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Global Change Programme

Dependency of Indian Economy on Natural Gas and Its Barriers

Mallika Bhowmick[1]

and

Titas Dutta[2]

Interns at GCP-JU

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Global Change Programme
Jadavpur University
Kolkata- 700032, West Bengal, India

[1; 2] MA Student of Economics, Hyderabad Central University

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ABSTRACT

With the rising population energy requirement of the Indian economy is going to be enormous and growing fast. Globally now the sole goal is to how decarbonize global economic activities in order to prevent climate change mainly due to anthropogenic emission ofgreenhouse gases. Growth of industry implies growing requirement of energy much of which comes from fossil fuel and electricity. Coal, oil, and natural gas are the three primary commercial energy sources. Coal is by far the most important fuel in the energy mix, but India's recent climate pledge underlined the country's commitment to a growing role for low-carbon sources of energy. Natural Gas fares the best among all other fossil fuels because of its low carbon emission and pollution level. However the share of natural gas in the energy mix is only 6% in India compared to 24% globally. This paper deals with the indigenous sources of Natural gas reserves in India both explored as well as unexplored , analyses the structure of the current Indian gas market, the infrastructural, political, and social constraints that are being faced towards achieving a gas based economy.

TABLE OF CONTENTS

1. INTRODUCTION

The Paris Agreement on climate change, which entered into force in November 2016, is at its heart an agreement about energy. Transformative change in the energy sector, the source of at least two-thirds of greenhouse-gas emissions, is essential to reach the objectives of the Agreement. The changes already underway in the energy sector reflect the potential of low carbon energy which in turn is a meaningful action related to climate change. Despite intensified efforts in many countries a huge section of the population does not have access to modern energy. India, home to 18% of the world's population, uses only 6% of the world's primary energy. India's energy consumption has almost doubled since 2000 and the potential for further rapid growth is enormous. If a well-managed expansion of energy supply can be achieved, the prize in terms of improved welfare and quality of life for India's 1.3 billion people is huge – first and foremost for the estimated 240 million that remain today without access to electricity. Coal is by far the most important fuel in the energy mix, but India's recent climate pledge underlined the country's commitment to a growing role for low-carbon sources of energy, led by solar and wind power. Natural gas fares best among all the fossil fuels whose consumption is rising by 50% due to its low carbon emission and pollution levels. Thus if we can shift towards a gas based economy by 2020 we can be low carbon and then towards a zero carbon human existence by 2080 and finally negative carbon if we want to stabilize the climate to the pre-industrial level. This is the Decarbonization path which is scientifically found and has to be followed. This is not an impossible task that we are heading towards. With the help of technology and its lifetime of innovations we can definitely achieve it. Thus we can say that natural gas will actually ease our path towards low carbon and will help us to shift our dependency from coal fired power plants to gas fired power plants and thereby reduce greenhouse gas emissions into the atmosphere.

2. RESERVES OF NATURAL GAS

The main natural gas reserves are onshore producing fields which are in the states of Assam in the northeast, Gujarat in the west and Tamil Nadu and Andhra Pradesh in the south. Some of the most promising areas are offshore, including the Krishna Godavari basin off the east coast. The production record in recent years has been strongly affected first by the start of production at the much-awaited KG-D6 offshore field in 2009, and then by it's faster than expected decline because of reported subsurface complexity. This has contributed to an overall decrease in Indian gas output since 2011.In addition to conventional gas resources, India also has large unconventional potential, both from coal bed methane (CBM) and shale gas. We have substantial amount of CBM reserves in states of West Bengal, Madhya Pradesh and Jharkhand. Even shale gas has high potential in India's gas production which is found in mainly six basins- Cambay, Assam-Arakan, Godwana, Krishna Godavari, Cauvery and Indo-Gangetic plane.

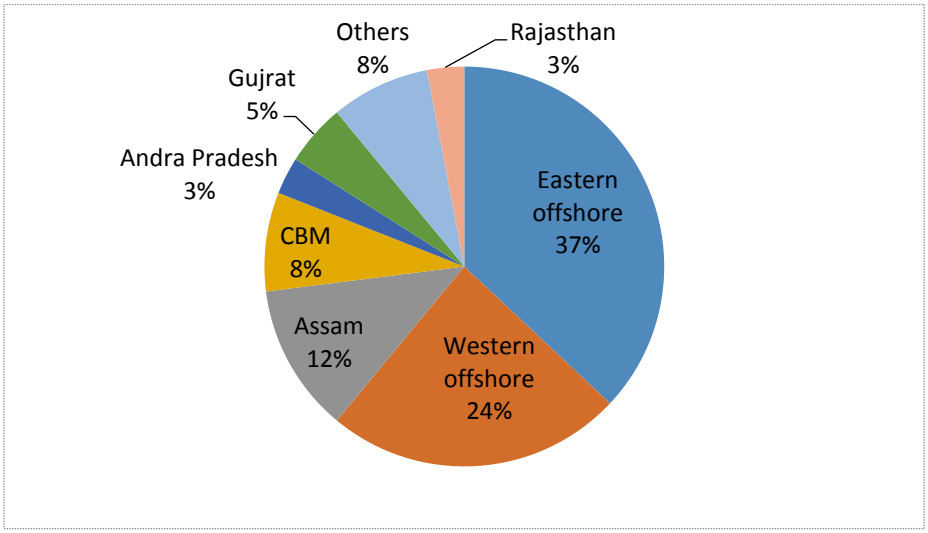

Fig 1: Natural Gas reserves as on (01.04.16)

Source: Petroleum and natural gas statistic, 2016

3. EXPLORATION STATUS

While most of the renewable resources appear meagre next to its needs, the same cannot be said for natural gas as its recoverable resources stand at 7.9 trillion cubic metres. Almost half of this is conventional gas (almost all offshore) and the rest is unconventional in the form of shale gas and coal bed methane. For a country that is short of hydrocarbons, India still has a considerable amount of unexplored potential. A number of sedimentary basins have either no or scanty data and require additional geo-scientific exploration for better assessment of resource potential. Areas identified by the Indian authorities as either "prospective" or "potentially prospective", i.e. awaiting significant levels of exploration, extend over some 1.1 million square kilometres (km2) of the almost 1.8 million km2 that make up India's 26 onshore and shallow water sedimentary basins. India's deep-water territory, also largely unexplored, adds another 1.3 million km2. Presently conventional gas production is dominated today by the ageing Vasai field on India's western coastal shelf: this field continue to attract investment by the operator, ONGC, which has long experience in optimizing performance from mature fields. Onshore conventional production consists of many small projects, only a handful of which contribute more than 5% of total onshore supply. There is potential for new gas discoveries onshore, considering the extent of unexplored acreage, but the larger potential lies offshore, with the deep-water Krishna-Godavari basin the center of activity since the initial discovery by Reliance, India's largest private sector corporation, at the KG-D6 block. Although resources are large, all of these sources of gas face substantial uncertainties: the disappointing production performance of Reliance's KG-D6 block has tempered expectations for offshore development. CBM projects have gotten off to a reasonable start, but development costs are still high. The shale gas resource is understood to be large, but appraisal is at a very early stage and large-scale production could run into significant problems over land use, water availability and acceptance by local communities.

Shale gas is an important variable in India's gas future. Shale gas potential has been identified in six basins: Cambay, Assam-Arakan, Gondwana, Krishna-Godavari, Cauvery and the Indo-Gangetic plain. To date, ONGC has drilled several shale research wells in the Gondwana and Cambay basins, but no commercial shale production exists today. Sub-sea gas hydrates have been identified in large quantities within India's territorial waters and have at least a potential role in supplying energy in the future.

Table 1: Natural gas reserves by category in India

	UltimatelyRecoverable Resources	Cumulative Production	Remaining RecoverableResources	Remaining %of URR	Proven Reserves
Conventional onshore	**1570**	**280**	**11280**	**82%**	**290**
Shallow offshore	**1810**	**500**	**1300**	**72%**	**340**
Deep offshore	**1480**	**70**	**1400**	**95%**	**770**
Coalbed Methane	**1230**	**0**	**1230**	**100%**	**20**
Shale gas	**2720**	**0**	**2720**	**100%**	**0**
Total India	**8810**	**850**	**7930**	**90%**	**1420**

Source: Natural Gas Scenario in India, Ministry of Petroleum and Natural gas, 2015-16

4. NATURAL GAS CONSUMPTION

The share of Natural Gas in India is only 6% where it is 24% globally. Power, fertilizer, city gas distribution (CGD), and refineries and petrochemicals are the key gas-consuming sectors.

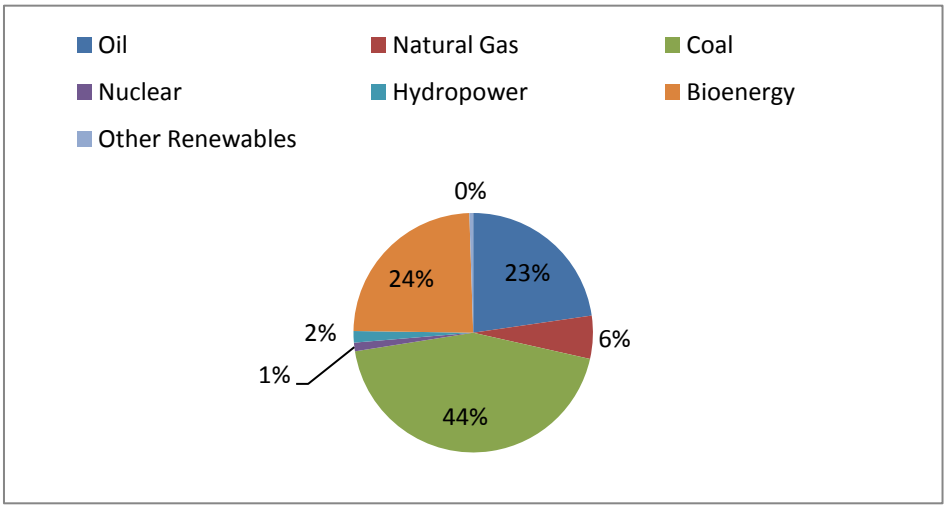

Fig 2: Share of Natural Gas in the Indian Energy Basket

Source: Petroleum and Natural Gas Statistics, 2016

Power, fertilizer, city gas distribution (CGD), and refineries and petrochemicals are the key gas consuming sectors.Total consumption of natural gas in 2015-16 stands at 47.849 BCM as against 46.955 BCM in 2014-15. Out of 47.849 BCM, 26.683 BCM (56%) is consumed for energy purpose as fuel and the balance 44% is used for non-energy purpose as feedstock for various industries.

