a national gas grid with an expected design capacity of around 721 MMSCMD. In the 13th plan additional pipeline from Guwahati to Baurani, Durgapur to Calcutta and Kochi to Tuticorn are expected to come up and any spillover pipelines from 12th plan will get completed. In addition regional networks will get developed in states getting transmission pipeline in the 12th plan thus strengthening the national gas grid.

By the end of the 13th five year plan, India is expected to have a natural gas pipeline network of around 31,432 kms with a design capacity of 782 MMSCMD with a nation wide gas grid and more uniform pipeline network coverage in place.

Post 13th plan, capacity addition linked to the pipelines that would get commissioned during the 12th plan but continue adding capacity has been considered. At the end of the of the projection period in 2030, the design capacity of the natural gas pipeline network in India is expected to touch 815 MMSCMD.

A summary of the natural gas pipeline infrastructure expected to be in place in the country at the end of the projection period has been summarized in Table 30.

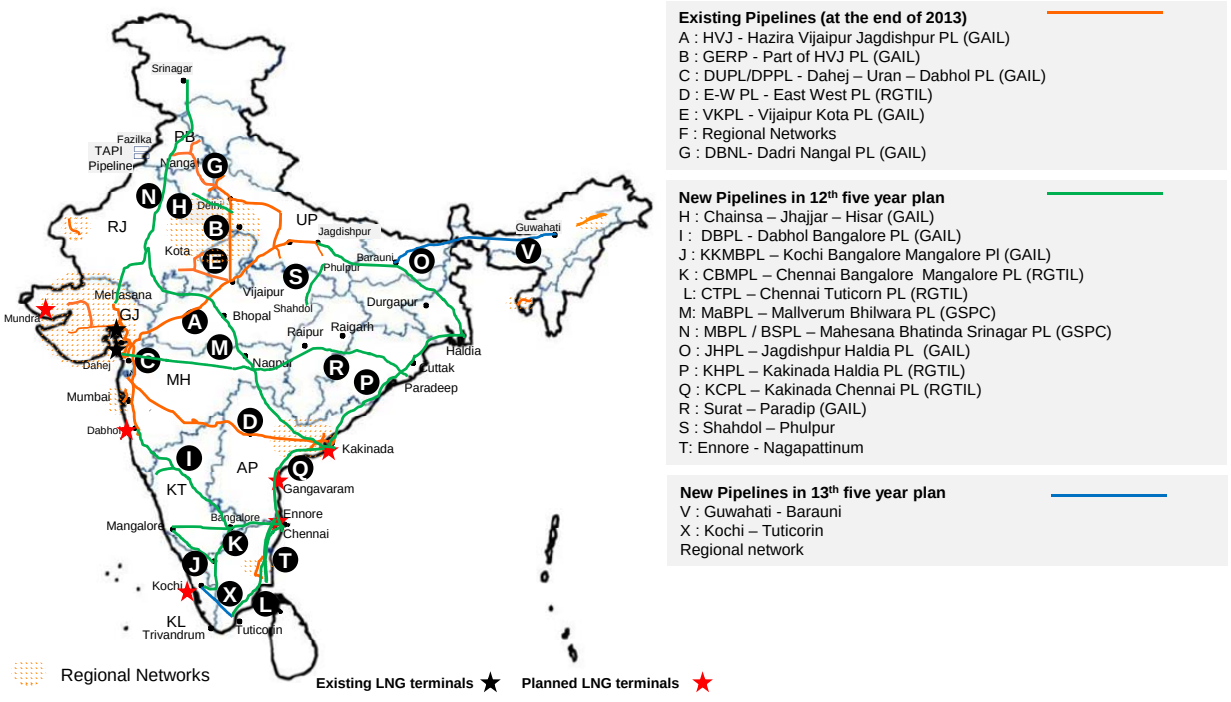
Table 30 Summary – Pipeline infrastructure in 2030

Pipelines	Design Capacity (mmscmd)	Length (Kms)
Existing before 2012	306	12144
Expected addition in the 12th plan	416	15928
Expected addition in the 13th Plan	60	3360
Incremental Capacity addition in MBBVPL/MBPL/Surat Paradip pipelines beyond 13th plan till 2030*	33	1295
Total	**815**	**32727**

Source: PNGRB / * *Annexure VII*

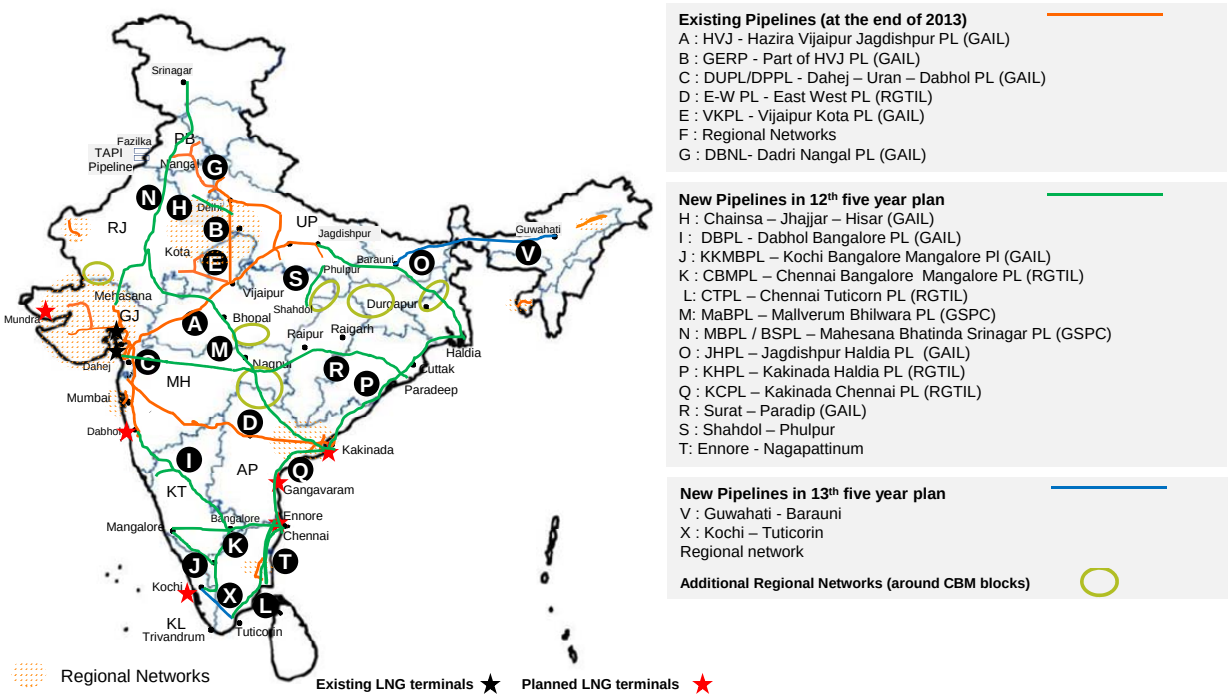
Natural gas transmission pipeline network at the end of the 13th five year plan has been depicted in the Indian map in Figure 19.

Figure 19: **Gas transmission network in India at the end of 13th five year plan**



Considering the nationwide gas grid proposed by ICF in its report submitted to PPAC and the CBM blocks that are likely to start production in near future, natural gas infrastructure in addition to the infrastructure plans outlined above is shown in Figure 20 on the Indian map.

Figure 20: **Infrastructure addition linked to ICF's NGG proposal and CBM Blocks**



3.4 Scope for further development

India is expected to have circa **32,727 Kms** of natural gas pipeline with a design capacity of **815 MMSCMD** in place by 2030. However, the addition of 'capacity at source' i.e. the capacity that actually connects supply points to the markets is likely to increase to 582 MMSCMD ***(Annexure VIII)*** only. This capacity indicates the potential of the gas transport pipeline infrastructure to meet the demand in the country. The expected demand, supply and pipeline capacity at source for the projection period has been provided in Table 31 and Table 32.

Table 31 Demand-Supply-Capacity from 2012-13 to 2021-22

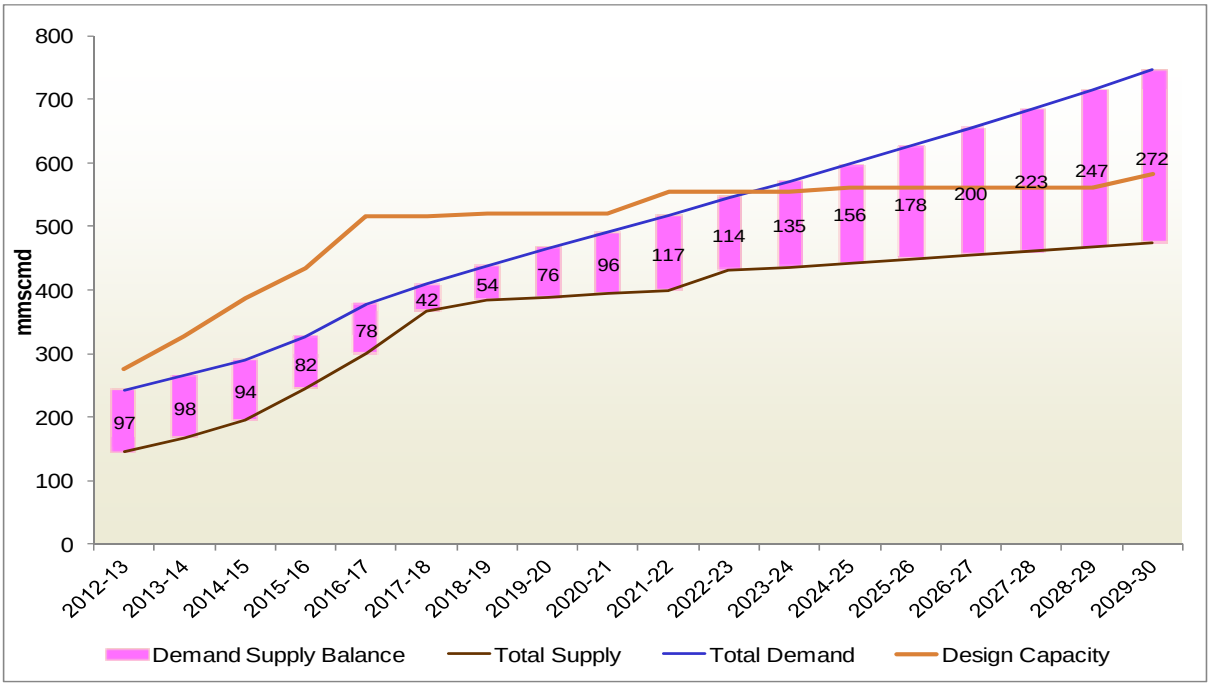
MMSC MD	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Total demand	243	265	290	326	378	409	438	465	490	516
Total supply	146	167	196	244	300	367	384	389	394	400
Total Design Capacity of pipelines	404	534	594	642	722	722	726	726	726	782
Capacity at source of pipelines	274	327	387	435	515	515	519	519	519	555

Table 31 Demand-Supply-Capacity from 2022-23 to 2029-30

	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
Total demand	545	571	598	626	654	684	714	746
Total supply	431	437	442	448	454	461	467	471
Total Design Capacity of pipelines	782	782	782	782	782	782	782	815
Capacity at source of pipelines	555	555	561	561	561	561	561	582

While the capacity at source in India is likely to be higher than the gas supply for all the projection years, it is likely to fall behind the total demand starting from 2023-24 till the end of the projection period in 2030 as shown in figure below.

Figure: Pipeline capacity compared to demand & Supply of gas



This suggests that further addition in pipeline infrastructure, in addition to the current plans, would be required post 13th five year plan to meet the rising demand for natural gas in the country. Regional markets with the biggest gap between the demand and planned addition in capacity need to be targeted for further expansion of pipeline infrastructure so that the infrastructure keeps pace with the ever rising demand. The expected share of each regional market in the total demand and planned pipeline capacity has been provided in Table 32.

Table 32 Regional Infrastructure in 2030

Market region	Constituent states	Design capacity (as % of total)	Total gas demand (as % of total)
North	Uttar Pradesh, Uttaranchal, J&K, Haryana, Punjab, Delhi, Himachal Pradesh, Rajasthan	206.9 (25%)	215.1 (29%)
East	West Bengal, Bihar, Jharkhand, Orissa	70.8 (9%)	60.7 (8%)
West	Maharashtra, Gujarat, Goa	229.9 (28%)	236.5 (32%)
North East	Assam, Arunachal Pradesh, Manipur, Meghalaya, Nagaland, Tripura, Mizoram, Sikkim	22.8 (3%)	23.6 (3%)
South	Tamil Nadu, Kerala, Karnataka, Andhra Pradesh	210.5 (26%)	173.1 (23%
Central	Madhya Pradesh, Chhattisgarh	74.4 (9%)	37.1 (5%)
Total	**All**	**815 (100%)**	**746 (100%)**

As can be seen above, the share of planned pipeline capacity for all regions is likely to meet the share of demand for these markets till 2030. However since the difference is not substantial and pipelines do require additional capacities, more pipelines could be planned to cover these regional markets based on actual progress in the buildup of demand. It should also be noted that the share of natural gas demand and pipeline infrastructure in the eastern and north-eastern markets is significantly lower than that for the other regions. There is a need to commit more resources towards stimulating demand in these regions so that greater balance is achieved in terms of the availability of natural gas. The increase in natural gas demand in the eastern and north-eastern regions resulting from additional initiatives and resources would need to be coupled with addition of more natural gas pipeline infrastructure here to support the development of the natural gas markets in these regions.

4 Gas Sector – Current status

The development of natural gas market as well as infrastructure in India today needs an enabling environment so that the intended results could be achieved in the most cost effective manner, in the least possible time and with maximum benefits to all stakeholders including consumers. This section outlines the present state of gas sector in India and brings out positives and details the improvements required for future development based on best practices and international examples.

4.1 Present State in India

The natural gas sector in India today is at the threshold of rapid growth supported by ever increasing demand for natural gas, increased exploration efforts under NELP, large scale discoveries of gas in the East Coast, commissioning of the LNG import terminals in the West Coast, new upcoming LNG import terminals and the regulators initiatives in the direction of development of a nation wide natural gas pipeline grid.

