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WORKING REPORT: GLOBAL AND REGIONAL (BBINS) PERSPECTIVE ON NATURAL GAS

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PREFACE

Energy Cooperation is one of the key focus areas in the South-Asian region, and the role of Natural Gas as a cleaner alternative to other fossil fuels in the region cannot be overlooked. In this context, we are pleased to present the "Global and Regional (BBINS) Perspective Report on Natural Gas", carried out under the South Asian Regional Initiative for Energy Integration (SARI/EI) project of USAID.

For establishing a gas-trading hub in the BBINS (Bangladesh, Bhutan, India, Nepal and Sri Lanka) region and developing a mature regional market, all the facts and prerequisites need to be collated and analyzed. The report presents a comprehensive overview of the NaturalGas potential and trade around the globe. It studies the status and distribution of natural gas in the BBINS region in terms of its reserves, production, consumption and future demand scenarios. It also studies the evolution of trade and pricing of natural gas in the region. This study enabled identification of the various hindrances and bottlenecks to the development of Natural Gas a major fuel in the region.

The study also attempts to analyze the existing conditions and further requirements for successfully setting up a functional gas-trading hub in the region. This report endeavours to enable policy makers, stakeholders and industry experts to make informed decisions to propel this idea further.

We sincerely thank USAID for supporting this project and providing their valuable inputs. I thank the IRADe team that worked tirelessly to bring about this project.

Professor Jyoti Parikh, PhD

Executive Director, IRADe

ACKNOWLEDGMENTS

The preparation of this Working Report on “Global and Regional (BBINS) Perspective on Natural Gas” for the South Asia Regional Initiative for Energy Integration (SARI/EI) Program would not have been possible without the valuable contributions of the multiple stakeholders.

We would like to express our sincere thanks to Mr. Michael Satin, Director of the Clean Energy and Environment Office, USAID/India and Ms. Monali Zeya Hazra, Regional Energy Manager and Clean Energy Specialist, USAID/India for their valuable inputs and suggestions, not to mention their wholehearted support for this activity.

Our sincere thanks are to Dr. Kirit Parikh, Chairman IRADe without whose valuable guidance, this report would never have seen the light of day. We hope this document will help policymakers, stakeholders, and industry experts to make informed decisions pertaining to the gas sector in the BBINS region.

We would like to thank Mr. Pankaj Batra, Project Director, SARI/EI for smooth functioning and providing the initial thrust to this report.

EXECUTIVE SUMMARY

Natural Gas is one of the most diverse fuels making it the third largest, after crude oil and coal, in global primary energy consumption in 2017. It is used across major industries as it is not only more efficient but also cleaner. The Middle Eastern region has the highest share of this resource while North America is the largest producer and consumer. Other areas, such as the Asia Pacific and European countries, meet their demands through imports. Trading of Natural Gas undertaken is through cross-country pipelines or in the form of Liquefied Natural Gas (LNG).

The BBINS (Bangladesh, Bhutan, India, Nepal and Sri Lanka) region recognizes the advantages of Natural gas as fuel and foresees it as an upcoming energy source. The BBINS region lacks substantial reserves of Natural Gas, with only 0.7% of the world's total reserves, while contributing 20.7% of global population as of 2017. In fact, Bhutan, Nepal and Sri Lanka do not hold any proven natural gas reserves.

As a result, only India and Bangladesh engage in commercial production of Natural Gas. However, exploratory drillings have indicated presence of some gas reserves in Sri Lankan offshore basins, and the country is keen to develop the resources. Consumption patterns of Natural Gas differ widely in the BBINS region. While it is a major fuel in Bangladesh, its prominence is limited to fertilizer and City Gas Distribution (CGD) sectors in India. In addition, at present there is no consumption of the fuel in Bhutan, Nepal and Sri Lanka (except for LPG). The BBINS region consumed 2.2% of total natural gas in the worldin the year 2017.

To cater to the demand for Natural Gas in the BBINS region, Liquefied Natural Gas (LNG) import has emerged as an option. India has six operational LNG terminals with a cumulative capacity of 42.5 mmtpa. Bangladesh has also invested in Floating Storage and Regasification Unit (FSRU) based LNG capacities of total 7.52 mmtpa. Sri Lanka has signed agreements to develop two LNG terminals to import Natural Gas. However, import through pipelines has not materialized in the region due to geopolitical reasons.