In 2015-16 highest consumption of natural gas under energy purpose was in power sector at 10.889 (41%) followed by City or Local Natural Gas Distribution Network at 5.464 BCM (20%).

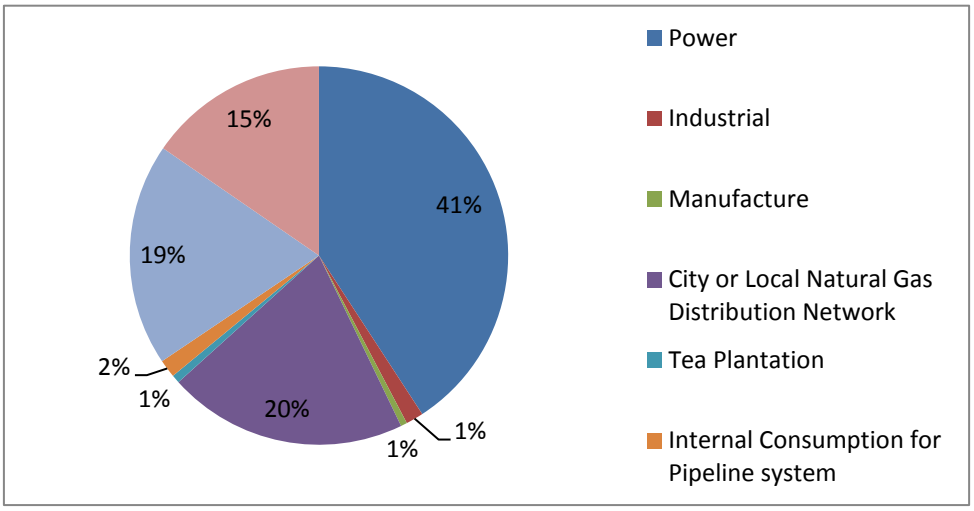

Fig 3: Sector-wise consumption of Natural Gas under energy purpose in 2015-16

Source: Petroleum and Natural gas statistics, 2016

Under non-energy purpose, maximum consumption was seen in fertilizer industry at 16.135 BCM (76%) followed by petrochemical sector at 3.77BCM.

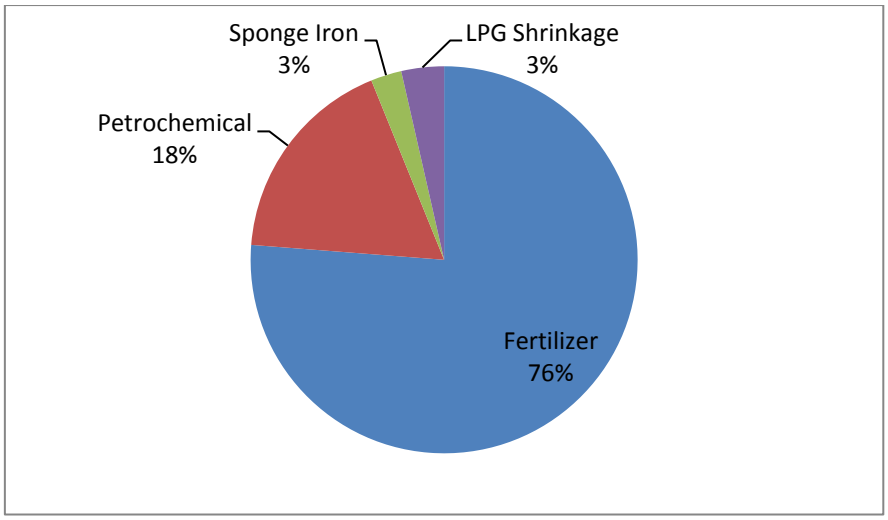

Fig 4: Consumption of Natural Gas in the non energy sector in 2015-16

Source: Petroleum and Natural Gas Statistics, 2016

We see that the total consumption of natural gas in the energy sector shows a declining trend since 2011-12 while the consumption of natural gas in the non-energy sector shows a steady growth. Consumption in the energy sector has declined by almost 200% by 2014-15.

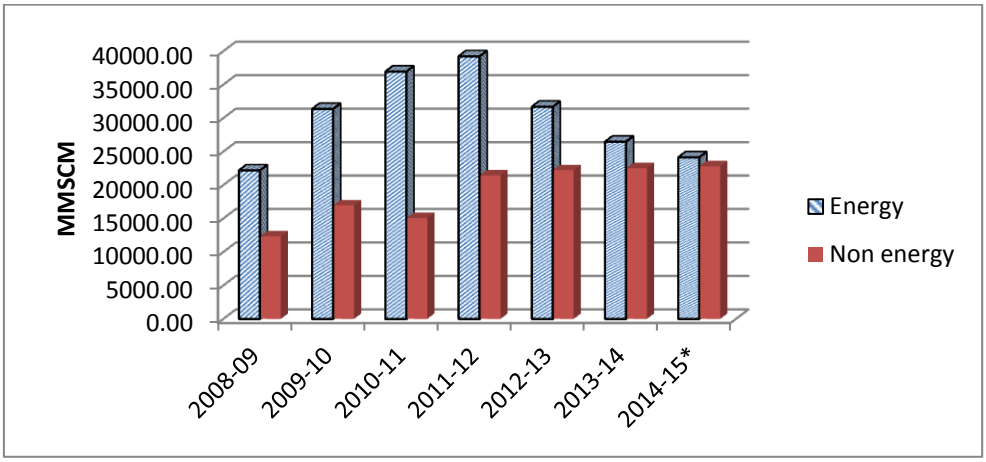

Fig 5: Trend of Natural Gas consumption Year wise

Source: Petroleum and Natural Gas Statistics, 2016

Now if we look into the sector wise consumption of LPG we see that Domestic Distribution consumes 90% share of LPG followed by 8% in the Non domestic sector.