The market for natural gas in India currently lacks depth with only a small number of producers (production still largely controlled by the state players), negligible number of shippers and a fairly limited number of consumers. Therefore, the market is limited in terms of bilateral contracts between producers/marketers and consumers of natural gas. The current short term (Spot) market that exist in India owing to a very limited number of players exhibits lack of liquidity as well as a lack of transparency. This lack of liquidity is one of the greatest impediments to the development of a transparent spot market in the country.

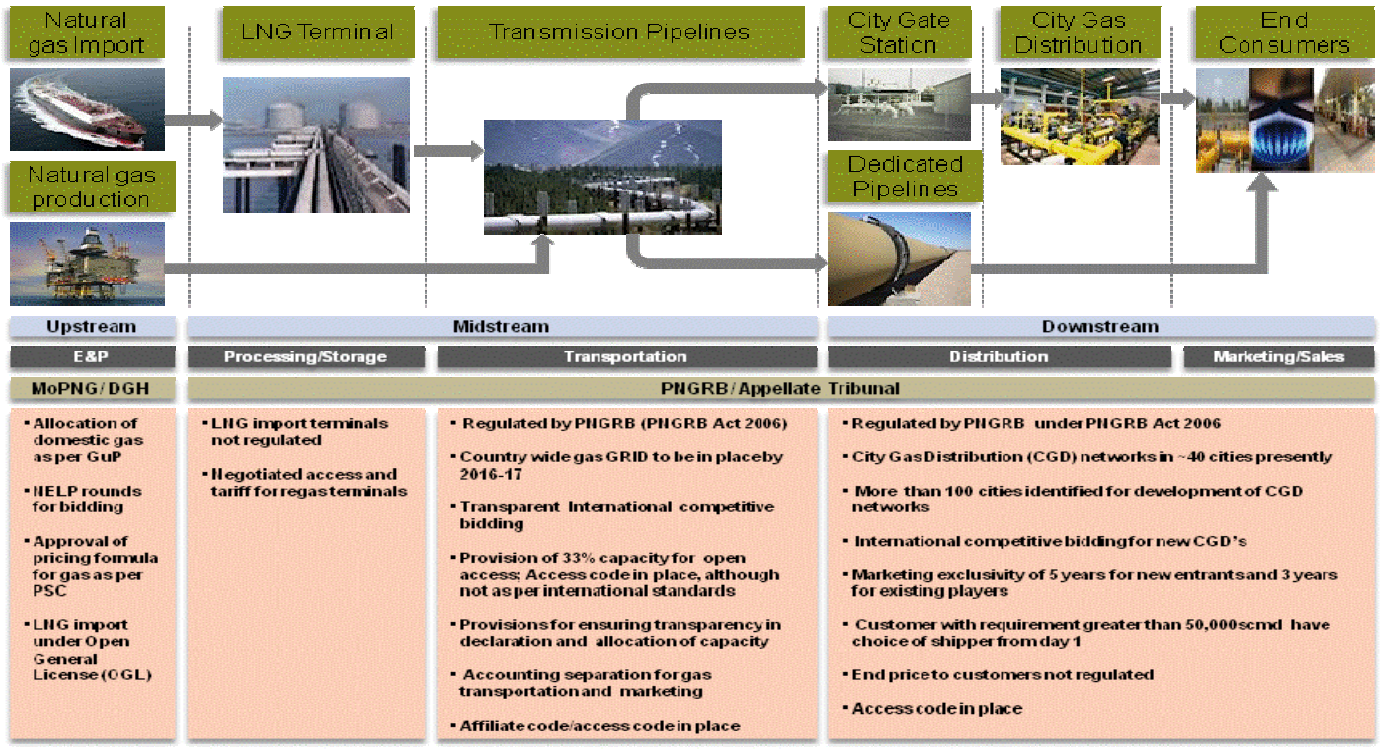
The unbundling of natural gas transportation and marketing is still to happen. However, it is envisaged that in the long run, with the maturing of gas market, the authorized entities will have transportation of natural gas as their sole business activity and will not have any business interests in the gas marketing or city or local gas distribution networks. PNGRB has already come out with draft regulations to ensure legal/ownership unbundling of transportation activity from other activities of an entity. Even before the unbundling is affected, PNGRB needs to ensure that the capacity in transportation pipelines is available on a transparent basis to all the shippers and consumers.

The natural gas pricing is moving towards a market determined pricing mechanism and Indian gas market is getting increasingly aligned with the global trends. Although this gets restrictive when volumes for gas produced locally gets allocated by GoI which impedes the development of a gas market and deters imports as it limits the demand for RLNG.

Equally important is the condition of sectors consuming gas like Power and Fertilizers which form the anchor load for any gas field or RLNG terminal. The affordability of these two key user segments depends upon the policy directives and regulatory reforms in these sectors. The reform in the power sector has moved at a very slow pace which is burdened even today with high AT&C losses, tariffs charged which are not cost reflective and mounting losses to the State Electricity Boards (SEB's) which are not bankable to sign power purchase agreements with power producers. In the Fertilizer sector the end product is subsidized with the government deciding the end price; thus limits the cost at which raw material like natural gas can be bought. Unless key reforms are not initiated in these two sectors it would keep affecting the development of the gas sector since the price signals will always be distorted.

A snapshot of present policy and regulatory environment across the natural gas value chain has been depicted in Figure 21.

Figure 21: **Natural gas chain (India)**



There are currently numerous provisions that facilitate the development of natural gas market as well as infrastructure in India. However, more needs to be done before India can move towards a more open and matured gas market

The following section on International example captures best practices from the two most developed markets US and UK which can be suitably adapted to Indian conditions.

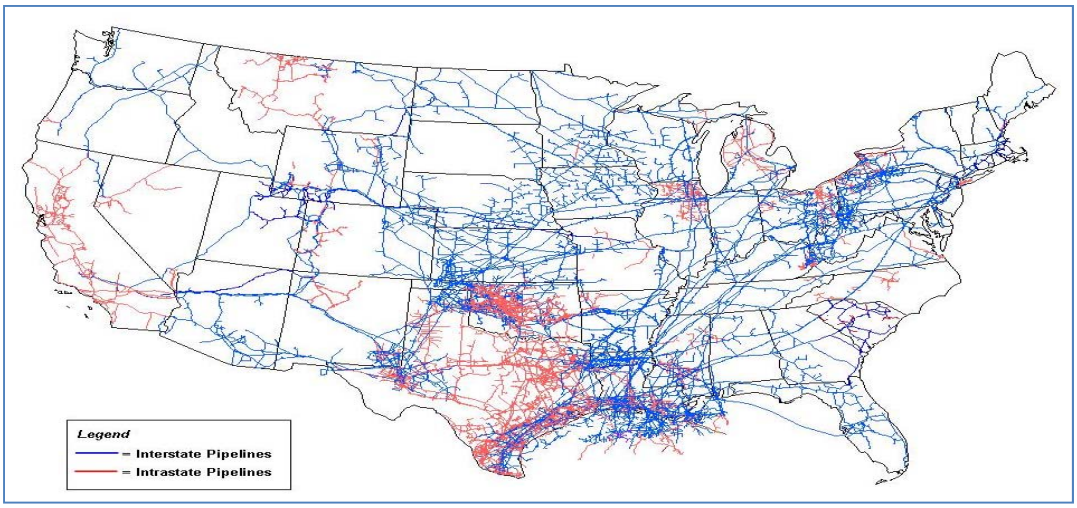
4.2 International Examples

4.2.1 USA

In USA, the wholesale natural gas market has seen radical change with the liberalization of natural gas prices, deregulation of entry into the market and unbundling of pipeline transportation from natural gas sales. These measures have helped create a competitive wholesale market in the country. In the pipeline transportation segment, while tariffs are set by the regulator on a cost basis, pipelines have some price flexibility. This has allowed pipeline companies to adjust more readily to changing market conditions.

The gas transportation pipelines network in USA has grown over time to facilitate quick and economic distribution of natural gas to and from almost any location in the country The vast network of natural gas transmission pipelines existing between and within states along with thousands of delivery, receipt, and interconnection points; hundreds of storage facilities; and more than 50 points for exporting and importing natural gas have supported the evolution of the wholesale gas market of USA into a truly competitive one. The gas pipeline network as it existed across the country in 2009 is presented in Figure 22.

Figure 22 U.S. Natural Gas Pipeline Network, 2009



Source – Energy Information Administration, Office of Oil & Gas, Natural Gas Division, Gas Transportation Information System

The natural gas transportation network delivers more than 23 Tcf of natural gas to over 70 million customers. This network is made up of about 1.5 million miles of mainline and other pipelines, and includes more than 200 mainline transmission pipeline companies, more than 1,300 local distribution companies (LDCs), and about 125 underground natural gas storage operators. Around 306,000 miles of high-pressure interstate and intrastate transmission pipelines transport natural gas from the producing areas to the market.

In the US natural gas market today, the interstate pipeline companies, which can serve only as transporters of natural gas, are regulated by the Federal Energy Regulatory Commission (FERC) in the rates they charge and the terms and conditions of service. The FERC grants general regulatory approval for investments decisions (LNG terminals and interstate pipelines), while Intrastate pipelines are regulated by state regulators. LDCs are regulated by state utility commissions, which oversee their rates and services, and procedures for maintaining adequate supplies for their customers. The competitive wholesale gas market of the US is characterized by natural gas trading through decentralized transactions among producers, marketers, local distribution companies, and large end consumers. Natural gas transactions are mostly arranged by gas marketers, which buy and sell natural gas on behalf of producers, distribution companies and large end users. Gas is traded in several market places. Spot markets typically develop where there are large number of buyers and sellers, such as at a pipeline interconnection near a large metropolitan area or at a major terminal in a gas-producing region. In USA, the Henry Hub in Louisiana is the largest market centre.

By aggregating supply and demand, spot markets offer industry participants the benefits of intensive competition among buyers and sellers, transparency, high liquidity, and greater efficiency in the pricing of natural gas. These spot markets generate efficient price signals about the market value of natural gas by instantly reacting to actual and expected changes in supply and demand. In the US, spot prices of natural gas at Henry Hub are a common indicator of market value. Hub operators have gradually increased the scope of hub services from physical transfer of natural gas to storage, processing, and trading services

The development of the physical market has been followed by the expansion of the financial market where gas market participants can hedge their risks. This has supported development of two distinct markets over time in the wholesale natural gas market in USA. The physical gas market with trading of contracts for physical natural gas delivery and the financial gas market with trading of contracts for price risk management.

Transportation and supply at federal level have most of the time separate shareholders (ownership unbundling). Pipelines companies may have marketing affiliates but there are strict rules governing the sharing of information between the pipeline and the affiliated marketing company. These marketing affiliates don't have a large market share; number of integrated companies at State level has marketing affiliates. At federal level, capacity allocation and tariffs are supervised by the FERC.

Due to the number of shippers and the independence of the transport operators, the secondary market in pipeline capacity has developed rapidly. FERC requires all capacity transactions to be transparent.

The introduction of electronic trading systems has allowed market participants to trade natural gas and pipeline capacity at all interconnected hubs and pipelines. Electronic systems are now used for trading

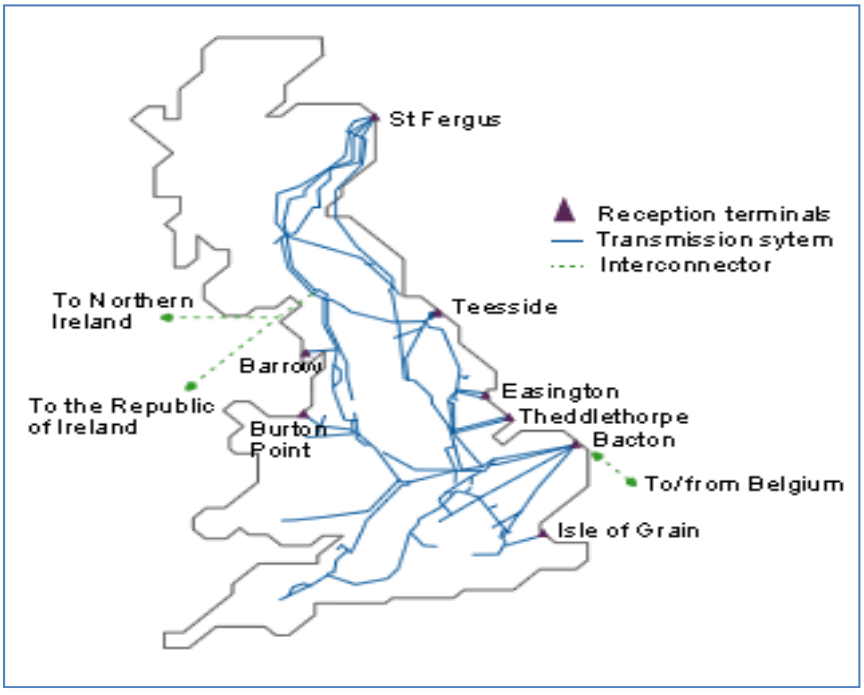
natural gas, pipeline capacity, and storage and for communication between pipeline companies and shippers. Large consumers and LDCs can choose their suppliers. End users choice depend on individual states.

4.2.2 UK

The shift in the UK natural gas market from being a monopolized market to a competitive market place has been catalyzed by structural as well as regulatory changes. Today, like in the US at federal level, gas transportation services in the UK are unbundled. Gas transport (the National Transmission System, (NTS) is owned and operated by National Grid.

The NTS, shown in Figure 23 on the UK map, is a high pressure gas network consisting of terminals, compressor stations, pipeline systems and offtakes. The gas is transported through 6,600 km of high pressure national and regional transmission systems and around 275,000 km of lower pressure local distribution systems. The NTS transports processed natural gas to power stations, large-scale industrial users and other offtake points, for distribution within eight regional gas distribution networks ("**GDNs**"). The Office of Gas and Electricity Markets (**Ofgem**) is the regulator for gas.