In India, upstream Natural Gas industry is dominated by state owned enterprises. Both ONGC and OIL are state owned enterprises with total share of 81% in domestic production of the fuel, which comprised 49.8% of domestic consumption in 2018. In Bangladesh, the production is dominated by International Oil Companies (IOCs) with a 60% share in current production. Midstream and Downstream sector companies are involved in processing, transportation and distribution of Natural Gas. They set up regasification terminals, pipeline infrastructure and retail pumps for gas distribution.

While Nepal and Bhutan have not included Natural Gas in their future energy scenario, it is expected to play a major role in the energy basket of India, Bangladesh and Sri Lanka. The projected demand growth rate of the fuel in the BBINS region comes out to be higher than rest of the world. This indicates the eagerness of the region to incorporate Natural Gas in their energy basket. Additionally, LPG usage can be substituted by safer PNG (Piped Natural Gas) fuel in the region for cooking purposes.

Unconventional gas resources have also shown some prospects, especially in India. Shale wells are being drilled and developed in the country. India has rich coal reserves, and thus prospects of Coal Bed Methane (CBM) are also high. However, other BBINS members do not possess any unconventional gas reserves.

Pricing of an energy resource has been an important factor in the region. While the pricing regime of domestic Natural Gas is largely influenced by the Government in Bangladesh with high subsidies, India has gradually moved to a market based pricing system for its domestic Natural Gas. The Indian Government does not interfere in pricing of LNG and buyers are free to strike a deal with exporters. This system has resulted in moderate average prices of gas in India, whereas prices are much lower in Bangladesh as compared with other countries.

Numerous roadblocks exist in the way of Natural Gas becoming a major fuel in the region. There are infrastructural problems in India such as low pipeline density, problems in land acquisition etc. that hinder effective distribution of the energy source in the region. Moreover, utilization of domestic coal is cheaper than imported gas, particularly in India. Bangladesh is struggling with overdependence on its current reserves. There is a widening demand and supply gap in the country, which threatens the energy security of the country. In addition to that, inefficient use of the resource further aggravates the problem.For a country like Sri Lanka, lack of experience in the sector presents itself as a bottleneck.

It has been established that domestic production of gas would not be able to fulfil the gas needs of the region, and thus imports will be required to suffice this demand. Since cross-country pipelines are not feasible, LNG import is the only alternative. To ensure reliable availability of gas, a mature market has to be developed in the region. In conclusion, robust planning and implementation with adequate policy support is required in the BBINS region to promote natural gas as a major fuel and build a market for it.

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LIST OF ABBREVIATIONS

BBINS	Bangladesh, Bhutan, India, Nepal, Sri Lanka
CGD	City Gas Distribution
LPG	Liquefied Petroleum Gas
LNG	Liquefied Natural Gas
FSRU	Floating Storage Regasification Unit
ONGC	Oil and Natural Gas Corporation
OIL	Oil India Limited
IOC	International Oil Companies
PNG	Piped Natural Gas
CBM	Coal Bed Methane
CIS	Commonwealth of Independent States
TCM	Trillion Cubic Meters
BCM	Billion Cubic Meters
GoG	Gas on Gas
OPE	Oil Price Escalation
BIM	Bilateral Monopoly
NET	Netback From Final Product
RCS	Regulation: Cost Of Service
RSP	Regulation: Social And Political
RBC	Regulation: Below Cost
NP	No Price
NBP	National Balancing Point
TTF	Title Transfer Facility
NYMEX	New York Mercantile Exchange
mmbtu	Metric Million British Thermal Unit
bbl	Barrel
WTI	West Texas Intermediate
MTOE	Million Tonnes of Oil Equivalent
CAGR	Compound Annual Growth Rate