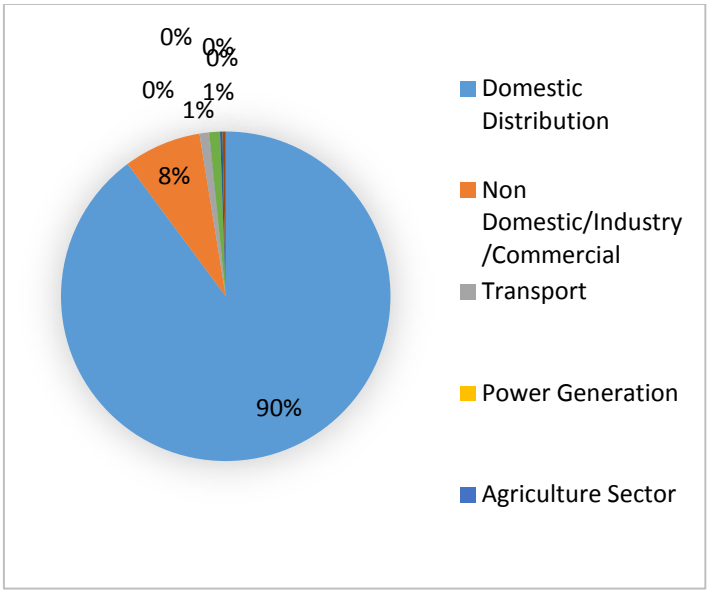

Fig 6: Sector wise consumption of LPG

Source: Petroleum and Natural Gas Statistic, 2016

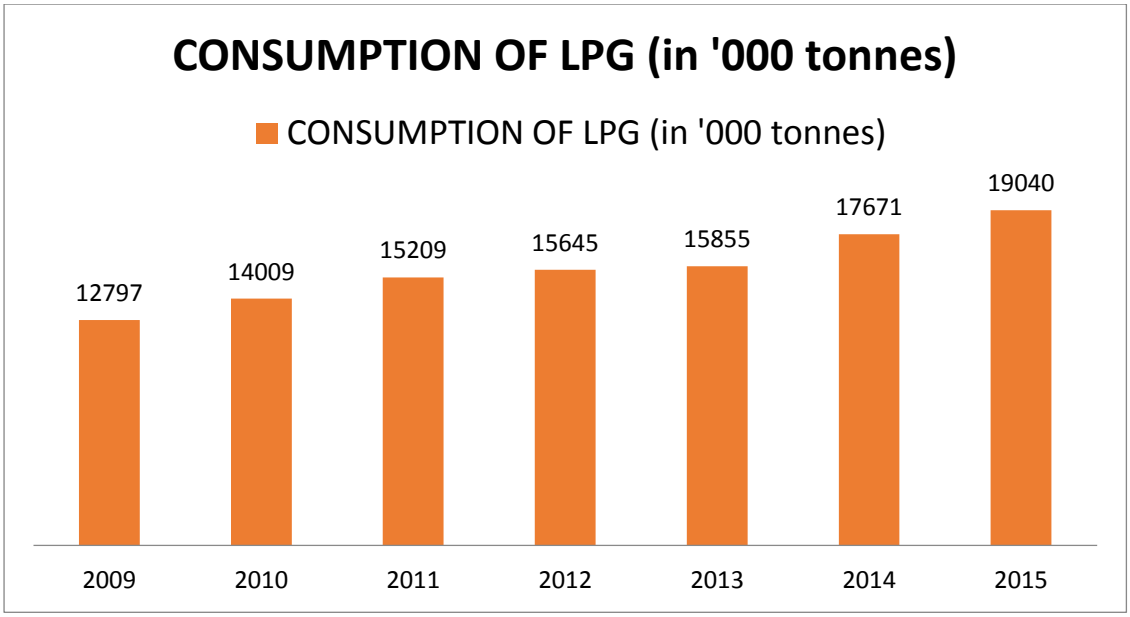

Fig 7

Source: Petroleum and Natural Gas Statistic, 2016

5. USE OF LPG IN RURAL INDIA

More than two decades ago, nearly two-thirds of rural and 16% of urban households used kerosene as their main lighting source. By 2012, this dependency came down substantially and the proportion of households using electricity for lighting shot up, according to a report by NSSO. However, for cooking, a large proportion of rural households continued to use traditional fuels during the period while urban areas registered a substantial increase in the use of LPG.

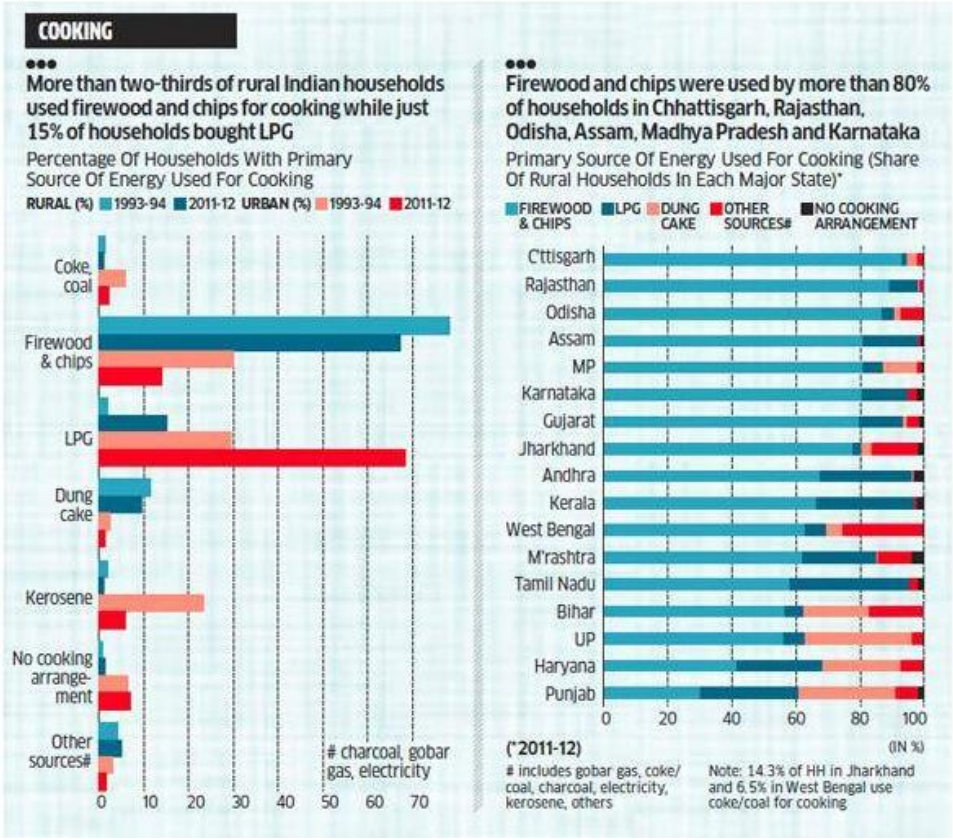

Fig 8: State wise consumption of LPG in Rural India and its

Source: Economic Times, 8Th October 2016

The figure above (constructed from this information) show the proportion of households using each type of cooking fuel, in urban and rural areas, respectively. In urban areas, the most commonly used fuel is LPG (47.96%), followed by firewood (22.74%) and kerosene (19.16%), with much lower dependence on other fuels. In the rural areas, in contrast, firewood is, by far, the most important fuel (64.10%). Other sources of biomass – crop residue (13.10%) and cow-dung (12.80%), are so far the main alternatives, although LPG (5.67%) is now increasing in importance. However, 72% of the country's households live in rural areas. Thus, the countrywide picture indicates that traditional biomass (firewood, crop waste, and dung) constitutes the main source of cooking fuels.

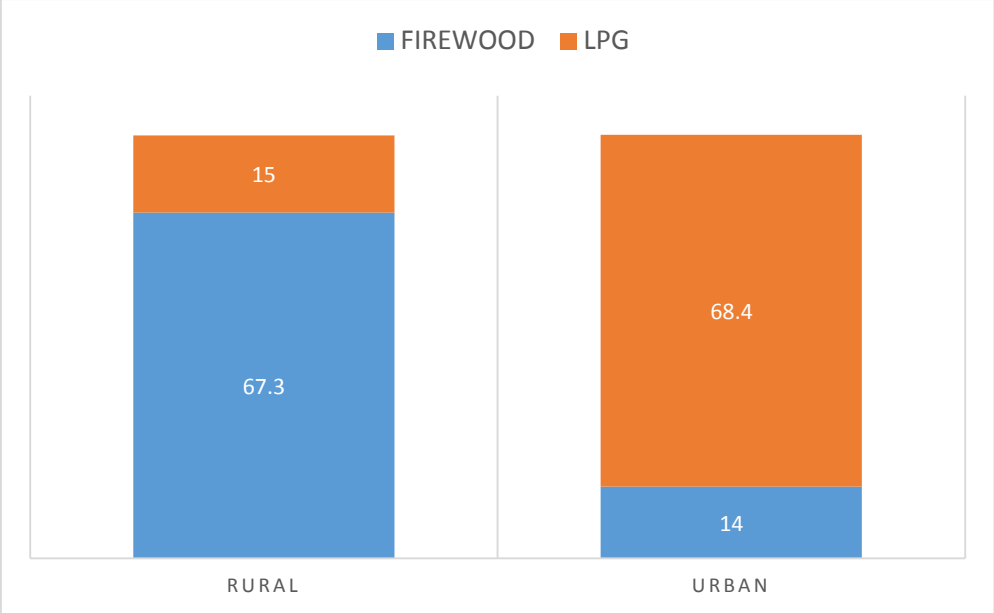

Fig 9: Rural Urban Consumption Of LPG(In %)
Source: Ministry of Statistics, 2015

What we see is more than 67% of rural households in India still now depend on This is a decline of only 12% over two decades, according to the latest data released by the ministry of statistics. The use of liquefied petroleum gas (LPG) for cooking in rural areas has increased from 2% to 15% of households during the period 1993-94 to 2011-12, an increase of 7.5 times.

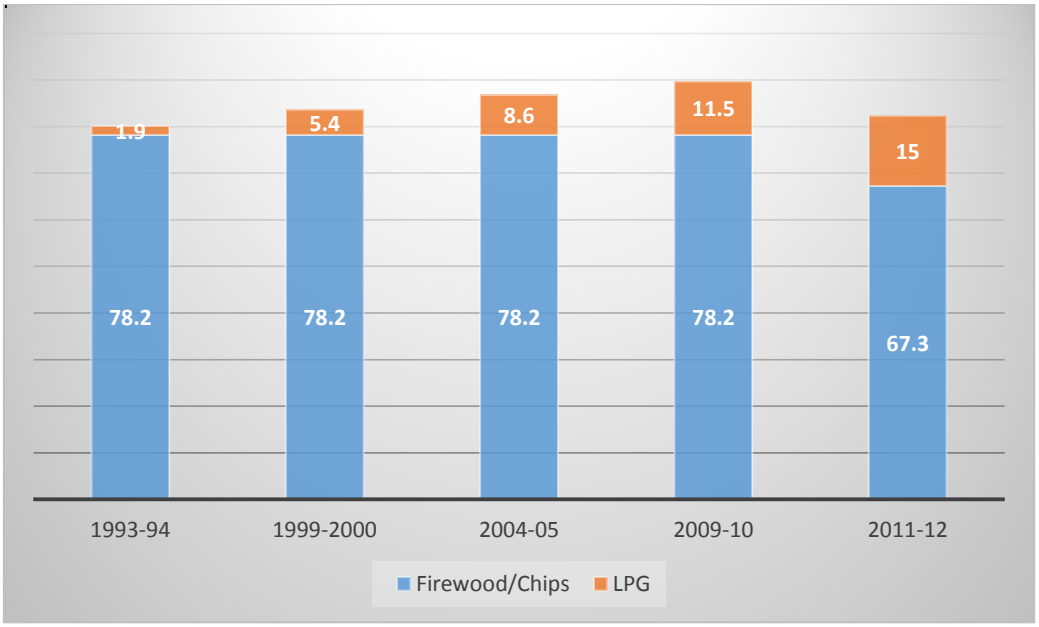

Fig 10: Growth rate of use of Firewood & LPG in Rural India (IN %)
Source: Ministry of Statistics and Programme Implementation, 2015

About one million deaths are reported annually in India due to household air pollution caused by fumes from cooking, heating and lighting activities. Of environmental and economic relevance is the fact that 14% of households in urban areas still cook with firewood. The encouraging aspect in urban households is that the use of kerosene has declined from more than 23% to 6%. In both rural and urban households, there are some who do not cook: 1% of rural households have no arrangements; the same holds good for nearly 7% of urban households. Again data from the states highlight the imbalances between rural and urban households. Poorer states use firewood, richer states LPG. More than 93% of rural households in Chhattisgarh use firewood or wood chips to cook with followed by Rajasthan (89%) and Odisha (87%). In urban India, Haryana reported more than 86% of households using LPG for cooking purpose, followed by Andhra Pradesh (77%) and Punjab (75%).