Figure 23 National Transmission System (UK)



Source – www.nationalgrid.com

National Grid operates independently of market participants on a for-profit basis. Its operations, including its investment in new pipeline infrastructure and the price shippers are charged for using pipelines, are

subject to economic regulation. It operates the system according to the *Network Code*. *Network Code* is a legal and contractual framework to supply and transport gas that establishes a common set of rules for all industry players and forms the basis of arrangements between National Grid and gas shippers. Gas shippers must be parties to this code in order to trade gas and transport gas over the NTS.

The National Balancing Point (NBP) which encompasses the whole transport grid is the most important hub in Europe. Gas which enters into the transport grid can be freely exchanged between shippers, gas to gas competition leads to a price of gas reflecting market conditions. An active financial gas market has also emerged in the UK natural gas market as the physical gas market has reached a certain level of maturity.

The pipeline transportation capacity is allocated through auctions in the UK natural gas market at each of the main terminals.

All consumers including domestic consumers can choose their suppliers.

4.2.3 Market evolution models

The development of natural gas market in USA and UK has followed different models. In the US retail competition has been done on a state by state basis. In the UK natural gas market already has a developed retail market segment and all customers can choose the shipper of their choice.

The key features of both the USA and UK markets are listed below

1.0 Existence of large number of market participants, providing depth to the market

2.0 No discrimination between shippers. Equal access to infrastructure

3.0 Mechanism to ensure that adequate investments are made on time

4.0 Transparency

5.0 No subsidies on gas, preventing any market distortions

6.0 Strong regulator (in the US the Federal regulator)

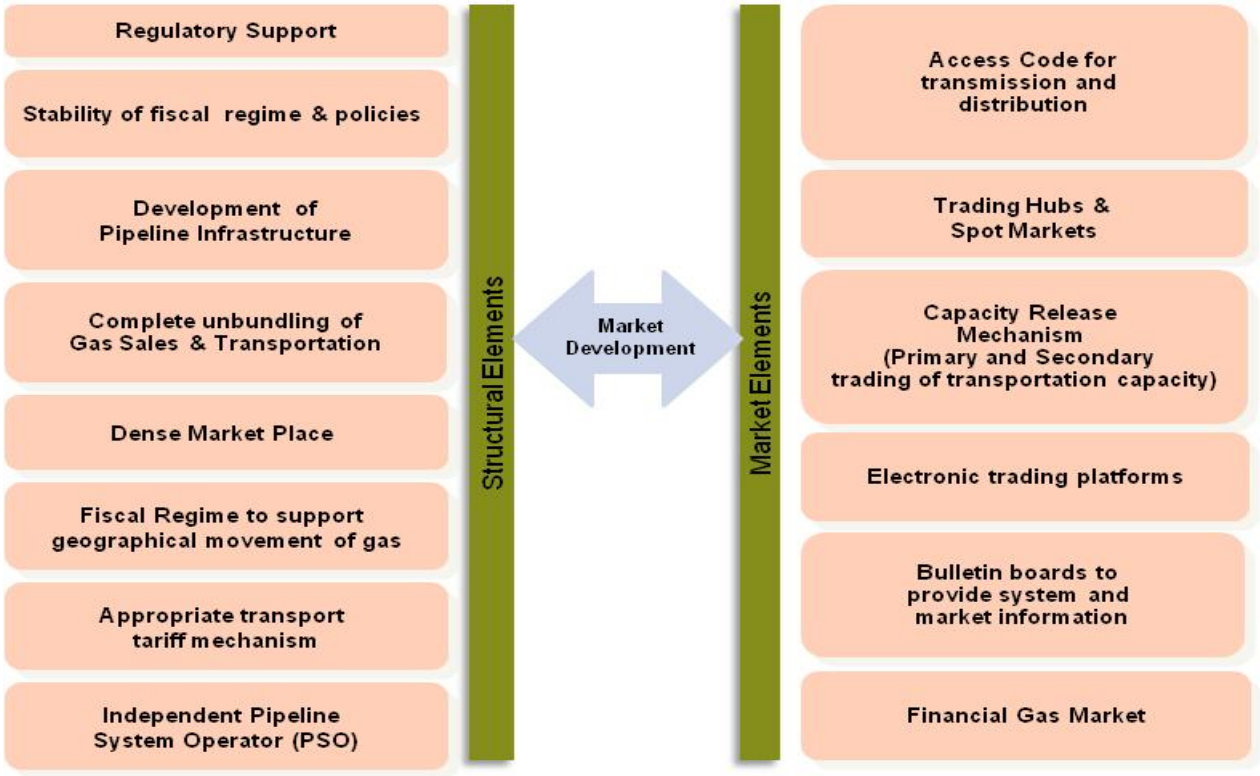
The above characteristics form the basic element for development of any market which can be adapted to Indian needs. While the markets in US and UK are mature, it needs to be mentioned that they have taken several years to reach to this stage.

4.3 Focus areas for India

Developing competitive natural gas markets and attracting investment in development of infrastructure may require frequent regulatory changes and interventions, as it happened in both USA and UK. However, increased regulatory risk and the risk of political intervention discourage investment in the natural gas sector. Therefore, it is important to introduce structural changes at the beginning of the reform to set the stage for developing markets and competition. Thereafter, continuous improvement in the regulatory framework must always support market development. The market forces have also proved to be vital and effective in the natural gas industry, once an appropriate structural and regulatory framework is put in place.

Given the international experience of attracting investments and in the development of the natural gas markets, the major elements that remain critical for creating an enabling environment in India for the development of natural gas market have been summarized in Figure 25.

Figure 24 Major structural and market elements for an enabling environment



Taking into consideration the present state of natural gas market and associated infrastructure in India as well as the international experience (discussed in last section), the issues for immediate attention could be broadly divided under the heads of Policy Issues and Regulatory issues. The key areas falling under these two heads have been listed in Table 35 followed by a detailed discussion covering the same.

Table 33 Focus Areas

Policy Issues	Regulatory Issues
✓ Enabling efficient usage of gas - through free market pricing and gas trading & promoting CCHP ✓ Infrastructure status to natural gas pipelines ✓ Policy focus on setting up strategic storage post 2020 ✓ Sufficient focus on the environmental and social impact linked to natural gas pipeline projects ✓ Expediting the approval process ✓ Reform and support key gas based consumption sectors ✓ Evaluate alternatives to the present differential tax regime ✓ Capacity building (resources) to help development of natural gas infrastructure ✓ Focus on securing long term gas supply tie ups	✓ Legal and Ownership unbundling of the activities of transportation and marketing of natural gas ✓ Need for a robust open access code for the natural gas pipelines ✓ Bidding guidelines and criteria for CGD and pipelines ✓ Establishment of liquid and transparent primary and secondary markets for trading pipeline capacity ✓ Evaluate a switch from the present "Zonal Postalized" tariff recovery system to an appropriate system like "entry–exit" or a hybrid system ✓ Setting up the gas grid management system run by an independent system operator ✓ Encourage development of liquid trading HUBs in India ✓ Development of regional pipelines (medium pressure pipelines)

4.3.1 Policy Issues

4.3.1.1 Enabling efficient usage of gas / Infrastructure status to gas piplelines

In order to provide adequate support to the development of natural gas market and encourage investment in the natural gas infrastructure in India, policy level initiatives would be required to allow gas to trade freely in the market where suppliers, large consumers, traders etc. could all participate. Development of such a trading platform is likely to facilitate establishment of aggregators/traders in the market place with varied business models who would in turn provide depth to the market and address the divergent needs of different suppliers and buyers of natural gas. Such a mechanism would lay the foundation for the

market based price discovery of natural gas. Going forward, it is essential to develop a trading platform to discover prices and create sufficient depth in the Indian natural gas market so that more investment finds its way into the natural gas infrastructure and the infrastructure that gets created gets utilized efficiently.

Efficient usage of gas should also be promoted through generation of power through CCHP, which is more efficient than central generating stations and reduces the pressure to add more generating capacity putting the scarce energy resource to best use.

It is suggested that gas transportation industry be given “infrastructure status” / tax benefits / remote area benefits / any other fiscal incentives, to create higher interest in this sector. It is also recommended that viability gap funding is provided to certain sub economical pipeline development projects.

4.3.1.2 Strategic Storage

The share of natural gas in the primary energy mix of India is expected to go beyond 20% by 2030 increasing, as a result, the importance of natural gas in the context of energy security. Therefore it is imperative that a comprehensive policy initiative be directed at exploring the option of maintaining strategic storage/buffer stock post 2020. Strategic storage is an important element of a risk management system aimed at increasing security of energy supply in a country. Strategic storage can not only address sudden disruptions in supply in crisis situations but it can also play a positive role in promoting fair competition and developing a free market.

PNGRB / GoI need to set up a committee to critically evaluate the need for such storage, the kind of storage which would be cost effective for the country (i.e select from options like caverns, underground storage, excess capacity at RLNG terminals and pipelines etc)

4.3.1.3 Environmental and Social Impact

Oil and gas pipeline projects have been among the biggest infrastructure projects in developing countries in recent years. The climate change impact of methane leakage from aging gas pipelines has been one of the biggest impacts of such projects in the past. Therefore it is important that the environmental and social impact linked to natural gas pipeline projects in the country also receives sufficient policy focus. Environmental and Social Impact Assessment (ESIA) is one framework that may help in preventing /minimizing any adverse impact resulting from laying of pipelines. In general there are five overarching goals of this framework:

1. To prevent adverse impact

2. To minimize the impact that cannot be entirely prevented

3. To mitigate the residual minimal impacts.

4. The residual minimized impacts should be fully compensated or offset such that the impacted people and environment are better off with the project.

5. Benefits to society, especially the affected people and to the environment should be maximized.

ESIA should lead to development of appropriate Environmental Management Plans (EMPs) to address the environmental and social impacts by the project. The pipeline route selection is the most important means of reducing environmental and social impacts and needs to be the centrepiece of ESIA. It is recommended that there should be a system of accredited ESIA agencies, which have a proven track record or have the demonstrable competencies, which will be considered for approvals of any pipeline project. Preference should be given to laying pipelines along identified utility corridors like existing product pipelines etc. Since India has a vast coastline and many demand centres also lie along this coast line, a feasibility of laying gas grid along the coast meeting environmental norms can be conducted.

A different approach has to be taken during pipeline construction to be more eco-friendly like river crossing by horizontal drilling under the river bed / aerial crossings, mountain crossing by tunnelling, reducing width of Right-of Way (ROW), extensive re-vegetation along ROWs etc. In addition special care has to be taken with buried pipelines in high seismic activity areas and landslides prone areas. The proven global practice of above-ground crossing of earthquake faults on flexible rails can be adopted. The “no-go” areas for laying and operating pipelines, need to identified and publicized up-front by the Government, especially Ministry of Environment & Forests (MoEF) and Ministry of Defence (MoD), so that the operators and the industry is aware of these restrictions. Green initiatives can be made mandatory, in gas pipeline operations viz. use of renewable energy, to say minimum 25%, like solar, wind etc and balance maybe only gas based power / use of eco-friendly materials in pipeline construction and operations / all measures to ensure “nil” escape of gas to atmosphere / rainwater harvesting at all gas processing, compressing, metering, distributing stations / green belt in gas plants (say 25% area).

The regulatory / statutory bodies need to develop policies and regulations keeping the above in view, in addition to several other requirements of various other agencies. It is essential that all aspects of pipeline laying, maintenance, operations and decommissioning are suitably covered to take care of the emerging pipeline grids in the country and also to avoid / mitigate any adverse impacts / accidents.

4.3.1.4 Expediting permission process

Transportation of petroleum products comprising of both liquids and gases through cross-county pipelines has proved to be safest and most environment friendly. Therefore, long lead critical clearances, which are pre-requisite for taking up field execution viz. forest approval, CRZ clearance and the Environmental

Clearance, should be facilitated by State and Centre Governments for fast track approvals. The statutory provisions for the pipelines, which are the most eco-friendly mode of transportation, must be made more lenient than what is currently in force. Currently, most of the provisions that are applicable to other infrastructure like highways, railways etc. are applied to pipelines also. Pipelines are by far the least destructive infrastructures. There is no permanent land acquisition and hence no R&R issue. In particular, for permission to traverse through forest land, permission from Gram Panchayats has been introduced. This is a very time consuming exercise and exposes the project to unwarranted hurdles. These should be dropped since there is no change in end use except for some minor restrictions of building a permanent structure in the ROU.

For RoU acquisition, it is essential to create public awareness about these projects of national importance. State Government must be made party to compensation finalisation and should thereafter remove hurdles, if any, faced during pipeline construction in case the same are on account of compensation.

In addition all states should have a provision of single window clearances to expedite projects of national importance like development of gas infrastructure.

4.3.1.5 Reform and support for key gas based consumers

Power sector form the anchor load for gas producers and gas pipeline and hence the health of power sector and consequently the reforms in the sector is critical to the development of gas infrastructure in India. The Government of India should focus on addressing the key issues in the power sector so that the ability for the gas based generating station to pay market prices is enhanced. This would also help to bridge the gap between demand and supply through the RLNG route.

Proper synchronisation needs to be there in power sector and gas sector regulations meant for gas based generating stations. This will enable development of peak load stations reducing the peak power deficit. In addition following steps can be taken to incentivise gas based power generation

- Tariff reforms including introduction of time of day tariffs
- Facilitating decentralized generation,

The above will help to promote gas based generation, and provide comfort to pipeline operators to build pipelines

In addition to the above a policy for DISCOMs to buy a certain percentage of power from gas based power projects would also be helpful to promote gas based power generation. It would ensure a marginal increase in tariff with an assurance of reliable power supply and low emissions. This proposal, which is similar to the Renewable Purchase Obligations (RPO) for renewable, could be considered.

In view of reduced gas availability to power plants, rostering of operation of power plants on a fortnightly or monthly basis amongst the IPPs of states like Andhra Pradesh on a revenue neutral basis will result in a likely increase of 10 – 15% in energy generation and efficient use of gas based plants. This measure would ensure efficient use of gas which is a scarce natural resource. There is a need to frame rostering policy by MoP&NG for efficient utilization of gas for power generation.