TAPI	Turkmenistan-Afghanistan-Pakistan-India
IPI	Iran-Pakistan-India
MMSCD	Million Standard Cubic Meters per Day
PSU	Public Sector Undertaking
PSC	Production Sharing Contract
NELP	New Exploration Licensing Policy
OVL	ONGC Videsh Ltd.
BGFCL	Bangladesh Gas Fields Company Ltd.
SGFL	Sylhet Gas Fields Ltd.
BAPEX	Bangladesh Petroleum Exploration and Production Company Limited
TGTDCL	Titas Gas Transmission and Distribution Company Ltd.
BGDCL	Bakhrabad Gas Distribution Company Ltd.
PGCL	Pashchimanchal Gas Company Limited
KGDCL	Karnaphuli Gas Distribution Company Ltd.
SGCL	Sundarban Gas Company Ltd.
GTCL	Gas Transmission Company Ltd.
GAIL	Gas Authority of India Ltd.
IOCL	Indian Oil Corporation Limited
GSPC	Gujarat State Petroleum Corporation Ltd.
AGCL	Assam Gas Company Limited
DNPL	Duliajan Numaligarh Pipeline Ltd.
RIL	Reliance Industries Ltd.
GDP	Gross Domestic Product
R&D	Research and Development
APM	Administrative Pricing Mechanism
GCV	Gross Calorific Value
BERC	Bangladesh Energy Regulatory Commission
MT	Metric Tonnes

CHAPTER 1:
GLOBAL OUTLOOK- NATURAL GAS

Natural Gas is one of the most widely used fossil fuels across the world, used in sectors such as power, industry, residential, commercial and transport. In 2017, the share of Natural Gas in the global primary energy consumption was 23.4%[1] , making it the third largest fuel after oil (share of 34.2%) and coal (share of 27.6%). Global primary energy consumption grew strongly in 2017, led by Natural Gas and renewables, with coal's share of the energy mix continuing to decline. Natural Gas is also a low carbon intensity fossil fuel and hence is globally recognized as an alternative fuel for low carbon economic development.

This chapter will cover the following topics:

- Regions with surplus Natural Gas
- Regions that contribute to Natural Gas trade
- Type of trades (pipeline vs. LNG) from various regions
- Key countries contributing to global gas trade
- Pricing of Natural Gas

1.1 Reserves

As on 2017, the global Natural Gas reserves stood at around 193 TCM[2] , wherein the Middle East region accounts for the highest share with 41% of total proved reserves. The CIS region (Commonwealth of Independent States[3]) holds the second highest share, followed by Asia Pacific and Africa. Figure 1.1 shows the spread of proved Natural Gas reserves in 2017. At the country level, Russia holds the highest reserves of Natural Gas followed by Iran, Qatar and Turkmenistan. Table 1.1 provides a list of top 10 countries with highest reserves of Natural Gas.

[1] *BP Statistical Review of World Energy, June 2018.*

[2] *BP Statistical Review of World Energy, June 2018.*

[3] *CIS includes Armenia, Azerbaijan, Belarus, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine and Uzbekistan.*