Most rural consumers have to spend long hours visiting the dealer's warehouse - sometimes on multiple days - several kilometres away from home for a refill. The loss of wages in these visits as well as the inconvenience and cost of arranging transport to carry cylinders from the

warehouse are a big deterrent for customers. Thus if we can bring the cylinders to their doorstep this will actually increase LPG consumption in rural India.

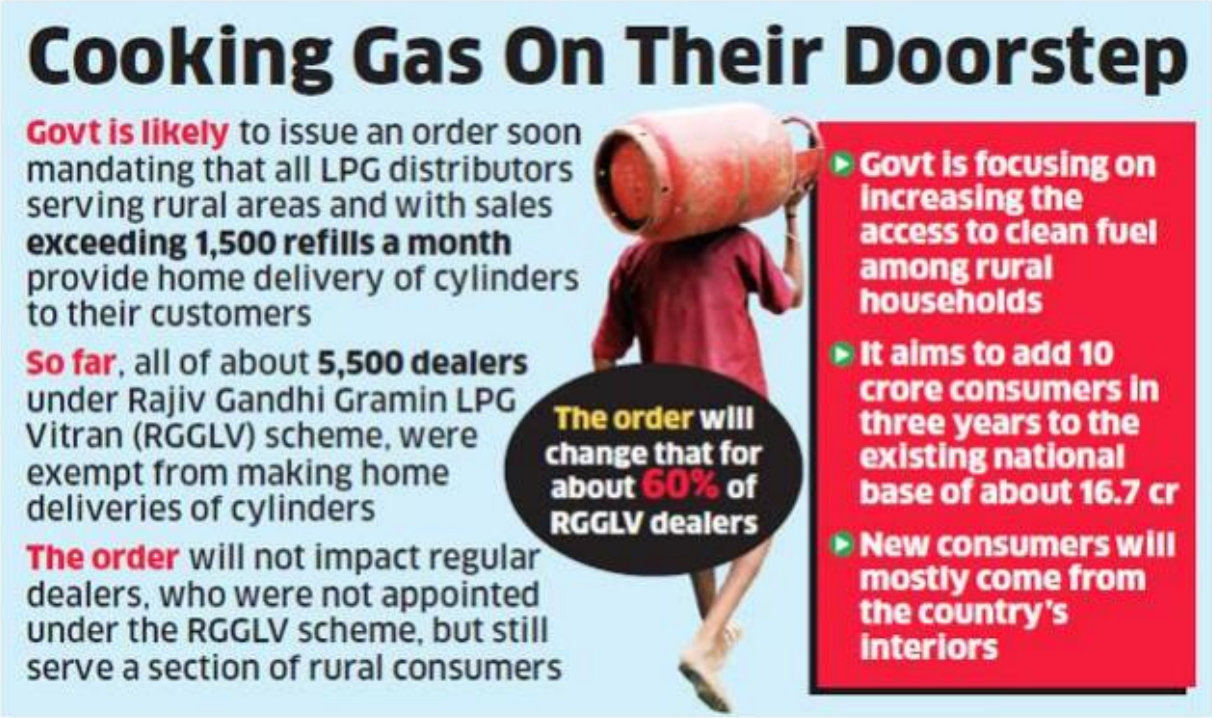

Fig 11: Source: Times of India, 8th October

The government is now focused on increasing the access to clean fuel among rural households. It aims to add 10 crore consumers in three years to the existing national base of about 16.7 crore. New consumers will mostly come from the country's interiors. It is likely to issue an oder soon mandating that all LPG distributors serving rural areas and with sales exceeding 1,500 refiills a month provide home delivery of cylinders to their customers.

6. ALLOCATION AND SUPPLY OF NATURAL GAS

Natural gas available in India can broadly be classified into two categories, viz. (i) Domestic Natural Gas and (ii) Imported Re-gassified Liquefied Natural Gas (R-LNG). Keeping in view the shortage of natural gas in the country, domestic gas is allocated to various sectors based on the Policy Guidelines issued by the Government from time to time. In case of imported gas, the marketers are free to import LNG and sell the R-LNG to customers. Statement showing sector-wise supplies of natural gas is given in table below

Table 2: Allocation and Supply Of Natural Gas in India

(Figures are in MMSCMD)

Sector	**Domestic**	**R-LNG**	**Domestic + R-LNG**
Fertilizers	30.30	12.64567	**42.95**
Gas Based LPG plants for LPG extraction	1.83	1.09	**2.92**
Power	27.26	2.170355	**29.43**
CGD for CNG & Domestic PNG Purpose	7.25	8.2337	**15.48**
TTZ	0.98	0.07	**1.05**
Small consumers having allocation less than 50,000 SCMD	2.45	2.575	**5.03**
Steel	1.32	1.8244	**3.14**
Refineries	1.89	10.454	**12.35**

Source: Natural Gas Scenario, Ministry of Petroleum and Natural Gas 2016

6.1 NATURAL GAS INFRASTRUCTURE IN INDIA:

Natural Gas Infrastructure consists of R-LNG terminals, Gas Pipelines and City Gas Distribution (CGD) networks.

- **Natural Gas Pipelines:** At present, the country has a gas pipeline network length of 14,987 Km having capacity of 401 MMSCMD spread over 15 States. At present, there is a strong regional imbalance within the country with regard to access natural gas. Few states like Gujarat, Maharashtra and UP together consume more that 65% of the available gas, while a large number of states have no access to gas. This regional imbalance is mainly on account of lack of pipeline infrastructure in many states like West Bengal, Bihar, Jharkhand, Orissa and Chhattisgarh. In order to take the benefits associated with natural gas to all states across the nation, it is essential that the pipeline network is expanded to all regions of the country. Ministry is contemplating to development of a National Gas Grid having multiple points of injection and multiple points of withdrawal. The proposed gas grid would connect the gas sources to major demand centers such as industrial clusters, big cities etc.

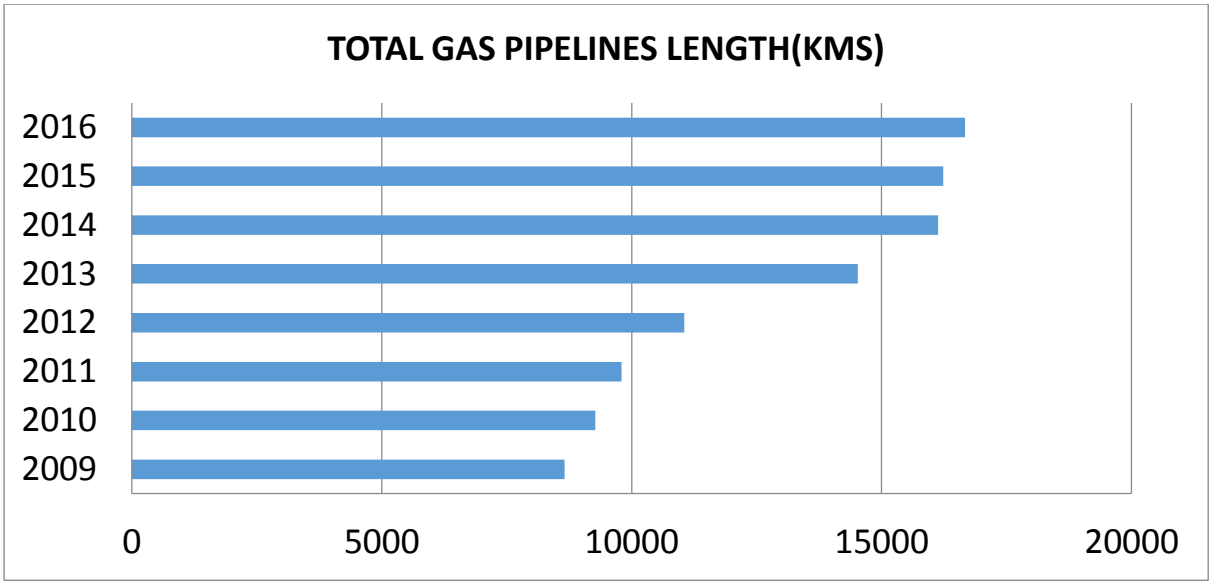

Fig 12

Source: Petroleum and natural gas Statistics, 2016

- **R-LNG Terminals:** At present, Natural Gas demand far exceeds domestic supply and this shortage is likely to prevail in the near future. Additional demand is catered through imported R-LNG. However, the demand for RLNG is price sensitive. During 2013-14, Kochi LNG terminal having 5 MMTPA capacity for re-gasification has been commissioned. With commissioning of Kochi Terminal, the total re-gasification capacity of four R-LNG terminals has increased to 22 MMTPA (79.2 MMSCMD). The capacity of these 4 R-LNG terminals is likely to be increased further to 32.5 MMTPA (117 MMSCMD) by 2016-17. The consumption of RLNG in the first six months of 2013-14 was 39 MMSCMD.