As in the case of power sector the Fertilizer sector today also requires policy initiatives to sustain increasing cost of gas in the sector. Currently fertilizer sector gets gas at various price points and from various fields / import terminals. It is desirable to allow aggregation cost to the fertilizer sector to enable them effective administration of different GSPA's thereby resulting in efficient utilization of available resources, reducing issues around take or pay etc. Further currently the sector gets gas on volume basis; it is highly desirable the same should be on heat value basis which is more fair and transparent mechanism.

4.3.1.6 Evaluate alternatives to the present differential tax regime

Natural gas attracts differential tax treatment in different states within India which restricts free movement and swaps across geographies. In swapping of natural gas the 'title of ownership' in gas is bartered with that of another entity, nearer to the end consumer, to enable delivery without gas having to travel over avoidable long distances. Swapping of gas helps in managing inherent limitations in handling, storage and transportation of natural gas. Double taxation and the absence of a trading platform make swap arrangements difficult, particularly in emerging gas markets like India. Therefore, it is important to evaluate alternatives to the present differential tax regime for natural gas so that free movement and swapping of gas gets facilitated across India.

Various options exist to resolve the above issues as discussed below

1.0 Change the Central Sales Tax (CST) Act to recognize contractual path to demonstrate sale of gas under CST. (Currently it follows the physical movement of the goods outside the state)
2.0 Include gas sales under Goods and service tax (GST) maybe with the highest tax slab to offset any revenue loss to states
3.0 Bring gas under declared good status

The above will not only enable the free movement of gas and encourage swapping and trading of gas, it will also ensure efficient utilization of pipeline and other infrastructure.

4.3.1.7 Capacity building (resources) to help development of natural gas infrastructure

Capacity building for the development of natural gas infrastructure, through development of training institutes for skilled and semi skilled workers, is an area that requires policy focus. Considering the

exponential growth of gas transmission pipelines and CGD networks that India is expected to see in near future, availability of skilled/semi-skilled work force is going to prove critical to the materialization of the gas infrastructure development plans. Although technological developments have led to reduction in manpower requirements for development of natural gas infrastructure over time, they have not been able to totally offset the latter. At the same time, existing institutions have not been able to provide the industry with a stable supply of skilled/semi skilled man power as a result of which the gap between the demand and supply of trained manpower has been increasing annually in recent years. Going forward, this shortfall in trained manpower may lead to delays in projects and cost over run thereby posing serious threat to gas infrastructure development projects. Therefore, it is essential that policy initiatives be taken to set up additional training institutes that can address the shortfall of skilled and semi skilled workmen. The initiative can also be taken by private/ public sector oil & gas companies as part of their corporate social responsibility (CSR) programmes.

4.3.1.8 Long term gas tie ups

The increasing usage of natural gas would not only be cleaner for the environment but it would also lead to greater diversification of the energy/fuel basket of India thereby strengthening the country's energy security. But in order to increase the consumption of natural gas in the country on a sustained basis, long term reliable supply arrangements/tie ups would be needed in addition to augmenting domestic energy resource base. This can be either through transnational pipeline or import of LNG.

Hence to ensure long term energy security of India, Govt. of India and its agencies should work with its political / diplomatic channels to provide necessary support to the importers of gas on tying up long term resources in foreign country which can either flow through LNG route or through pipelines based on the geographical proximity with the country

This is important since the issue assumes geopolitical overtones. Also all large consumers of gas like China are working at the highest level in the government to ensure such suppliers for long term.

4.3.2 Regulatory Issues

The natural gas space in India has seen major regulatory reforms in recent years. The PNGRB, after it was constituted in 2007, has notified several regulations covering authorization of natural gas pipelines, tariff for common carrier or contract carrier pipelines, common access code for pipelines and standards related to the technical and health/safety/environment aspects linked to the design, construction, and maintenance of natural gas pipelines. Helped by these initiatives the investment in natural gas pipeline

infrastructure has also been substantial in recent times. However, there remain certain areas of improvement for ensuring a rapid development of natural gas infrastructure in the country.

There is a need for synchronization of regulations across the value chain. Non alignment creates problems with gas based power generating stations and urea producers wherein they suffer due to issues like different shutdown days allowed, events of force majeure and drawl rate flexibility etc.

The PNGRB should ensure that the regulations are dynamic and should keep on changing / evolving keeping in view the factors like past experience, state of maturity of the market and stakeholder requirements. Some key changes required in the current environment are discussed below

4.3.2.1 Unbundling of Transportation and Marketing of natural gas

Unbundling of the activities of transportation and marketing of natural gas has yet to happen in the country. The unbundling of these two activities prevents cross subsidies between the two activities and creates a level playing field for all shippers, avoiding favours by transporters to its supply affiliate. The development of a large number of supply companies (that purchase natural gas in the wholesale market, resell it downstream, and use the transportation services of pipeline and distribution companies) also gets facilitated by the act of unbundling. An increase in the number of such companies pushes down their resale markups due to competition thereby passing through cost savings from the production segment to the end users. At present the Regulations provide only for accounting and financial separation (by maintaining separate financial records and books of accounts for the regulated activity) if an entity's affiliate is engaged or an entity on its own engages in both transportation and marketing of natural gas. However, PNGRB Act 2006 empowers PNGRB to decide timeline for legal and ownership unbundling of transportation and marketing activities. As a first step PNGRB has floated a concept paper on the same which is a step in the right direction. Internationally, bundling of transportation and marketing activities has been seen to foster investments into the natural gas infrastructure space during the early stages of development. However, unbundling has set the stage for rapid market development following such investment helping markets move towards maturity. In India too, there is a need to unbundle marketing and transportation activities (legal unbundling followed by ownership unbundling) to ensure further development of natural gas market. Based on the state of current market in India legal unbundling is recommended in next 1-2 yrs and further based on the progress of development of the gas grid and competition in the Indian market, a decision on ownership unbundling can be taken.

4.3.2.2 Robust Open Access Code

There is a need for a robust open access code for the natural gas pipelines as it is expected to facilitate access to pipeline infrastructure and benefit market participants. Natural gas producers get benefit from it as open access allows new suppliers to reach consumers Downstream participants like the distribution entities get benefit from direct access to the natural gas producers and a greater choice in gas supply. End users also benefit through increased competition and choice of gas distributors. Guidelines notified by PNGRB allow utilization of capacity in a natural gas pipeline by any entity on a non-discriminatory basis as well as the assignment and trading of capacity in the open market. PNGRB has also come out with an "Access Code" for natural gas pipelines. However, the code needs to be strengthened further in order to achieve the desired outcome. The current code is not designed to deal adequately with multiple owner operators leading to issues of compatibility. PNGRB needs to setup a separate committee to come out with suitable recommendations to strengthen the access code, in line with developed codes of matured markets.

4.3.2.3 Review of mechanism of infrastructure Development

For development of any infrastructure the developers need to be given assurance of reasonable returns, sustainable for a timeframe which helps them to achieve funding

Currently the infrastructure is developed by calling bids which has some inherent issues like

1. Taking bid with all capex and opex for next 25 years, which is a reasonably long period for assumptions.
2. Each bidder can bid for capacity accordingly to its assessment, results in different pipeline size under same bid
3. No appropriate authentication of availability of source and demand, etc.

These factors are not only difficult to assess, for such a long period and at times results in adding avoidable capex in the project but also make it difficult to compare at the same level. Moreover, pipelines are capital intensive long gestation projects and require funding by the institution therefore certainity regarding the revenue is of prime importance for the financial closure of the project.

There is need to review the current mechanism of awarding the authorization for development of infrastructure, the mechanism needs to be such that it ensures

a. All entities bid for the same product or capacity.
b. Technical parameters may fixed by all the interested parties in co-ordination with PNGRB

c. Bid can be called on the basis of capex and tariff can be allowed as per the tariff determination regulations.
d. With the change in scenarios additional capex can be introduced in the project as allowing compensation on the capex would always be in the hand of PNGRB and the same can be appropriately provided to the entity.

4.3.2.4 Capacity trading

Development of natural gas transportation market also remains one of the important steps in the movement of Indian natural gas market towards maturity. At present, the regulations provide for capacity trading. However, establishment of liquid and transparent primary and secondary markets for trading pipeline capacity still looks distant. While in the primary market pipeline companies can sell transportation contracts to marketers, local distribution companies, or end users, the secondary market allows pipeline companies and holders of transportation contracts to resell the unused capacity. Unbundling is expected to facilitate the development of a short-term transportation market in the country (where pipeline companies and transportation contract holders would be able to offer available capacity for sale) by introducing a need for simultaneous clearing of natural gas and transportation markets (given that market participants acquire natural gas based on the availability of transportation, and vice versa) and promoting transparent and fair pricing of transportation service. A robust open access code would also support the development of transportation market by facilitating infrastructure sharing.

4.3.2.5 Tariff recovery mechanism

Tariff recovery is a function of the maturity of infrastructure and the sophistication of the natural gas market in a country. In India, tariff recovery has moved from the earlier “postalized” basis to the present “zonal postalized” basis. The former system implied a uniform tariff across the length of the natural gas pipeline meaning no discrimination between customers on the basis of distance or volume. In this system, however, the users far away from the source along the length of the pipeline were allegedly subsidized at the cost of the users that were located closer to the natural gas source. The latter system implies that the tariff remains uniform within a tariff zone and the tariff for a successive tariff zone could be at least equal to or greater than the previous tariff zone. Now, as a nation wide network of pipelines (national gas grid), with multiple sources and destinations for natural gas, is emerging in India, a switch could be attempted to the mature tariff system which not only provides access to the customers located geographically disadvantageous locations but also provide platform for a competitive market to develop, One of such system called “entry–exit” tariff system is used in some European countries including the UK. In this system, contractual path of the transportation services is broken into two transactions i.e (i) entry transaction and (ii) exit transaction and both can be entered separately. In this system different entry and exit points are identified in the pipeline system which can also be on zonal basis, where the shipper has

to pay one tariff to enter into a zone and another one to exit it. In this system separate booking of entry and exit capacity allows shippers and new entrants to book capacity without any contractual path and allows shippers to buy and sell freely gas once having paid the tariff to enter into the zone thus creating the conditions for a gas market.

However, keeping multi ownership structure of pipelines and tax provisions of the country in view, Entry – Exit system prevalent in European countries may need customization before implementation. Alternatively a hybrid of zonal and above system can be evaluated further to ensure it meets the objective of delivering gas at a reasonable price across India. It may emerge that a mix of the current system for long distance pipeline and an entry –exit for meshed systems like in west and north of India may work better. It is suggested that a separate group may be setup to study the tariff system prevalent in other countries and come out with a suitable tariff mechanism to meet the stated objectives and need of the country.

4.3.2.6 Independent operator for system discipline and security of supply

There is also a need to consider constituting a independent Pipeline System Operator (PSO) in order to streamline tariff-sharing among various pipeline system owners as well as ensuring system discipline. The natural gas pipeline network operating in the country today is operated by six players – GAIL (India), Gujarat State Petronet Limited (GSPL), Gujarat Gas Company Limited (GGCL), Reliance Gas Transportation Infrastructure Limited (RGTIL), Indian Oil Corporation Limited (IOCL), and Assam Gas Company Limited (AGCL). In such a multi-operator environment, a revenue sharing model may be implemented where all pipeline owners would be allowed to develop a network according to the PNGRB regulations while the PSO would work as a shell company, operating the entire network, having equity of each pipeline owner proportionate to the pipeline capacity that the owner entity offers to the PSO. Alternatively, a model where the entry charge would be collected by the transporter, wherever the gas enters a pipeline system, and the exit charges would be collected by the PSO, who delivers the gas to a customer, may be implemented. In this model the sharing of revenues would be decided by the PSO based on a formula. The setting up of PSO will bring uniformity in access parameters among pipelines and hence ensure system discipline and supply security. Since the setting up of a PSO is a cumbersome and time consuming activity, the regulator should start the process of setting up of the framework and infrastructure for such a PSO, so that the same can be operationalised with development of the gas grid in next 3-5yrs.

The issues raised above can also be resolved reasonably in the interim through a robust access code as discussed earlier with pipeline interconnectivity issues resolved through that mechanism.

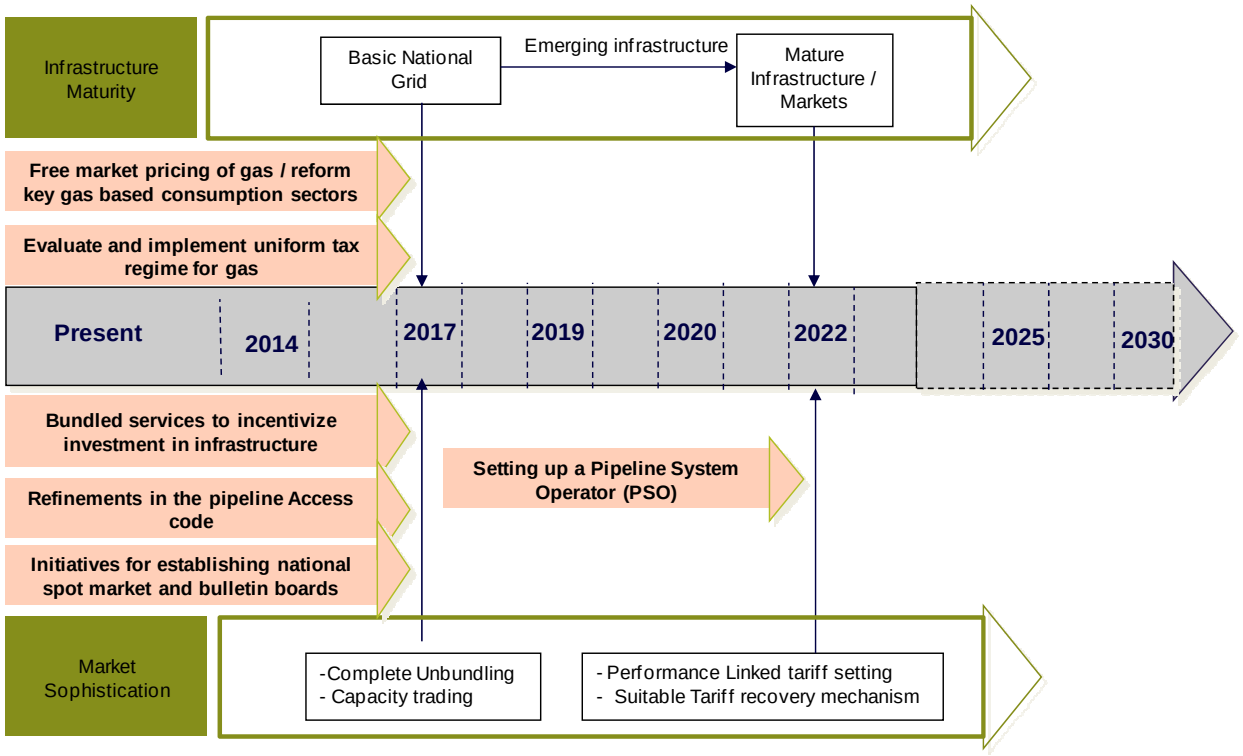
4.3.2.7 HUBs/Spot markets

For the development of liquid trading HUBs in India, it is important to address the issue of transparency associated with trading at such platforms. Mechanisms like the bulletin boards (on the company websites) help in achieving transparency in trading transactions among the participants. Bulletin boards are aimed at providing transparent, real time and independent information to all market participants including market observers (including governments) on the state of the gas market, system constraints, market opportunities etc. Establishing bulletin boards in India can facilitate gas trading and pipeline capacity trading by providing readily available system and market information. Once the market is sufficiently liquid the trading platform can be migrated to independent exchanges.