Table 3: Existing Operational R-LNG Terminals

Location	Owner	Terminals Capacity (in MMTPA)		
		2014-15	2015-16	2016 – 17
Dahej	PLL	10	10	15
Hazira	Hazira LNG	5	5	7.5*
Kochi	PLL	5	5	5
Dhabol	GAIL	2	5	5
Total Existing Capacity (MMTPA)		**22**	**25**	**32.5**
Total (MMSCMD)		**79.2**	**90**	**117**

Source: Natural gas scenario in India, Ministry of Petroleum and Natural Gas

- **City Gas Distribution (CGD) Infrastructure:** The CGD sector comprises of Compressed Natural Gas (CNG) and Piped Natural Gas (PNG) customers. With increased availability of gas in the country, the CGD network has been enlarged to cover various cities supplying gas for domestic consumers, public transport, and commercial/ industrial entities. As on 31.12.2013, there are a total of 936 compressed natural gas (CNG) stations across the country and 24, 14,288 households with Piped Natural Gas (PNG) connectivity. The consumption of gas in the CGD network during 2013-14 was around 15.48 MMSCMD, of which 8.60 MMSCMD was used for CNG (transport) & PNG (domestic) and 6.88 MMSCMD was used for Industrial & Commercial PNG. In order to promote CNG (transport) and PNG (domestic) and for a developed CGD sector in the country, Ministry has taken a decision to meet 100% requirement (to the maximum extent possible) of CNG (transport) and PNG (domestic) of all CGD entities across the nation without any discrimination amongst entities. Guidelines in this regard have been issued in February, 2014. This decision has brought down the price of CNG (Transport) and PNG (domestic) across the nation and has led to increase in the consumption of natural gas, an environmentally friendly fuel, in the sector. The Ministry is formulating guidelines relating to grant of rights to entities for sale of

CNG as transportation fuel through CNG Stations. The intent of the envisaged guidelines is to promote setting up of several CNG stations in various cities/towns across the country, including along highways, and also to foster competition amongst eligible entities in the CNG segment, analogous to that in liquid transportation fuel (MS, HSD and ATF) segment. This would lead to faster rollout of large number of CNG stations across the nation.

Out of total natural gas production of 32.249 BCM in 2015-16, 66% (21.177 BCM) is from ONGC (nomination), 9% (2.838 BCM) from OIL (nomination) and 25% (8.235 BCM)) from PSC regime.

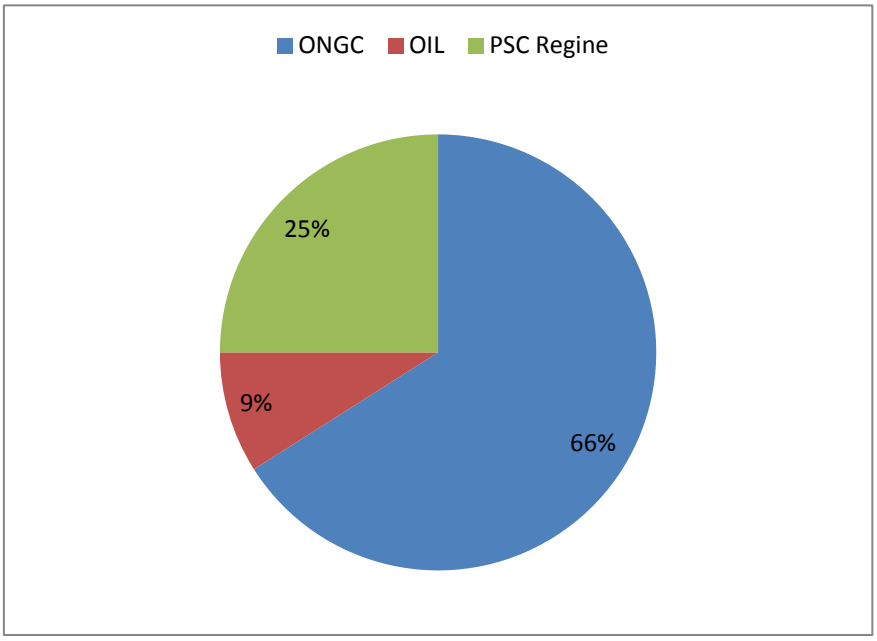

Fig 13: % Share in NG production during 2015-16

Source: Natural Gas Scenario in India

7. LNG BRIDGES THE GAS SUPPLY DEFICIT IN INDIA'S ENERGY LANDSCAPE

With domestic production falling short of the country's needs, India is set to import increasing volumes of natural gas, primarily in the form of liquefied natural gas (LNG) (helped by a period of lower LNG prices over the medium term) but also, potentially, via

pipeline. India is currently the world's fourth-largest importer of LNG, behind Japan, South Korea and China. During FY10-FY15, Indian LNG imports increased at a CAGR of 11.1% to 15.5 MMT, with LNG's share in the overall gas supplies rising from 20% to 38% during the period.

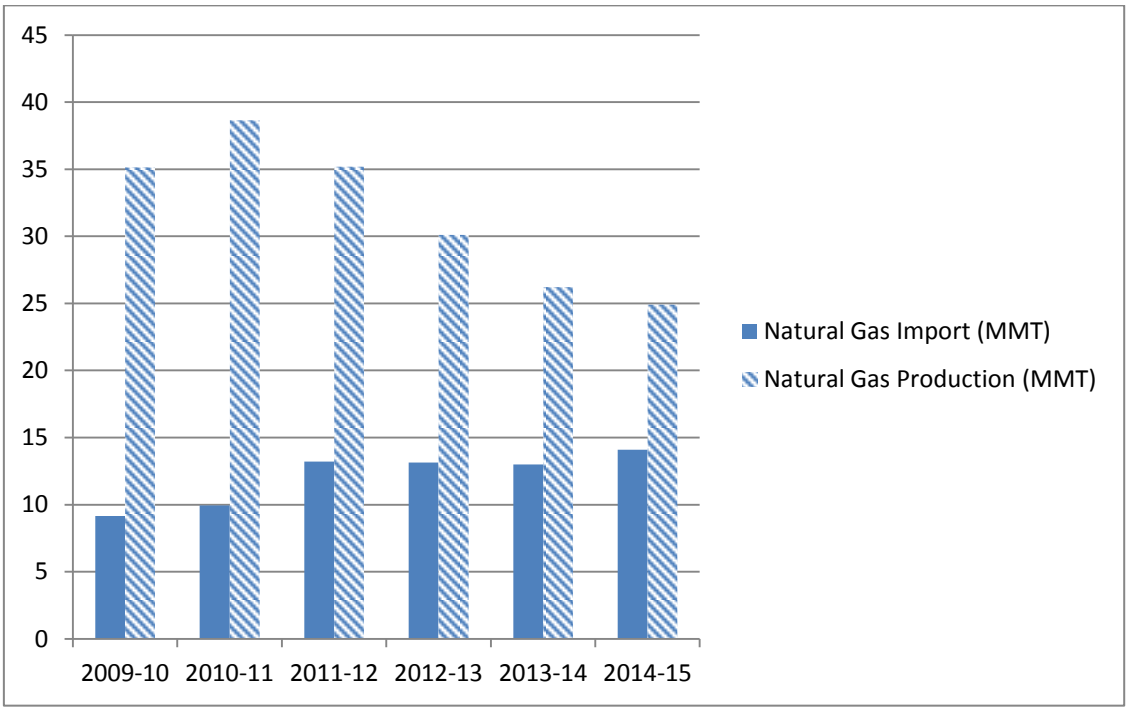

Fig 13: Domestic Production Vs. Import of Natural Gas

Source: Petroleum and Natural Gas Statistic, 2016

Turkmenistan and Iran are the main prospective pipeline suppliers, although, in both cases, the prospects and timing are clouded by political uncertainties. In our projections, gas imports rise to over 80 BCM in 2040, with around 85% of the total being met by LNG and the remainder by pipeline.The main uncertainty for imported natural gas relates to price and how and where this gas can find a niche in the Indian domestic market. India is reasonably well placed for LNG supply, because of its proximity to the Middle East and to prospective exports from East Africa; but this is, nonetheless, a relatively costly source of energy for many domestic users. In the power sector, for example, LNG (even at $6/MBTU) is too expensive to compete with imported coal as a fuel for baseload or most mid-merit electricity

demand , leaving gas with only a limited role as a way to balance the system and meet peaks in power demand.

Increased reliance on LNG will also require adequate infrastructure: as of March 2015, India had four operational LNG terminals, giving it a total import capacity of 28 bcm, although other LNG terminals are in different stages of planning. Given that India's natural gas pipeline and storage network is limited; we anticipate that the focus for new LNG terminals will be the southern regions that are currently not served by major gas pipelines. There are plans to boost gas supply by pipeline center on two proposed major pipelines, the Turkmenistan-Afghanistan-Pakistan-India pipeline (TAPI) and the Iran-Pakistan-India pipeline (IPI). Discussions on both have been going on for many years, but there are still substantial political and commercial obstacles; the security situation in Afghanistan and the relationship between India and Pakistan fall into the first category; open questions about pricing and financing into the second. Nonetheless, we see potential for one or both of these projects to be viable in the long term and project that gas imports to India start in the latter part of the 2020s. In either case, Turkmenistan's large resources may have an important role to play, either directly as supplier in the case of TAPI or indirectly in the case of IPI.

India plans to more than double its annual LNG import capacity to 50 million tonnes in the next few years .Also, as part of strategy to move towards a gas-based economy, the first LNG-driven bus is likely to start plying in Kerala recently. While globally natural gas makes up for 24 per cent of the energy basket, it is just 6.5-7 per cent in India. "We would like to raise the share of natural gas in the energy basket to 15 per cent in the next 3-5 years," said Mr Dharmendra Pradhan Ministry of Oil and Natural gas. With domestic gas output dropping, imports of the environment friendly fuel presents the best option.

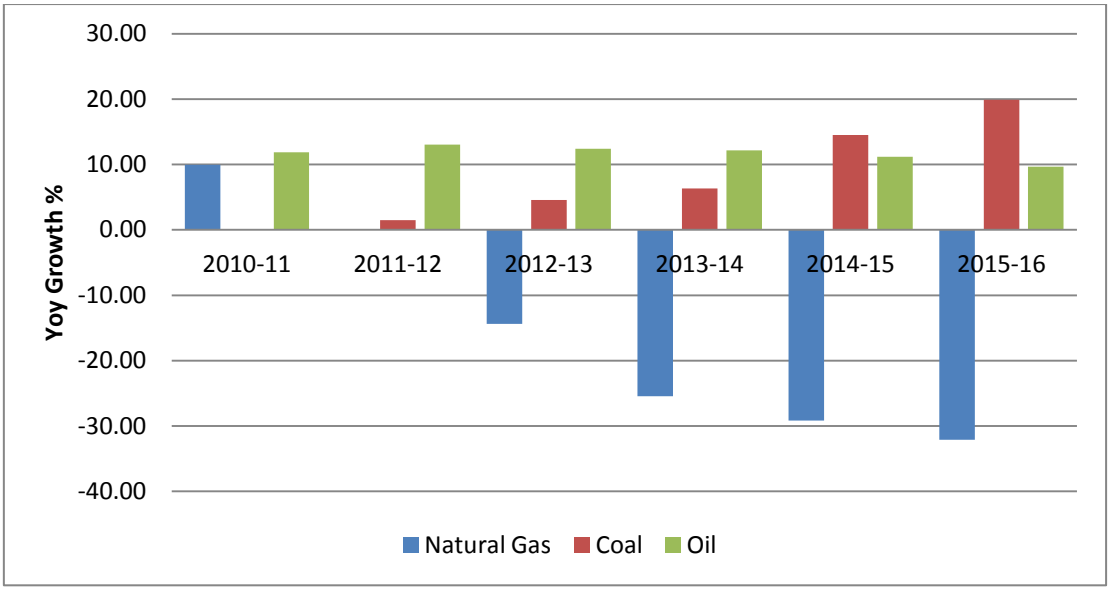

Fig 14: YoY growth in energy production by various sources in India

Source: Petroleum and Natural Gas Statistics

With domestic gas output dropping since 2012-13 due to the faster than expected decline of the Krishna Godavari Basin imports of the environment friendly fuel presents the best option.

8. PRICES OF NATURAL GAS

Looming over all of these projections is the key question of whether the price available to domestic gas producers will be sufficient to incentivize the investment required. Our analysis of India's gas supply costs suggests that most new commercial gas developments are marginal in the price environment prevailing in the second-half of 2015: the new gas pricing formula put in place in 2014 initially established a price for domestic producers of around $5.6 per million British thermal units (MBtu), but subsequent six-monthly revisions brought this down to around $4/MBtu, because of falls in the reference prices to which it is linked (Economic Times, 2016)

Natural gas prices are affected mainly through the US demand and it's seasonal in nature wherein in winters its prices fluctuate heavily. Also they have direct correlation with crude

oil prices. It is measured in million British thermal units (mmBTUs), but in some countries it is traded in Gigajoule also. The world's most liquid derivative contracts for natural gas are traded on NYMEX, while in India it is traded on MCX.

Prices of Natural gas have been struggling since 2014. Recently 1st October 2016 the domestic natural price has been dropped by 18% to a multi-year low of $ 2.50 per unit due to a decline in global prices. From the diagram given below we see that the Domestic price of Natural gas has a correlation with International price of NG and show a declining trend since 2014.

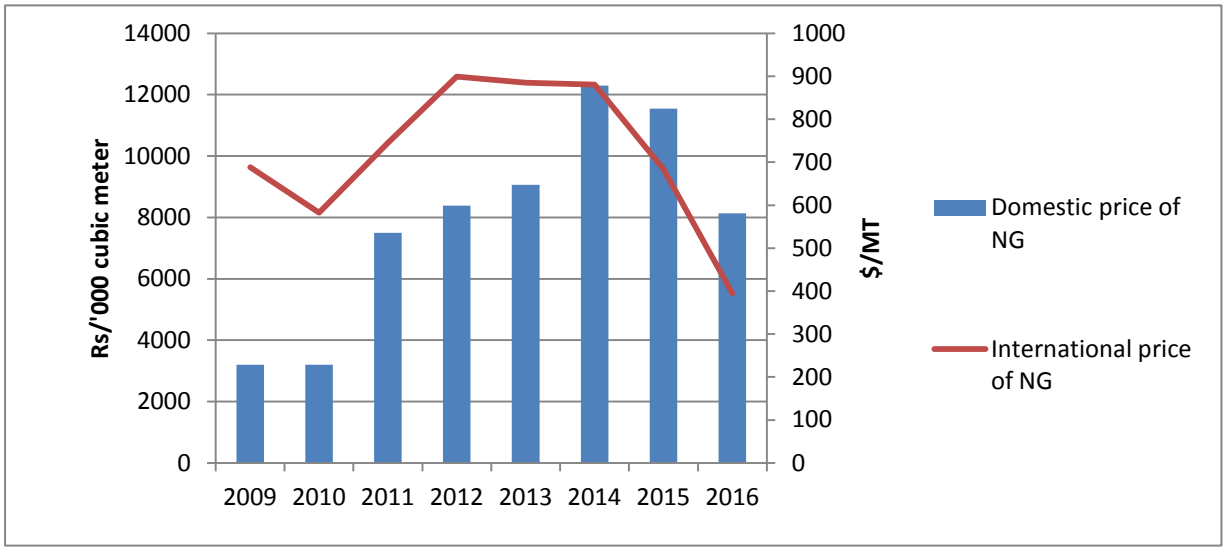

Fig 15: Year wise Trend in Natural Gas Price

Source: Petroleum and Natural Gas Statistics

This adversely affected producers by eroding profits and thereby putting pressure on the margins of the explorers such as Oil and Natural gas Corp and Reliance Industries. This however benefitted users including fertilizers companies and power generators by lowering costs. The chairman of ONGC said the company lost Rs 4200 core in revenue for each dollar's drop in local gas price. This lower price also translates less royalty and chess for the government.

India has struggled to follow US and Europe in giving natural gas price a greater role for electricity production in place of polluting coal power. Lower prices will actually hamper investment needed in this sector. The government needs to encourage domestic producers by ensuring a fair minimum price.

9. FUTURE OUTLOOK

- More of energy efficiency with Low carbon sources of energy.
- Extraction of fossil fuels must get less and less rather zero investment from global investors. It has to be only domestic.
- Facilitate Carbon Capture and storage for all fossil fuels in India.
- Transmission of Power to gas
- Government should focus on putting a price on carbon and rewarding industries who are adopting good practices.

10. INDIA'S BARRIERS TO NATURAL GAS

India is heavily reliant on imports for natural gas. Half of the natural gas resources are conventional (in the form of shale gas and coal bed methane). The rate at which the produced reserve is replenished through exploration and development activities that turn resources into proven resources is positive in case of natural gas. In the last seven year, India produced about 280 bcm of gas and 330 bcm of proven reserves excluding the offshore KG-D6 finds.

Natural Gas production during the year 2015-2016 is 32.249 bcm which is 4.18% lower than production of 33.657 bcm in 2014-2015. This was mainly due to natural decline in some of the fields, under performance of wells, and closure of wells for maintenance activities, unplanned shut down of GAIL gas line and less off-take by the consumers. A total of 7 wells in D1 and D3 in MA field ceased to flow in 2015-2016 due to water and sand ingress issues. Production from wells of KG-D6 also declined rapidly.

Increased reliance on LNG would also require adequate infrastructure. As of March 2015, India had four operational terminals with the import capacity of 28 bcm. India's natural gas pipeline and storage are limited thus focus for the new LNG terminals will be on the southern regions that are not currently served with major pipelines.

10.1 TECHOLOGICAL BARRIER

India still has a considerable amount of unexplored reserve potential. Areas identified are either prospective or potentially prospective i.e. it require some level of exploration. It extends over 1.1 million square kilometres of the almost 1.8 million square kilometres that makes up to 26 onshore oil shores and shallow water sedimentary basins in India. India's deep water territory which is about 1.3 million square kilometres is also largely unexplored.

Getting incentives right for the increase in exploration by attractive pricing and licensing policies.

The shale gas production is understood to be large but appraisal is still at a very early stage. And its large scale production could have more significant problems over land use, water availability and acceptance by the local communities.

Table 4: Technological Barriers

	TECHNOLOGICAL	POLITICAL	ENVIRONMENTAL	ECONOMICAL	LEGAL	SOCIAL
TECHNLOGICAL	1.Geo scientific research exploration needed for better assessment of potential and India lacks adequate technological knowhow. (IEO) 2.Inadequate infrastructure with limited import capacity and storage. (IEO)	1.Physical distance between India and the importing country via Pakistan is a geo political issue. (IEO)		1.Technical complexities associated with transportation. 2.Pipelining requires a huge amount of investment. (IEO)	1.Exploring activity needs sufficiently attractive licensing policies.	

10.2 POLITICAL BARRIERS

With the falling natural gas production in India, the country needs to import gas mainly in the Liquefied form (LNG) and also via pipelines. Turkmenistan and Iraq are the main pipeline suppliers of India. But in both cases the prospects and timing have political uncertainties.

According to the recent projections, gas imports are to rise up to 80 bcm in 2040 and 85% of the total being met by LNG and the rest by pipelines.