4.3.3 Indicative Action Plan

An indicative action plan has been presented in Figure 25 with broad level timelines for making progress towards a mature natural gas market in India both in terms of infrastructure and market sophistication. It needs to be emphasized that a stable policy and regulatory climate remains critical to the development of natural gas sector and associated infrastructure. It can develop investor confidence; attract investments and make availability of funds for projects easier. It is also important that implementation of projects is helped further by single window clearance.

Figure 25 Action plan for development



Given the development plans for natural gas infrastructure, it is expected that a basic national gas grid would be in place by the end of the 12th five year plan. Once the basic pipeline network is in place, legal and ownership unbundling of natural gas marketing and transportation may be introduced along with initiatives that facilitate trading of primary and secondary transport capacity. Before such time, bundled service offering is likely to incentivize investment in infrastructure. The time till 2016-17 should also be utilized for refinements in the existing pipeline access code and testing initiatives directed at development of a spot market for natural gas. The government should also encourage movement of gas through swaps, trading etc by an enabling tax regime which avoids double taxation. Setting up of an independent pipeline System Operator (PSO) and switching to the suitable tariff mechanism (entry –exit or a mix of current system with other mechanisms) from the present zonal system of tariff may be achieved by the end of the 13th five year plan. The natural gas infrastructure in India is also likely to see maturity during this time.

References:

1) 12th – 13th five year Plan document – “Plan Document”

2) National Gas Grid study – ICF / (PPAC / USTDA)

3) Report on Pooling of Natural Gas – Planning Commission

4) Integrated Energy Policy – Approved 2008

5) Saumitra Chaudhuri report on Policy for Pooling of Natural Gas Prices and Pool Operating Guidelines

6) Working group report on 12th Plan (Power / Fertilizer/ P&NG/Coal)

7) International Regulations

8) Power Regulations – Policy & regulatory changes

9) Infraline Oil & Gas database

ANNEXURE – I

LIST OF THERMAL (Gas Based) POWER STATION AS ON 31.03.2012

Sr. No.	Region/ State	Sector	Owner	Name of Project	P M		Unit No	No of Unit	Capacity	Total Capacity
1	Delhi	State Sector	Pr PCL	Indra Prasatha CCPP	GT-Gas	Gas	1	1	30	**30.00**
	Delhi	State Sector	Pr PCL	Indra Prasatha CCPP	GT-Gas	Gas	2	1	30	**30.00**
	Delhi	State Sector	Pr PCL	Indra Prasatha CCPP	GT-Gas	Gas	3	1	30	**30.00**
	Delhi	State Sector	Pr PCL	Indra Prasatha CCPP	GT-Gas	Gas	4	1	30	**30.00**
	Delhi	State Sector	Pr PCL	Indra Prasatha CCPP	GT-Gas	Gas	5	1	30	**30.00**
	Delhi	State Sector	Pr PCL	Indra Prasatha CCPP	GT-Gas	Gas	6	1	30	**30.00**
	Delhi	State Sector	Pr PCL	Indra Prasatha CCPP	GT-Gas	WHRB	7	1	30	**30.00**
	Delhi	State Sector	Pr PCL	Indra Prasatha CCPP	GT-Gas	WHRB	8	1	30	**30.00**
	Delhi	State Sector	Pr PCL	Indra Prasatha CCPP	GT-Gas	WHRB	9	1	30	**30.00**
2	Delhi	State Sector	Pr PCL	Pragati CCPP	GT-Gas	Gas	1	1	104.6	**104.60**
	Delhi	State Sector	Pr PCL	Pragati CCPP	GT-Gas	Gas	2	1	104.6	**104.60**
	Delhi	State Sector	Pr PCL	Pragati CCPP	GT-Gas	WHRB	3	1	121.2	**121.20**
3	Delhi	State Sector	Pr PCL	Pragati CCPP	GT-Gas	Gas	1	1	250	**250.00**
	Delhi	State Sector	Pr PCL	Pragati CCPP	GT-Gas	Gas	2	1	250	**250.00**
	Delhi	State Sector	Pr PCL	Pragati CCPP	GT-Gas	Gas	3	1	250	**250.00**
4	Delhi	State Sector	NDPL	Rithala CCPP	GT-Gas	Gas	2	1	35.75	**35.75**
	Delhi	State Sector	NDPL	Rithala CCPP	GT-Gas	Gas	1	1	35.75	**35.75**
	Delhi	State Sector	NDPL	Rithala CCPP	GT-Gas	Gas	1	1	36.5	**36.50**
5	Jammu & Kashmir	State Sector	J & K PDC	Pampore Gas Power Station	GT-Gas	Liq. Fuel	1	1	25	**25.00**
	Jammu & Kashmir	State Sector	J & K PDC	Pampore Gas Power Station	GT-Gas	Liq. Fuel	2	1	25	**25.00**
	Jammu & Kashmir	State Sector	J & K PDC	Pampore Gas Power Station	GT-Gas	Liq. Fuel	3	1	25	**25.00**
	Jammu & Kashmir	State Sector	J & K PDC	Pampore Gas Power Station	GT-Gas	Liq. Fuel	4	1	25	**25.00**
	Jammu & Kashmir	State Sector	J & K PDC	Pampore Gas Power Station	GT-Gas	Liq. Fuel	5	1	25	**25.00**
	Jammu & Kashmir	State Sector	J & K PDC	Pampore Gas Power Station	GT-Gas	Liq. Fuel	6	1	25	**25.00**
	Jammu & Kashmir	State Sector	J & K PDC	Pampore Gas Power Station	GT-Gas	Liq. Fuel	7	1	25	**25.00**
6	Central Sector	Central Sector	NTPC	Anta CCPP	GT-Gas		1	1	88.71	**88.71**

	Central Sector	Central Sector	NTPC	Anta CCPP	GT-Gas		2	1	88.71	**88.71**
	Central Sector	Central Sector	NTPC	Anta CCPP	GT-Gas		3	1	88.71	**88.71**
	Central Sector	Central Sector	NTPC	Anta CCPP	GT-Gas	WHRB	4	1	153.2	**153.20**
7	Central Sector	Central Sector	NTPC	Auriaya CCPP	GT-Gas	WHRB	5	1	109.3	**109.30**
	Central Sector	Central Sector	NTPC	Auriaya CCPP	GT-Gas	WHRB	6	1	109.3	**109.30**
	Central Sector	Central Sector	NTPC	Auriaya CCPP	GT-Gas		1	1	111.19	**111.19**
	Central Sector	Central Sector	NTPC	Auriaya CCPP	GT-Gas		2	1	111.19	**111.19**
	Central Sector	Central Sector	NTPC	Auriaya CCPP	GT-Gas		3	1	111.19	**111.19**
	Central Sector	Central Sector	NTPC	Auriaya CCPP	GT-Gas		4	1	111.19	**111.19**
8	Central Sector	Central Sector	NTPC	Dadri CCPP	GT-Gas		1	1	130.19	**130.19**
	Central Sector	Central Sector	NTPC	Dadri CCPP	GT-Gas		2	1	130.19	**130.19**
	Central Sector	Central Sector	NTPC	Dadri CCPP	GT-Gas		3	1	130.19	**130.19**
	Central Sector	Central Sector	NTPC	Dadri CCPP	GT-Gas		4	1	130.19	**130.19**
	Central Sector	Central Sector	NTPC	Dadri CCPP	GT-Gas	WHRB	5	1	154.51	**154.51**
	Central Sector	Central Sector	NTPC	Dadri CCPP	GT-Gas	WHRB	6	1	154.51	**154.51**
9	Central Sector	Central Sector	NTPC	Faridabad CCGT	GT-Gas		1	1	137.76	**137.76**
	Central Sector	Central Sector	NTPC	Faridabad CCGT	GT-Gas		2	1	137.76	**137.76**
	Central Sector	Central Sector	NTPC	Faridabad CCGT	GT-Gas	WHRB	3	1	156.07	**156.07**
10	Rajasthan	State Sector	RRVUNL	Dhaulpur CCGT	GT-Gas		1	1	110	**110.00**
	Rajasthan	State Sector	RRVUNL	Dhaulpur CCGT	GT-Gas		2	1	110	**110.00**
	Rajasthan	State Sector	RRVUNL	Dhaulpur CCGT	GT-Gas	WHRB	3	1	110	**110.00**
11	Rajasthan	State Sector	RRVUNL	Ramgarh Gas Power Station	GT-Gas		1	1	3	**3.00**
	Rajasthan	State Sector	RRVUNL	Ramgarh Gas Power Station	GT-Gas		2	1	35.5	**35.50**
	Rajasthan	State Sector	RRVUNL	Ramgarh Gas Power Station Stage St-II	GT-Gas		3	1	37.5	**37.50**
	Rajasthan	State Sector	RRVUNL	Ramgarh Gas Power Station Stage-II	GT-Gas	WHRB	4	1	37.8	**37.80**
12	Goa	Pvt.	Reliance Salgaocar	Salgaocar Gas Power Station GOA (GT)	GT-Gas	Liq. Fuel		1	48	**48.00**
13	Gujarat	Pvt.	Torrent Power Generation Ltd,.	Vatva Gas Power Station	GT-Gas	Gas	1	1	33	**33.00**
	Gujarat	Pvt.	Torrent Power Generation Ltd,.	Vatva Gas Power Station	GT-Gas	Gas	2	1	33	**33.00**
	Gujarat	Pvt.	Torrent Power Generation Ltd,.	Vatva Gas Power Station	GT-Gas	WHRB	3	1	34	**34.00**

14	Gujarat	Pvt.	Torrent Power Generation Ltd,.	Sugen C C P P	GT-Gas	Gas	1	1	382.5	**382.50**
	Gujarat	Pvt.	Torrent Power Generation Ltd,.	Sugen C C P P	GT-Gas	Gas	2	1	382.5	**382.50**
	Gujarat	Pvt.	Torrent Power Generation Ltd,.	Sugen C C P P	GT-Gas	Gas	3	1	382.5	**382.50**
15	Gujarat	Pvt.	ESSAR Pvt.	Essar Gas Power Station	GT-Gas	Gas	1	1	110	**110.00**
	Gujarat	Pvt.	ESSAR Pvt.	Essar Gas Power Station	GT-Gas	Gas	2	1	110	**110.00**
	Gujarat	Pvt.	ESSAR Pvt.	Essar Gas Power Station	GT-Gas	Gas	3	1	110	**110.00**
	Gujarat	Pvt.	ESSAR Pvt.	Essar Gas Power Station	GT-Gas	WHRB	4	1	185	**185.00**
16	Gujarat	State Sector	GSEGCL	Haziira Gas Power Station	GT-Gas	Gas	1	1	52	**52.00**
	Gujarat	State Sector	GSEGCL	Haziira Gas Power Station	GT-Gas	Gas	2	1	52	**52.00**
	Gujarat	State Sector	GSEGCL	Haziira Gas Power Station	GT-Gas	WHRB	3	1	52.1	**52.10**
	Gujarat	State Sector	GSEGCL	Haziira Gas Power Station	GT-Gas	Gas	4	1	351	**351.00**
17	Gujarat	Pvt.	GIPCL	Baroda Gas Power Station	GT-Gas	Gas	5	1	106	**106.00**
	Gujarat	Pvt.	GIPCL	Baroda Gas Power Station	GT-Gas	Gas	6	1	54	**54.00**
18	Gujarat	State Sector	GSECL	Dhuvaran CCPP-I	GT-Gas	Gas	1	1	67.85	**67.85**
	Gujarat	State Sector	GSECL	Dhuvaran CCPP-II	GT-Gas	Gas	3	1	72	**72.00**
	Gujarat	State Sector	GSECL	Dhuvaran CCPP-I	GT-Gas	WHRB	2	1	38.77	**38.77**
	Gujarat	State Sector	GSECL	Dhuvaran CCPP-II	GT-Gas	Gas	4	1	40	**40.00**
19	Gujarat	State Sector	GSECL	Utran Gas Power Station	GT-Gas	Gas	1	1	33	**33.00**
	Gujarat	State Sector	GSECL	Utran Gas Power Station	GT-Gas	Gas	2	1	33	**33.00**
	Gujarat	State Sector	GSECL	Utran Gas Power Station	GT-Gas	Gas	3	1	33	**33.00**
	Gujarat	State Sector	GSECL	Utran Gas Power Station	GT-Gas	WHRB	4	1	45	**45.00**
	Gujarat	State Sector	GSECL	Utran CCGT	GT-Gas	Gas	5	1	374	**374.00**
20	Gujarat	Pvt.	GTE Corp.	Peguthan Gas Power Station	GT-Gas	Gas	1	1	135	**135.00**
	Gujarat	Pvt.	GTE Corp.	Peguthan Gas Power Station	GT-Gas	Gas	2	1	135	**135.00**
	Gujarat	Pvt.	GTE Corp.	Peguthan Gas Power Station	GT-Gas	Gas	3	1	135	**135.00**
	Gujarat	Pvt.	GTE Corp.	Peguthan Gas Power Station	GT-Gas	Gas	4	1	250	**250.00**
21	Maharashtra	State Sector	MAHAGENCO	Uran Gas Power Station	GT-Gas	Gas	5	1	108	**108.00**
	Maharashtra	State Sector	MAHAGENCO	Uran Gas Power Station	GT-Gas	Gas	6	1	108	**108.00**
	Maharashtra	State Sector	MAHAGENCO	Uran Gas Power Station	GT-Gas	Gas	7	1	108	**108.00**

	Maharashtra	State Sector	MAHAGENCO	Uran Gas Power Station	GT-Gas	Gas	8	1	108	**108.00**
	Maharashtra	State Sector	MAHAGENCO	Uran Gas Power Station	GT-Gas	Gas	9	1	120	**120.00**
	Maharashtra	State Sector	MAHAGENCO	Uran Gas Power Station	GT-Gas	Gas	10	1	120	**120.00**
22	Maharashtra	Pvt.	TATA Power Co.	Trombay Gas Power Station	GT-Gas	WHRB	2	1	60	**60.00**
	Maharashtra	Pvt.	TATA Power Co.	Trombay Gas Power Station	GT-Gas	Gas	1	1	120	**120.00**
23	Central Sector	Central Sector	NTPC	Gandhar CCPP	GT-Gas	Gas	1	1	144.3	**144.30**
	Central Sector	Central Sector	NTPC	Gandhar CCPP	GT-Gas	Gas	2	1	144.3	**144.30**
	Central Sector	Central Sector	NTPC	Gandhar CCPP	GT-Gas	Gas	3	1	144.3	**144.30**
	Central Sector	Central Sector	NTPC	Gandhar CCPP	GT-Gas	WHRB	4	1	224.49	**224.49**
24	Central Sector	Central Sector	NTPC	Kawas Gas Power Station	GT-Gas	Gas	1	1	106	**106.00**
	Central Sector	Central Sector	NTPC	Kawas Gas Power Station	GT-Gas	Gas	2	1	106	**106.00**
	Central Sector	Central Sector	NTPC	Kawas Gas Power Station	GT-Gas	Gas	3	1	106	**106.00**
	Central Sector	Central Sector	NTPC	Kawas Gas Power Station	GT-Gas	Gas	4	1	106	**106.00**
	Central Sector	Central Sector	NTPC	Kawas Gas Power Station	GT-Gas	Gas	5	1	116.1	**116.10**
	Central Sector	Central Sector	NTPC	Kawas Gas Power Station	GT-Gas	Gas	6	1	116.1	**116.10**
25	Central Sector	Central Sector	NTPC & GAIL	Ratnagiri Gas Power Station	GT-Gas	Multi-Fuel		1	240	**240.00**
	Central Sector	Central Sector	NTPC & GAIL	Ratnagiri Gas Power Station	GT-Gas	Multi-Fuel		1	240	**240.00**
	Central Sector	Central Sector	NTPC & GAIL	Ratnagiri Gas Power Station	GT-Gas	Multi-Fuel		1	260	**260.00**
	Central Sector	Central Sector	NTPC & GAIL	Ratnagiri Gas Power Station	GT-Gas	Multi-Fuel		1	240	**240.00**
	Central Sector	Central Sector	NTPC & GAIL	Ratnagiri Gas Power Station	GT-Gas	Multi-Fuel		1	240	**240.00**
	Central Sector	Central Sector	NTPC & GAIL	Ratnagiri Gas Power Station	GT-Gas	Multi-Fuel		1	260	**260.00**
	Central Sector	Central Sector	NTPC & GAIL	Ratnagiri Gas Power Station	GT-Gas	Multi-Fuel		1	240	**240.00**
	Central Sector	Central Sector	NTPC & GAIL	Ratnagiri Gas Power Station	GT-Gas	Multi-Fuel		1	240	**240.00**
	Central Sector	Central Sector	NTPC & GAIL	Ratnagiri Gas Power Station	GT-Gas	Multi-Fuel		1	260	**260.00**
26	Andhra Pradesh	Pvt.	LANCO	Lanko Kondapalli Gas Power Station	GT-Gas	Gas	1	1	233	**233.00**
	Andhra Pradesh	Pvt.	LANCO	Lanko Kondapalli Gas Power Station	GT-Gas	WHRB	1	1	133	**133.00**
27	Andhra Pradesh	Pvt.	BSES	Gautami C C P P	GT-Gas	Gas		1	145	**145.00**
	Andhra Pradesh	Pvt.	BSES	Gautami C C P P	GT-Gas	Gas		1	145	**145.00**
	Andhra Pradesh	Pvt.	BSES	Gautami C C P P	GT-Gas	WHRB		1	174	**174.00**

28	Andhra Pradesh	Pvt.	BSES	Konaseema C C P P	GT-Gas	Gas	1	1	140	**140.00**
	Andhra Pradesh	Pvt.	BSES	Konaseema C C P P	GT-Gas	Gas	2	1	140	**140.00**
	Andhra Pradesh	Pvt.	BSES	Konaseema C C P P	GT-Gas	Gas	2	1	165	**165.00**
29	Andhra Pradesh	Pvt.	BSES	Peddapuram Gas Power Station	GT-Gas	Gas	1	1	142	**142.00**
	Andhra Pradesh	Pvt.	BSES	Peddapuram Gas Power Station	GT-Gas	WHRB	2	1	78	**78.00**
30	Andhra Pradesh	Pvt.	GVK Ind	Jegrupadu Gas Power Station	GT-Gas	Gas	1	1	52.8	**52.80**
	Andhra Pradesh	Pvt.	GVK Ind	Jegrupadu Gas Power Station	GT-Gas	Gas	2	1	52.8	**52.80**
	Andhra Pradesh	Pvt.	GVK Ind	Jegrupadu Gas Power Station	GT-Gas	Gas	3	1	52.8	**52.80**
	Andhra Pradesh	Pvt.	GVK Ind	Jegrupadu Gas Power Station	GT-Gas	WHRB	4	1	77	**77.00**
	Andhra Pradesh	Pvt.	GVK Ind	Jegrupadu Gas Power Station	GT-Gas	Gas	5	1	140	**140.00**
	Andhra Pradesh	Pvt.	GVK Ind	Jegrupadu Gas Power Station	GT-Gas	WHRB	6	1	80	**80.00**
31	Andhra Pradesh	Pvt.	LANCO	Kondapalli Gas Power Station	GT-Gas	Gas	1	1	112	**112.00**
	Andhra Pradesh	Pvt.	LANCO	Kondapalli Gas Power Station	GT-Gas	Gas	2	1	112	**112.00**
	Andhra Pradesh	Pvt.	LANCO	Kondapalli Gas Power Station	GT-Gas	WHRB	3	1	126	**126.00**
32	Andhra Pradesh	Pvt.	Vemagiri Power Corp.	Vemagiri ,CCPP	GT-Gas	Gas	1	1	233	**233.00**
	Andhra Pradesh	Pvt.	Vemagiri Power Corp.	Vemagiri ,CCPP	GT-Gas	WHRB	2	1	137	**137.00**
33	Andhra Pradesh	Pvt.	SPGL (Spectrum)	Godavari Gas Power Station	GT-Gas	Gas	1	1	47	**47.00**
	Andhra Pradesh	Pvt.	SPGL (Spectrum)	Godavari Gas Power Station	GT-Gas	Gas	2	1	47	**47.00**
	Andhra Pradesh	Pvt.	SPGL (Spectrum)	Godavari Gas Power Station	GT-Gas	Gas	3	1	47	**47.00**
	Andhra Pradesh	Pvt.	SPGL (Spectrum)	Godavari Gas Power Station	GT-Gas	WHRB	4	1	67	**67.00**
34	Karnataka	Pvt.	GMR Energy Ltd.	Tanir Bavi Gas Power Station	GT-Gas	Liq. Fuel	1	1	42.5	**42.50**
	Karnataka	Pvt.	GMR Energy Ltd.	Tanir Bavi Gas Power Station	GT-Gas	Liq. Fuel	2	1	42.5	**42.50**
	Karnataka	Pvt.	GMR Energy Ltd.	Tanir Bavi Gas Power Station	GT-Gas	Liq. Fuel	3	1	42.5	**42.50**
	Karnataka	Pvt.	GMR Energy Ltd.	Tanir Bavi Gas Power Station	GT-Gas	Liq. Fuel	4	1	42.5	**42.50**
	Karnataka	Pvt.	GMR Energy Ltd.	Tanir Bavi Gas Power Station	GT-Gas	WHRB	5	1	50	**50.00**

35	Kerala	Pvt.	BSES Pvt.Co.	Cochin Gas Power Station	GT-Gas	WHRB	3	1	39	**39.00**
	Kerala	Pvt.	BSES Pvt.Co.	Cochin Gas Power Station	GT-Gas	Liq. Fuel	1	1	45	**45.00**
	Kerala	Pvt.	BSES Pvt.Co.	Cochin Gas Power Station	GT-Gas	Liq. Fuel	2	1	45	**45.00**
	Kerala	Pvt.	BSES Pvt.Co.	Cochin Gas Power Station	GT-Gas	Liq. Fuel	4	1	45	**45.00**
36	Pondich erry	State Sector	PPCL (Gas)	Karaikal Gas Power Station	GT-Gas	Gas	1	1	22.9	**22.90**
	Pondich erry	State Sector	PPCL (Gas)	Karaikal Gas Power Station	GT-Gas	WHRB	2	1	9.6	**9.60**
37	Central Sector	Central Sector	NTPC	Rajiv Gandhi CCPP	GT-Gas	Liq. Fuel	1	1	115.2	**115.20**
	Central Sector	Central Sector	NTPC	Rajiv Gandhi CCPP	GT-Gas	Liq. Fuel	2	1	115.2	**115.20**
	Central Sector	Central Sector	NTPC	Rajiv Gandhi CCPP	GT-Gas	Liq. Fuel	3	1	129.18	**129.18**
38	Tamil Nadu	State Sector	KUTTAL AM CCPP	Kuttalam Gas Power Station unit1	GT-Gas	Gas	1	1	63	**63.00**
	Tamil Nadu	State Sector	KUTTAL AM CCPP	Kuttalam Gas Power Station	GT-Gas	WHRB	2	1	37	**37.00**
39	Tamil Nadu	Pvt.	PPN Power Co.Ltd.	Pillaiperumalana llur Gas Power Station	GT-Gas	Gas	1	1	225	**225.00**
	Tamil Nadu	Pvt.	PPN Power Co.Ltd.	Pillaiperumalana llur Gas Power Station	GT-Gas	WHRB	2	1	105.5	**105.50**
40	Tamil Nadu	Pvt.	Aban Power Co.Ltd.,	Karuppur CCGT	GT-Gas	Gas	1	1	70	**70.00**
	Tamil Nadu	Pvt.	Aban Power Co.Ltd.,	Karuppur CCGT(Waste Heat Steam)	GT-Gas	WHRB	2	1	49.8	**49.80**
41	Tamil Nadu	Pvt.	PENNA Electric Ltd.	Valentharvy GPS	GT-Gas	Gas	1	1	38	**38.00**
	Tamil Nadu	Pvt.	PENNA Electric Ltd.	Valentharvy GPS	GT-Gas	WHRB	2	1	14.8	**14.80**
42	Tamil Nadu	State Sector	TNEB	Basin Bridge Gas Power Station	GT-Gas	Liq. Fuel	1	1	30	**30.00**
	Tamil Nadu	State Sector	TNEB	Basin Bridge Gas Power Station	GT-Gas	Liq. Fuel	2	1	30	**30.00**
	Tamil Nadu	State Sector	TNEB	Basin Bridge Gas Power Station	GT-Gas	Liq. Fuel	3	1	30	**30.00**
	Tamil Nadu	State Sector	TNEB	Basin Bridge Gas Power Station	GT-Gas	Liq. Fuel	4	1	30	**30.00**
43	Tamil Nadu	State Sector	TNEB	Kovikalappal Gas Power Station	GT-Gas	WHRB	2	1	38	**38.00**
	Tamil Nadu	State Sector	TNEB	Kovikalappal Gas Power Station	GT-Gas	Gas	1	1	69	**69.00**
44	Tamil Nadu	State Sector	TNEB	Narimanam Gas Power Station	GT-Gas	Gas	1	1	5	**5.00**
	Tamil Nadu	State Sector	TNEB	Narimanam Gas Power Station	GT-Gas	Gas	2	1	5	**5.00**