The main uncertainty with the import of the natural gas is price related and where and how to find an opening in the Indian market. India is well placed for LNG supply because of its proximity with the Middle East and the prospective export from East Africa. But it is a relatively costly source of energy for many domestic users. In the power sector, use of LNG even at $6/Mbtu is costly compared to imported coal as base load or most mid merit electricity demand.

Table 5: Political Barriers

	TECHNOLOGICAL	POLITICAL	ENVIRONMENTAL	ECONOMICAL	LEGAL	SOCIAL
POLITICAL		1.Political barriers in the import of natural gas from Iraq and Turkmenistan via Pakistan. 2.Market regulation by government agency leading to market failures. 3.Political and commercial obstacles in the TAPI and IPI pipelines. (EPW)		1.Market regulation by government with the goal of social welfare maximization leads to market failure. Private firms fail to invest due to low prices set by the government. (IEO) 2.Lack of policies in India to support natural gas production. (EPW) 3.The effective price of natural gas is distorted by geo political premiums or discounts, natural monopoly rents charged by the dedicated transmission network and infrastructure.(EPW)		

10.3 ENVIRONMENTAL BARRIERS

Environmental barriers in India include the problem over land use. The major problem is the water stress in India. The low water availability rules out the possibility of natural gas production in India. Methane gas leakage also offsets the benefits of using the clean fuel Natural Gas. Natural gas also faces competition with agriculture in case of water use.

Table 6: Environmental Barriers

	TECHNOLOGICAL	POLITICAL	ENVIRONMENTAL	ECONOMICAL	LEGAL	SOCIAL
ENVIRONMENTAL			1.Large scale production in India could have significant problem over land use. (IEO) 2.Problems of water availability. (IEO) 3.Methane gas leakage offsetting the benefits of fuel switching. (IEO)	1.Water stress and the sensitivity in the competition with agricultural use for a scarce resource. (IEO)		

10.4 ECONOMICAL BARRIERS

In the new policies scenario, India's natural gas production increases from 35 bcm in 2013 to 90 bcm in 2040, but it still needs to import 80 bcm. Gas production today is dominated by ageing Vasai fields on India's western coastal shelf and attracts investments by ONGC onshore conventional production consists of small projects consisting more than 5% of the total on shore oil production. There is a potential of new gas discoveries on shore but the greater potential lies off shore. The deep water Krishna-Godavari basin is the centre of activity since the initial discovery by Reliance, India's largest private sector corporation. The discoveries are in water depth of 700 to 1700 metres and the wells are technically challenging i.e. having a high development cost. The KG-D6 project suffered from well performance issues like higher than expected water production and sand entry. Thus results in high declining rate.

Table 7: Economical Barriers

	TECHNOLOGICAL	POLITICAL	ENVIRONMENTAL	ECONOMICAL	LEGAL	SOCIAL
ECONOMICAL				1.Import dependant country. (fig 1) 2.Large investments required. 3.Uncertainties of the price of the natural gas due to lack of competitive market. 4.Falling natural gas production in India. (fig 2) 5.Import barriers including price and opening in the domestic market. (fig 3) 6.Lack of market (competitive) for natural gas in India. 7.High development cost. 8.Demand and supply imbalance.(EPW)		

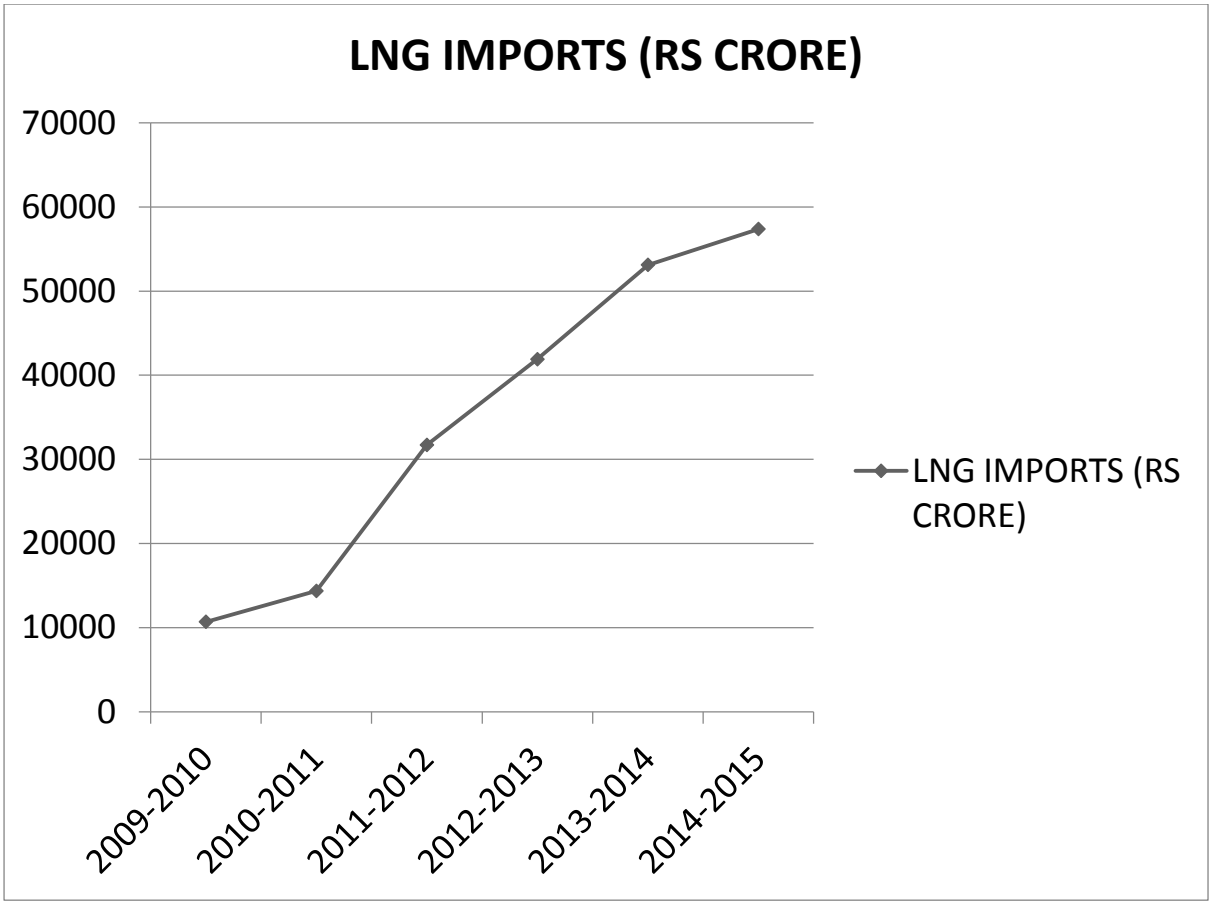

FIG 16SOURCE: PNG STAT 2016

The contribution of the conventional on shore fields is almost stagnant but the opportunities of substantial growth are first in the off shore basins followed by the onshore coal bed methane (CBM) which is assumed to increase by 2020. although resources are large but still the gas production face uncertainties like the disappointing production performance of Reliance's KG-D6 block and the CBM projects have high development cost.

India has a large CBM resource and also policies to support the development but yet to result in significant volume of gas output. The production started in 2007 and stood at 0.2 bcm at 2013. The profitable wells are shallow and do not require large scale hydraulic fracturing. But much of the resources lie in the complex environment which requires large investment.

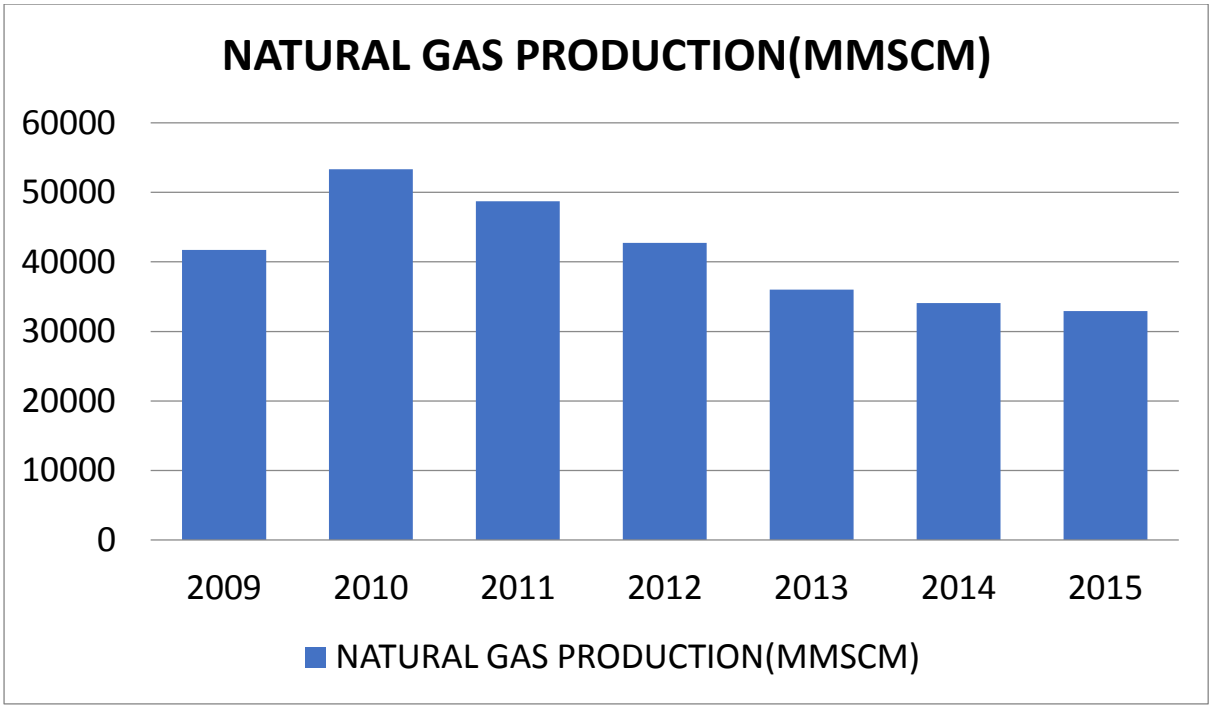

Fig: 18

Source: Petroleum and Natural Gas Statistics 2016

The key question is whether the price available to domestic gas producer will be sufficient to incentivise the investment requirements. An analysis of India's gas supply costs suggests that the new commercial gas developments are marginal price.

India provides an illustration of the difficulty faced by many gas import-dependent economies i.e. how to find the prices that is acceptable in the gas-consuming sectors and also enough to attract investments in supply. There is no such domestic trade hub yet in place to determine the market value of gas in India. So the long debated solution is to pick a basket of international prices to generate a reference price, although any of these choices has the risk of being out of step with the actual dynamics of the Indian gas market.

Based on the new formula and international price trajectories for the different reference prices, the gas price available to India's domestic producers should rise from the present level of $4/Mbtu to $7/Mbtu by 2025 and to $9/Mbtu by 2040. However the price is not sufficient to attract investments in the gas sector.

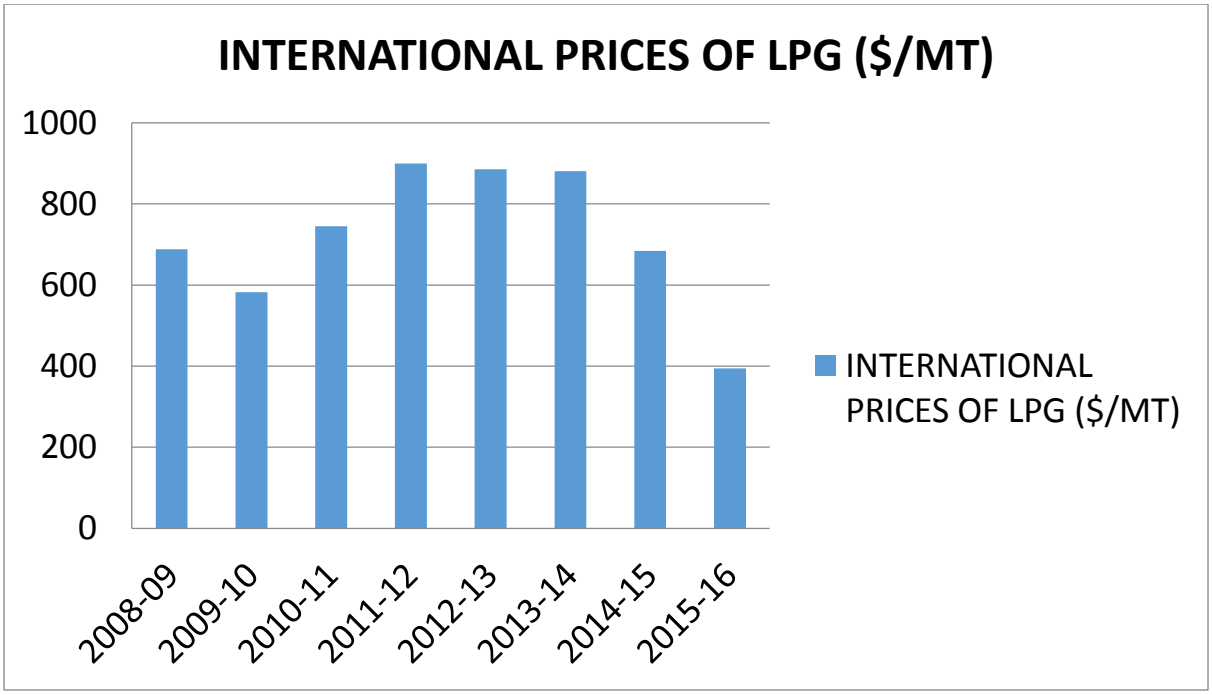

FIGURE 18 SOURCES: PNG STAT 2016

According to the recent estimation India needs to develop 200 bcm of ne gas resources over the period to 2040 in the new policies scenario. Investments need to made in exploration and development and some gas needed as early as 2020 would require a higher price than that implied by the existing formula.

A higher price of gas would not only affect the investment but the situation could also be altered by a change in the fiscal terms or a reduction in the risk associated with investment in India. Unconventional gas could also change the India's supply curve if CBM or shale could be brought at a cost of less than $7/Mbtu. But the given intensity of drilling that would be required to cut down the cost to these levels, the challenges are significant.

10.5 LEGAL BARRIERS

33 blocks covers almost two-third of the 26,000 square kilo metres available for the coal bad exploration. This has been awarded to the operators since 2001 but delays in the development process are common. It arises from the complex permitting process and the uncertainties of the gas price. Based on the resource size and the need for gas in India, a rise in the CBM production can be anticipated starting in 2020 and output reaching up to 28bcm by 2040.

Table 8: Legal Barriers

	TECHNOLOGICAL	POLITICAL	ENVIRONMENTAL	ECONOMICAL	LEGAL	SOCIAL
LEGAL				1.Incentives for an increasing exploring activity through attractive licensing arrangements and pricing policies. (IEO)	1.Complex permitting process. (IEO)	

10.6 SOCIAL BARRIERS

Two-third of the Indian households depend on food subsidies for survival and the same proportion of households have little or no access to modern commercial energy in any form. There is no international price for natural gas unlike oil. Markets for natural gas are two distinct commodities with different market dynamics. And the prices of natural gas used for domestic purpose depends on factors that differ immensely from its pricing for trade across countries either through LNG or pipelines. LNG does not have an international bench mark price because of its limited infrastructure and trading volumes. Similarly the prices of piped

natural gas are not market determined. The effective price of piped natural gas is distorted by regional geo-political premiums or discounts, natural monopoly rents charged by the dedicated transmission networks and infrastructure.

Table 9: Social Barriers

	TECHNOLOGICAL	POLITICAL	ENVIRONMENTAL	ECONOMICAL	LEGAL	SOCIAL
SOCIAL				1.Two third of the Indian household depend on food subsidies for survival and thus have little or no access to modern forms of commercial energy.		1.Large production process may not be accepted by the local communities. 2. Production might require displacement from one place to another.

11. FUTURE PROSPECTS OF NATURAL GAS IN INDIA

11.1 SHALE GAS IN INDIA

Shale gas is an important variable in the India's gas future and its potential has been identified in the six basins of India: Cambay, Assam-Arakan, Gondwana, and Krishna. Godavari, Cauvery and the Indo-Gangetic plain. The resource size is large but the activity barely started. A shale policy issued in October 2013 assigned the rights to exploit shale gas to the national oil companies, but this approach is likely to open up under the NELP X

licensing round, which would confer rights to develop all hydrocarbon resources within a given block, both conventional and unconventional. ONGC has drilled several shale research wells in Gondwana and Cambay basins but no commercial shale gas production exists as of now. In long term, water use is the key issue for the shale outlook in India given the water stress and the and the sensitivity in the competition with the agricultural use for a scarce resource. A limited supply of the shale gas is included in the projections starting from 2015 and reaching about 15 bcm per year in 2040.

11.2 SUB-SEA GAS HYDRATES

Sub-sea hydrates have been found in large amounts within the India's territorial water and have a potential role in supplying power in India in future. India's Natural Gas Hydrate Programme has run several expeditions to map and sample prospective sites off the eastern shore. Although the resource could be vast but the high cost and uncertainties over commerciality leads to exclusion of gas hydrate production from the projections.

12. CONCLUSION

In India the most optimistic story is our improved energy efficiency in industrial sector. From the data of 1970's what we used to say in 1980's is that whether India is growing or not could be told by how much energy it is using. Energy growth was then the only indicator. But today we have actually decoupled energy growth from economic growth. Our GDP will be growing but can we say that we will be using less and less energy and emissions will be less and less? Yes it is. Our Indian Industries have shown it is possible which a fantastic achievement through energy efficiency improvement is. Now energy intensity is declining which means

energy efficiency is increasing. Things are changing. We have fuel efficient cars on the road with which we are driving more with less fuel. Now for saying whether a country is growing or not we do not say energy is the indicator the only indicator now is GDP growth. We have significant amount of unexplored natural gas reserves in the form of Coal-bed Methane and Shale Gas in the states of West Bengal, Jharkhand, Bihar, Orissa. Regional imbalance prevails among states due to gas pipelines. Thus huge investment is needed for infrastructural development in India.

Plans are to boost gas supply by pipeline center on two proposed major pipelines, the Turkmenistan-Afghanistan-Pakistan-India pipeline (TAPI) and the Iran-Pakistan-India (IPI), but there are still substantial political and commercial obstacles. The security situations in Afghanistan and the relationship between India and Pakistan fall in the first category opens questions about pricing and financing. These political uncertainties and the availability of relatively inexpensive LNG in the medium term rule out an early prospect of India receiving pipeline gas. However there is potential that one or both the projects will be viable in long term and gas imports in India will start in later part of 2020. In both cases Turkmenistan's large gas supply has an important role to play in India's gas supply either directly by TAPI or indirectly by IPI with increased Turkmenistan exports to Iran meeting a part of northern Iranian demand and freeing up Iranian gas in the south, where most of Iran's gas is produced for export.

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