45	Tamil Nadu	State Sector	TNEB	Valuuthur Gas Power Station	GT-Gas	WHRB	3	1	34	**34.00**
	Tamil Nadu	State Sector	TNEB	Valuuthur Gas Power Station	GT-Gas	WHRB	4	1	32.4	**32.40**
	Tamil Nadu	State Sector	TNEB	Valuuthur Gas Power Station	GT-Gas	Gas	1	1	60	**60.00**
	Tamil Nadu	State Sector	TNEB	Valuuthur Gas Power Station	GT-Gas	Gas	2	1	59.8	**59.80**
46	D.V.C	Central Sector	D.V.C	Maithon Gas Power Station	GT-Gas	Liq. Fuel	1	1	30	**30.00**
	D.V.C	Central Sector	D.V.C	Maithon Gas Power Station	GT-Gas	Liq. Fuel	2	1	30	**30.00**
	D.V.C	Central Sector	D.V.C	Maithon Gas Power Station	GT-Gas	Liq. Fuel	3	1	30	**30.00**
47	West Bengal	State Sector	WBPDC	Haldia Gas Power Station	GT-Gas	Liq. Fuel	2	1	20	**20.00**
	West Bengal	State Sector	WBPDC	Haldia Gas Power Station	GT-Gas	Liq. Fuel		1	20	**20.00**
48	West Bengal	State Sector	WBPDC	Kasba Gas Power Station	GT-Gas	Liq. Fuel	2	1	20	**20.00**
	West Bengal	State Sector	WBPDC	Kasba Gas Power Station	GT-Gas	Liq. Fuel		1	20	**20.00**
49	West Bengal	State Sector	WBPDC	Siliguri Gas Power Station	GT-Gas	Liq. Fuel	1	1	20	**20.00**
50	Assam	State Sector	A.S.E.B	Lakwa Gas Power Station	GT-Gas	Gas	1	1	15	**15.00**
	Assam	State Sector	A.S.E.B	Lakwa Gas Power Station	GT-Gas	Gas	2	1	15	**15.00**
	Assam	State Sector	A.S.E.B	Lakwa Gas Power Station	GT-Gas	Gas	3	1	15	**15.00**
	Assam	State Sector	A.S.E.B	Lakwa Gas Power Station	GT-Gas	Gas	4	1	15	**15.00**
	Assam	State Sector	A.S.E.B	Lakwa Gas Power Station	GT-Gas	Gas	5	1	20	**20.00**
	Assam	State Sector	A.S.E.B	Lakwa Gas Power Station	GT-Gas	Gas	6	1	20	**20.00**
	Assam	State Sector	A.S.E.B	Lakwa Gas Power Station	GT-Gas	Gas	7	1	20	**20.00**
	Assam	State Sector	A.S.E.B	Lakwa Gas Power Station	GT-Gas	Gas	8	1	37.2	**37.20**
51	Assam	State Sector	A.S.E.B	Namrup Gas Power Station	GT-Gas	Gas	4	1	11	**11.00**
	Assam	State Sector	A.S.E.B	Namrup Gas Power Station	GT-Gas	Gas	1	1	20	**20.00**
	Assam	State Sector	A.S.E.B	Namrup Gas Power Station	GT-Gas	Gas	2	1	21	**21.00**
	Assam	State Sector	A.S.E.B	Namrup Gas Power Station	GT-Gas	Gas	3	1	21	**21.00**
	Assam	State Sector	A.S.E.B	Namrup, Wasteheat Gas Power Station	GT-Gas	WHRB	6	1	22	**22.00**
52	Assam	State Sector	A.S.E.B	Namrup Thermal Power Station(M F)	GT-Gas	Gas	5	1	24	**24.00**
53	Assam	Pvt.	DLF Power Co.	Adamtilla Gas Power Station	GT-Gas	Gas	1	1	3	**3.00**

	Assam	Pvt.	DLF Power Co.	Adamtilla Gas Power Station	GT-Gas	Gas	2	1	3	**3.00**
	Assam	Pvt.	DLF Power Co.	Adamtilla Gas Power Station	GT-Gas	WHRB	3	1	3	**3.00**
54	Assam	Pvt.	DLF Power Co.	Baskhandi Gas Power Station	GT-Gas	Gas	1	1	3.5	**3.50**
	Assam	Pvt.	DLF Power Co.	Baskhandi Gas Power Station	GT-Gas	Gas	2	1	3.5	**3.50**
	Assam	Pvt.	DLF Power Co.	Baskhandi Gas Power Station	GT-Gas	Gas	3	1	3.5	**3.50**
	Assam	Pvt.	DLF Power Co.	Baskhandi Gas Power Station	GT-Gas	Gas	4	1	5	**5.00**
55	Central Sector	Central Sector	NEEPCO	Agartala Gas Power Station	GT-Gas	Gas	1	1	21	**21.00**
	Central Sector	Central Sector	NEEPCO	Agartala Gas Power Station	GT-Gas	Gas	2	1	21	**21.00**
	Central Sector	Central Sector	NEEPCO	Agartala Gas Power Station	GT-Gas	Gas	3	1	21	**21.00**
	Central Sector	Central Sector	NEEPCO	Agartala Gas Power Station	GT-Gas	Gas	4	1	21	**21.00**
56	Central Sector	Central Sector	NEEPCO	Kathalguri CCPP	GT-Gas	WHRB	7	1	30	**30.00**
	Central Sector	Central Sector	NEEPCO	Kathalguri CCPP	GT-Gas	WHRB	8	1	30	**30.00**
	Central Sector	Central Sector	NEEPCO	Kathalguri CCPP	GT-Gas	WHRB	9	1	30	**30.00**
	Central Sector	Central Sector	NEEPCO	Kathalguri CCPP	GT-Gas	Gas	1	1	33.5	**33.50**
	Central Sector	Central Sector	NEEPCO	Kathalguri CCPP	GT-Gas	Gas	2	1	33.5	**33.50**
	Central Sector	Central Sector	NEEPCO	Kathalguri CCPP	GT-Gas	Gas	3	1	33.5	**33.50**
	Central Sector	Central Sector	NEEPCO	Kathalguri CCPP	GT-Gas	Gas	4	1	33.5	**33.50**
	Central Sector	Central Sector	NEEPCO	Kathalguri CCPP	GT-Gas	Gas	5	1	33.5	**33.50**
	Central Sector	Central Sector	NEEPCO	Kathalguri CCPP	GT-Gas	Gas	6	1	33.5	**33.50**
57	Tripura	State Sector	TSECL	Baramura Gas Power Station Extn.	GT-Gas	Gas	1	1	21	**21.00**
	Tripura	State Sector	TSECL	Baramura Gas Power Station	GT-Gas	Gas	2	1	5	**5.00**
	Tripura	State Sector	TSECL	Baramura Gas Power Station	GT-Gas	Gas	3	1	5	**5.00**
	Tripura	State Sector	TSECL	Baramura Gas Power Station	GT-Gas	Gas	4	1	6.5	**6.50**
	Tripura	State Sector	TSECL	Baramura Gas Power Station	GT-Gas	Gas	5	1	21	**21.00**
58	Tripura	State Sector	TSECL	Rokhia Gas Power StationPhase II	GT-Gas	Gas	2	1	8	**8.00**
	Tripura	State Sector	TSECL	Rokhia Gas Power StationPhase II	GT-Gas	Gas	3	1	8	**8.00**
	Tripura	State Sector	TSECL	Rokhia Gas Power StationPhase II	GT-Gas	Gas	4	1	8	**8.00**

	Tripura	State Sector	TSECL	Rokhia Gas Power StationPhase II	GT-Gas	Gas	5	1	8	**8.00**
	Tripura	State Sector	TSECL	Rokhia Gas Power StationPhase II	GT-Gas	Gas	6	1	8	**8.00**
	Tripura	State Sector	TSECL	Rokhia Gas Power StationPhase II	GT-Gas	Gas	7	1	8	**8.00**
	Tripura	State Sector	TSECL	Rokhia Gas Power Station-II, Unit - VII	GT-Gas	Gas	8	1	21	**21.00**
	Tripura	State Sector	TSECL	Rokhia Gas Power Station-II, Unit - VIII	GT-Gas	Gas		1	21	**21.00**
									Total Capacity (MW)	**18381.05**

ANNEXURE – II

Gas Demand for Future Power plants

A: Gas Demand for Planned Projects under Construction / Partly Commissioned

S.No	Name of Project	State	Agency	Capacity (MW)	Gas Requirement at 90% PLF (MMSCMD)	Gas Requirement at 70% PLF (MMSCMD)	Year of Commissioning
Projects Slipped from 11th Plan							
1	PRAGATI-III (BAWANA)	DELHI	PPCL	750.0	3.6	2.8	250 MW commissioned in 2012-13 / remaining 500 MW likely in 2013-14
2	PIPAVAV JV CCGT Block-1,2	Gujarat	GSECL	702.0	3.37	2.62	351 MW commissioned in 2012-13 / 351 MW likely in 2013-14
	Sub-Total			**1452**	**6.97**	**5.42**	
Projects Planned for 12th Plan (gas availability from local sources)							
3	NAMRUP CCGT	Assam	APGCL	100.0	0.48	0.37	2013-14
4	RAMGARH	Rajasthan	RRVUNL	160.0	0.77	0.60	110 MW commissioned in 2012-13 & balance 50 MW likely in 2013-14
5	TRIPURA GAS**	Tripura	OTPC	726.6	3.5	2.71	363.3 MW commissioned in 2012-13 & remaining 363.3 MW likely in 2013-14
6	MONARCHAK Gas	Tripura	NEEPCO	100.0	0.48	0.37	2013-14
	Sub-Total			**1086.6**	**5.23**	**4.05**	
	Total			**2538.6**	**12.2**	**9.47**	

B: Projects Under Advanced Stage of Construction

S.No.	Name of Project	State	Agency	Capacity (MW)	Gas Requirement at 90% PLF (MMSCMD)	Gas Requirement at 75% to A.P. Projects/70 % PLF Non AP Projects (MMSCMD)	Year of Commissioning ** (Tentative)
1	Vemagiri exp	A.P.	GREL	768	3.68	3.07	2013-14
2	Lanco Kondapalli Exp (St-III)	A.P.	LANCO	770	3.70	3.08	2013-14
3	Kashipur CCGT Phase I&II	Uttarakhand	Sravanti Energy P Ltd	450	2.16	1.68	2013-14
4	Samalkot CCGT Expansion	A.P.	Reliance Power	2400	11.52	9.6	2013-14 /2014-15
5	Panduranga CCGT - Ph-I	A.P.	PSPL	110	0.53	0.44	2013-14
6	Sugen Phase-I Unit -4	Gujarat	Torrent Power	382.5	1.84	1.43	Plant commissioned in March 2013
7	Dgen	Gujarat	Torrent Power	1200	5.76	4.48	2013-14
8	CCGT by M/s Beta Infratech Private Ltd	Uttarakhand	Beta Infratech	225	1.08	0.84	2013-14
9	CCGT by M/s Gama Infraprop Pvt Ltd	Uttarakhand	Gamma Infraprop Ltd	225	1.08	0.84	2013-14
10	CCGT by M/s Pioneer Gas Power Ltd	Maharashtra	Pioneer Gas Power Ltd	400	1.92	1.49	2014-15
11	Astha Power Gas Engine with co-generation	A P.	M/s Astha Power Ltd	35	0.17	0.14	2013-14
12	Dhruvan Exp Ph-III	Gujarat	GSECL	375	1.9	1.48	2013-14
TOTAL				**7346.5**	**35.34**	**28.56**	

**- Subject to availability of gas

C: Projects for Which Orders have been Placed but Delayed Construction due to Non Availability of Gas

S.No.	Name of Project	State	Agency	Capacity (MW)	Gas Requirement at 90% PLF (MMSCMD)	Gas Requirement at 75% to A.P. Projects/70% PLF Non AP Projects (MMSCMD)	Year of Commissioning ** (Tentative)
1	Jegrupadu Exp. (St-III)I	A.P.	GVK	400	1.92	1.6	2016-17
2	Gautami St-II (Phase-I)	A.P.	GVK	800	3.84	3.2	2016-17
3	CCGT by RVK (Rajahmundry) Private Ltd.	A.P.	RVK	436	2.09	1.74	2016-17
4	CCPP by M/s Guruji Power Pvt Ltd (GPPL)	Uttarakhand	Guruji Power	110	0.53	0.41	2016-17
5	Latur CCPP	Maharashtra	Hecate Power Systems P Ltd.	800	3.84	2.99	2016-17
6	CCPP by M/s H Energy Co. Pvt. Ltd.	Maharashtra	H Energy	350	1.68	1.31	2016-17
7	CCGT by M/s KPR Chemicals Ltd.	AP	KPR Chemicals	225	1.08	0.9	2016-17
8	PPN Expansion by PPN Power Generation Co Ltd	Tamil Nadu	PPN Power Generation Co Ltd	1080	5.18	4.03	2016-17
TOTAL				**4201**	**20.16**	**16.18**	

**- Subject to availability of gas

D: Gas Requirement of power projects Recommended by Ministry of Power for completion in the 12th plan

S.No.	Name of Project	State	Agency	Capacity (MW)	Gas Requirement at 90% PLF (MMSCMD)	Gas Requirement at 75% to A.P. Projects/70% PLF Non AP Projects (MMSCMD)	Year of Commissioning ** (Tentative)
1	NTPC's Kawas & Gandhar	Gujarat	NTPC	2600	12.48	9.7	2016-17
2	NTPC's Kayamkulam - II	Kerala	NTPC	1050	5.04	3.92	2016-17
3	DMICDC	Maharastra	DMICDC	1000	4.8	3.73	2016-17
4	Puducherry at Yannam	Puducherry	PPCL	350	1.68	1.31	2016-17
5	Faridabad HPGENCO	Haryana	HPGCL	750	3.6	2.8	2016-17
6	Karimnagar	A.P.	APGENCO	700	3.36	2.8	2016-17
	Grand Total			**6450**	**30.96**	**24.26**	

ANNEXURE – III

Plant wise gas requirement of UREA plants in India in 2010-11

Name of the Unit	2010-11
	MMSCMD
On HBJ Pipeline	
NFL- Vijaypur I & II	3.73
CFCL-Gadepan-I&II	4.13
IFFCO-Aonla-I& II	4.38
IFFCO-Phulpur-I&II	3.70
KSFL-Shahjahanpur	2.21
TCL-Babrala	2.24
IGFL-Jagdishpur	2.23
SFC-Kota	0.62
Non-HBJ Pipeline	
Kribhco-Hazira	4.15
NFCL- Kakinada-I&II	3.12
RCF-Trombay-V	1.95
RCF-Thal	4.31
IFFCO-Kalol	1.30
GSFC-Vadodara	1.99
GNFC-Bharuch	1.07
BVFCL, Namrup	2.02
Sub total of demand (A)	**43.14**

Source - Infraline

ANNEXURE – IV

A) Demand projections for switching plants from 2012-2030 (MMSCMD)

Naphtha Based Plants

	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Napththa Based										
ZIL- Goa	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
MCFL – Mangalore	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SPIC Tuticorin	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66
MFL (Madras Fertilizers) Manali	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54
FACT – Udyogmandalam	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Dil – Kanpur	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
Sub total of demand (C)	**8.12**	**8.12**	**8.12**	**8.12**	**8.12**	**8.12**	**8.12**	**8.12**	**8.12**	**8.12**

	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
Napththa Based								
ZIL- Goa	1.28	1.28	1.28	1.28	1.28	1.28	1.28	1.28
MCFL – Mangalore	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
SPIC Tuticorin	1.66	1.66	1.66	1.66	1.66	1.66	1.66	1.66
MFL (Madras Fertilizers) Manali	1.54	1.54	1.54	1.54	1.54	1.54	1.54	1.54
FACT – Udyogmandalam	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Dil – Kanpur	1.70	1.70	1.70	1.70	1.70	1.70	1.70	1.70
Sub total of demand (C)	**8.12**	**8.12**	**8.12**	**8.12**	**8.12**	**8.12**	**8.12**	**8.12**

Fuel Oil Based Plants

	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Fuel Oil Based										
NFL - Panipat	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
NFL- Nangal	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NFL - Bhatinda	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
GNFC	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Sub total of demand (D)	**3.75**	**3.75**	**3.75**	**3.75**	**3.75**	**3.75**	**3.75**	**3.75**	**3.75**	**3.75**

	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
Fuel Oil Based								
NFL - Panipat	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
NFL- Nangal	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
NFL - Bhatinda	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
GNFC	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Sub total of demand (D)	**3.75**	**3.75**	**3.75**	**3.75**	**3.75**	**3.75**	**3.75**	**3.75**

B) Demand projections for closed units from 2012-2030 (MMSCMD)

Closed Units	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
FCI - Ramagundam	0.0	0.0	0.0	2.20	2.20	2.20	2.20	2.20	2.20	2.20
FCI - Sindri	0.0	0.0	0.0	0.00	2.20	2.20	2.20	2.20	2.20	2.20
Other Units*	0.0	0.0	0.0	2.20	4.40	6.60	6.60	6.60	6.60	8.80
Sub total of demand (F)	**0.0**	**0.0**	**0.0**	**4.40**	**8.80**	**11.00**	**11.00**	**11.00**	**11.00**	**13.20**

Closed Units	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
	MMSCMD	MMSCMD	MMSCMD	MMSCMD	MMSCMD	MMSCMD	MMSCMD	MMSCMD
FCI – Ramagundam	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20
FCI – Sindri	2.20	2.20	2.20	2.20	2.20	2.20	2.20	2.20
Other Units*	11.00	11.00	11.00	11.00	11.00	11.00	11.00	11.00
Sub total of demand (F)	**15.40**	**15.40**	**15.40**	**15.40**	**15.40**	**15.40**	**15.40**	**15.40**

** HFCL - Durgapur, HFCL - Barauni, HFCL - Haldia, FCI - Talcher, FCI – Korba, FCI - Gorakhpur*

C) Demand projections for expansion projects from 2012-2030 (MMSCMD)

	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Expansion Units										
IFFCO- Kalol	0.00	0.00	0.03	2.93	2.93	2.93	2.93	2.93	2.93	2.93
IFFCO-Aonla	0.00	0.00	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
IFFCO-Phulpur	0.00	0.00	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Other Units*	0.00	0.00	0.00	4.40	8.80	13.20	15.40	15.40	15.40	15.40
Sub total of demand (E)	**0.00**	**0.00**	**0.43**	**7.73**	**12.13**	**16.53**	**18.73**	**18.73**	**18.73**	**18.73**

	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
Expansion Units								
IFFCO- Kalol	2.93	2.93	2.93	2.93	2.93	2.93	2.93	2.93
IFFCO-Aonla	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
IFFCO-Phulpur	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Other Units*	15.40	15.40	15.40	15.40	15.40	15.40	15.40	15.40
Sub total of demand (E)	**18.73**	**18.73**	**18.73**	**18.73**	**18.73**	**18.73**	**18.73**	**18.73**

** Kribhco-Hazira, RCF-Thal, CFCL-Gadepan, TCL-Babrala, IGFL-Jagdishpur, KSFL-Shahjahanpur, NFCL - Kakinada*

D) Demand projections for Greenfield projects from 2012-2030 (MMSCMD)

	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Green Field Projects										
Matix fertilizers & chemicals, Burwan [CBM]	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
ZIL- Belgaum	0.00	0.00	0.00	0.00	2.46	2.46	2.46	2.46	2.46	2.46
DIL - Kanpur (Brown Field)	0.00	0.00	0.00	0.00	4.60	4.60	4.60	4.60	4.60	4.60
GSFC - Dahej (Brown Field)	0.00	0.00	0.00	0.00	3.50	3.50	3.50	3.50	3.50	3.50
Oswal Chem & Fertilizers Limited	0.00	0.00	0.00	0.00	2.40	2.40	2.40	2.40	2.40	2.40
IFFCO - Nellore Fertlizer project	0.00	0.00	0.00	0.00	3.00	3.00	3.00	3.00	3.00	3.00
Sub total of demand (G)	**2.40**	**2.40**	**2.40**	**2.40**	**18.36**	**18.36**	**18.36**	**18.36**	**18.36**	**18.36**

	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
Green Field Projects								
Matix fertilizers & chemicals, Burwan [CBM]	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
ZIL- Belgaum	2.46	2.46	2.46	2.46	2.46	2.46	2.46	2.46
DIL - Kanpur (Brown Field)	4.60	4.60	4.60	4.60	4.60	4.60	4.60	4.60
GSFC - Dahej (Brown Field)	3.50	3.50	3.50	3.50	3.50	3.50	3.50	3.50
Oswal Chem & Fertilizers Limited	2.40	2.40	2.40	2.40	2.40	2.40	2.40	2.40
IFFCO - Nellore Fertlizer project	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
Sub total of demand (G)	**18.36**	**18.36**	**18.36**	**18.36**	**18.36**	**18.36**	**18.36**	**18.36**

E) Demand projections for revamp projects from 2012-2030 (MMSCMD)

	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22
Revamp Projects										
Kribhco, Hazira	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
NFL Vijaypur	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
NFCL Kakinada	0.60	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
RCF thal	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Sub total of demand (B)	**2.45**	**2.55**	**2.55**	**2.55**	**2.55**	**2.55**	**2.55**	**2.55**	**2.55**	**2.55**

	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30
Revamp Projects								
Kribhco, Hazira	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
NFL Vijaypur	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
NFCL Kakinada	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70
RCF thal	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Sub total of demand (B)	**2.55**	**2.55**	**2.55**	**2.55**	**2.55**	**2.55**	**2.55**	**2.55**

ANNEXURE – V

Gas consumption by CGD entities for the year 2010-11 (MMSCMD)

	Domestic				Imported				
CGD Entity	**APM**	**PMT**	**KG-D6**	**Other**	**R-LNG**	**Total**	**APM as Percent of Total Consumption**	**Non-APM as Percent of Total Consumption**	**R-LNG as Percent of Total Consumption**
Central UP Gas Limited, Kanpur	0.1	0.0	0.0	0.0	0.0	0.1	83.0	0.0	17.0
Central UP Gas Limited, Bareilly	0.1	0.0	0.0	0.0	0.0	0.1	100.0	0.0	0.0
GAIL Gas Limited, Kota	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GAIL Gas Limited, Meerut	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GAIL Gas Limited, Dewas	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
GAIL Gas Limited, Sonepat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Green Gas Limited (Lucknow)	0.1	0.0	0.0	0.0	0.0	0.1	100.0	0.0	0.0
Green Gas Limited (Agra)	0.0	0.0	0.0	0.0	0.0	0.0	98.0	0.0	2.0
GSPC Gas	0.0	0.0	0.0	0.0	3.8	3.8	0.0	0.0	100.0
IGL	2.1	0.0	0.1	0.0	0.5	2.7	78.0	5.0	17.0
MNGL	0.0	0.0	0.0	0.0	0.0	0.0	86.0	0.0	14.0
TNGCL	0.0	0.0	0.0	0.0	0.0	0.0	62.0	38.0	0.0
GGCL	0.2	1.7	0.0	0.4	1.1	3.4	5.0	63.0	32.0
BGL	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0
Sabarmati Gas	0.0	0.0	0.1	0.0	0.6	0.7	0.0	10.0	90.0
Charotar Gas	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	100.0
Siti Energy	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
Vadodara Municipal Corporation	0.1	0.0	0.0	0.0	0.0	0.1	99.0	0.0	1.0
MGL	1.4	0.0	0.3	0.0	0.1	1.8	78.0	16.0	6.0
AGCL	0.5	0.0	0.0	0.0	0.0	0.5	95.0	5.0	0.0
HPCL	0.0	0.0	0.1	0.0	0.0	0.1	0.0	91.0	9.0
Total	**4.653**	**1.69**	**0.565**	**0.483**	**6.226**	**13.617**	**34.20%**		**45.70%**

ANNEXURE – VI

GA's assumed to get CGD networks in the period 2016-17 to 2021-22

Cities planned for CGD networks as per the 4th bidding round

S.No	GA	State	Year
1	Ernakulam	Kerala	2017
2	Rangareddy & Medak	Andhra Pradesh	2017
3	Nalgonda	Andhra Pradesh	2017
4	Khammam	Andhra Pradesh	2017
5	Alibag/Pen	Maharashtra	2017
6	Lonavla/Khopoli	Maharashtra	2017
7	Guna	Madhya Pradesh	2017
8	Shajahanpur	Uttar Pradesh	2017

Other cities to get CGD network in future

S.No	City to be covered	State	Population (Census 2011)*	Year
1	Patna	Bihar	1,683,200	2017
2	Nashik	Maharashtra	1,486,973	2017
3	Dhanbad	Jharkhand	1,161,561	2018
4	Jodhpur	Rajasthan	1,033,918	2018
5	Raipur	Chhattisgarh	1,010,087	2018
6	Solapur	Maharashtra	951,118	2018
7	Aligarh	Uttar Pradesh	872,575	2018
8	Bhubaneshwar	Orissa	837,737	2018
9	Saharanpur	Uttar Pradesh	703,345	2018
10	Gorakhpur	Uttar Pradesh	671,048	2018
11	Guntur	Andhra Pradesh	651,382	2018
12	Bikaner	Rajasthan	647,804	2018
13	Amravati	Maharashtra	646,801	2019
14	Bhillai	Chhattisgarh	625,697	2019
15	Warangal	Andhra Pradesh	620,116	2019
16	Durgapur	West Bengal	566,937	2019
17	Ajmer	Rajasthan	542,580	2019

S.No	City to be covered	State	Population (Census 2011)*	Year
18	Jammu	Jammu And Kashmir	503,690	2019
19	Gaya	Bihar	463,454	2019
20	Bokaro	Jharkhand	413,934	2019
21	Bellary	Karnataka	409,644	2019
22	Latur	Maharashtra	382,754	2019
23	Rohtak	Haryana	373,133	2020
24	Bhilwara	Rajasthan	360,009	2020
25	Ahmadnagar	Maharashtra	350,905	2020
26	Kollam	Kerala	349,033	2020
27	Rampur	Uttar Pradesh	325,248	2020
28	Shimoga	Karnataka	322,428	2020
29	Chandrapur	Maharashtra	321,036	2020
30	Thrissur	Kerala	315,596	2020
31	Nizamabad	Andhra Pradesh	310,467	2020
32	Tumkur	Karnataka	305,821	2020
33	Hissar	Haryana	301,249	2021
34	Panipat	Haryana	294,150	2021
35	Karnal*	Haryana	286,974	2021
36	Rourkela	Orissa	273,217	2021
37	Durg	Chhattisgarh	268,679	2021
38	Ratlam	Madhya Pradesh	264,810	2021
39	Hapur	Uttar Pradesh	262,801	2021
40	Arrah	Bihar	261,099	2021
41	Karimnagar	Andhra Pradesh	260,899	2021
42	Etawah	Uttar Pradesh	256,790	2021
43	Mirzapur	Uttar Pradesh	233,691	2022
44	Ramagundam	Andhra Pradesh	229,632	2022
45	Vizianagarm	Andhra Pradesh	227,533	2022
46	Thanjavur	Tamil Nadu	222,619	2022
47	Yamunagar	Haryana	216,628	2022
48	Yamunanagar	Uttar Pradesh	216,628	2022
49	Eluru	Andhra Pradesh	214,414	2022
50	Dindigul	Tamil Nadu	207,225	2022
51	Kharagpur	West Bengal	206,923	2022
52	Deoghar	Jharkhand	203,116	2022

*http://www.census2011.co.in/city.php

ANNEXURE – VII

Pipeline Development Schedule for pipelines expanding capacity beyond 13th plan (As per PNGRB authorization)

Year	**2014**	**2024**	**2027**	**2029**	**2031**
Name of pipeline	Year 1	Year 10	Year 13	Year 15	Year 17
Mallavaram - Bhopal - Bhilwara - Vijaypur	52.86	52.86	56.99	60.07	63.43
Mehsana - Bhatinda	42.94	47.17	51.98	55.5	59.54
Year	**2015**	**2025**	**2028**	**2030**	
Surat-Paradip	60.00			67.83	
Total					

ANNEXURE – VIII

Pipeline capacity addition at source

Existing Capacity at source

Name of pipeline	Design Capacity	Source
	MMSCMD	
HVJ/GREP+DVPL-1	53	Hazira
DUPL/DPPL	19.9	Dabhol
Mumbai Regional Pipeline	7.0	Uran
KG Basin Pipeline Network	16.0	KG basin
TRIPURA	2.3	TRIPURA
Assam Regional Pipeline	2.5	Assam
Gujarat Pipeline Network	3.9	Gujarat
Cauvery Basin Network	3.9	Cauvery Basin
EWPL	80.0	Kakinada
Gujarat Gas Grid Network	43	Gujarat
Hazira-Ankleshwar	5.0	Hazira
Assam Gas Company	6.0	Assam
Total	**242.5**	

Planned additions at source (till 2030)

Name of pipeline	Design Capacity	Source
	MMSCMD	
Kochi-Kanjirkkod-Bangalore-Mangalore	16.0	Kochi
Jagdishpur - Haldia	32.0	Haldia
Dabhol - Bangalore	16.0	Dabhol
Kakinada-vasudevpur-Haldia	26.7	Kakinada
Kakinada - Chennai	26.7	Kakinada
Chennai - Tuticorin	13.3	Chennai
Chennal - Bangalore - Mangalore	13.3	Chennai
GSPL Gujarat Grid	0.0	Gujarat
Mallavaram - Bhopal - Bhilwara - Vijaypur	52.9	Kakinada
Surat-Paradip	60.0	Paradip
Ennore - Puducherry - Nagapattinam	12.5	Ennore
Others	70.1	
Total	**339.5**	