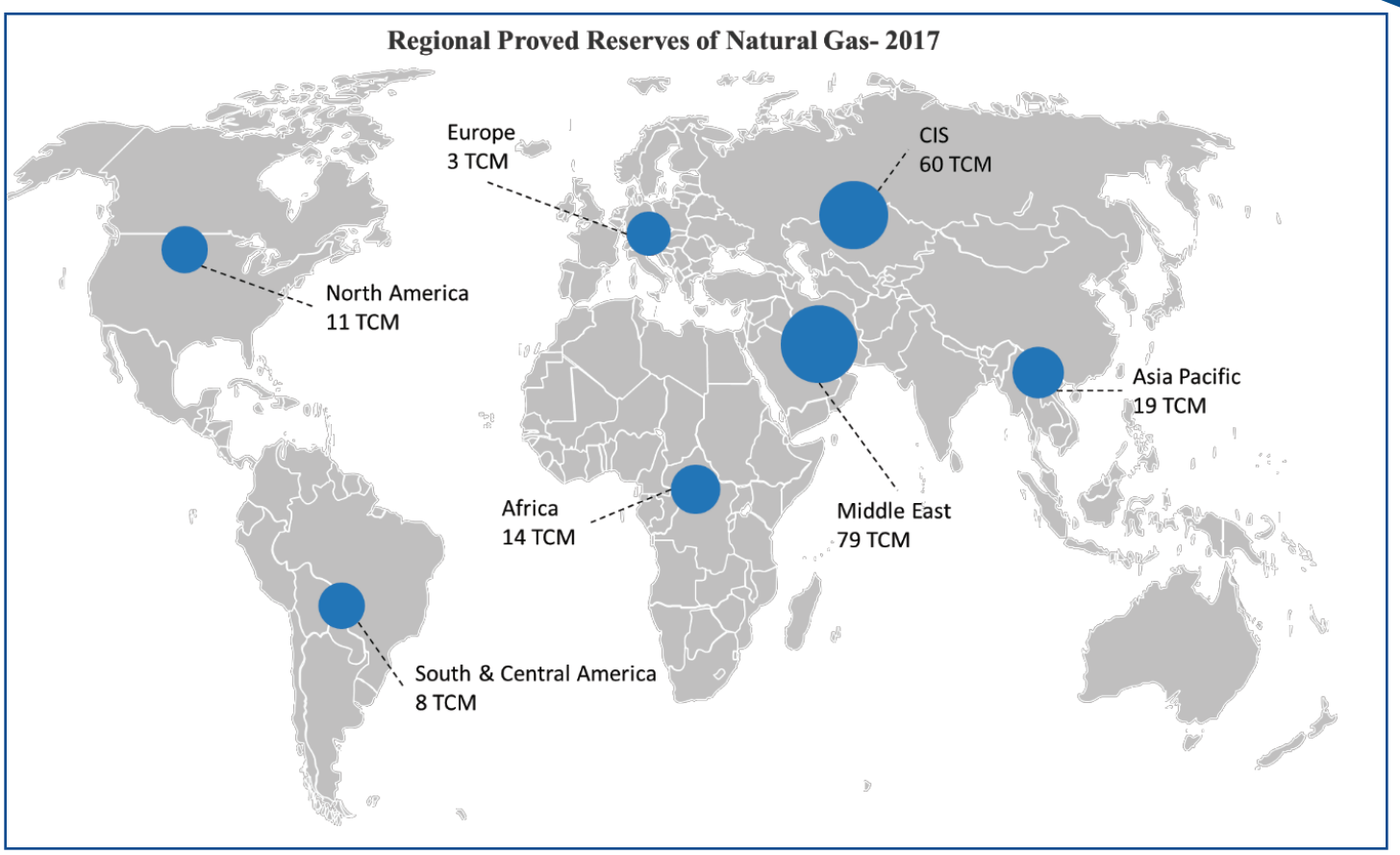


Figure 1.1 Proved Natural Gas Reserves in 2017 (Source: BP Statistical Review of World Energy, June 2018 and analysis IRADe)

Table 1.1 Top 10 countries with highest Natural Gas Reserves in 2017 (Source: BP Statistical Review of World Energy, June 2018 and analysis IRADe)

Country	**Region**	**TCM**
Russian Federation	CIS	35.0
Iran	Middle East	33.2
Qatar	Middle East	24.9
Turkmenistan	CIS	19.5
US	North America	8.7
Saudi Arabia	Middle East	8.0
Venezuela	S. & Cent. America	6.4
United Arab Emirates	Middle East	5.9
China	Asia Pacific	5.5
Nigeria	Africa	5.2

1.2 Production and Consumption

The North American region is the largest producer and consumer of natural gas in the world. Within that region, the United States is both the largest Natural Gas producer as well as consumer in the world. Region-wise Natural Gas production and consumption patterns are provided in Figure 1.2. The difference between production and consumption is highest in the CIS region (around 241 BCM), followed by Middle East region (123 BCM), Africa (83 BCM), North America (9 BCM), and South and Central America (6 BCM). Therefore, these regions have the potential to export to other regions, which is highlighted in the upcoming sections.

The Asia Pacific and the European regions are net importers of Natural Gas, i.e., their consumption is higher than production. Table 1.2 highlights the top producers and consumers of the fuel at a regional level. Table 1.3 provides the top 10 Natural Gas producer and consumer in 2017.

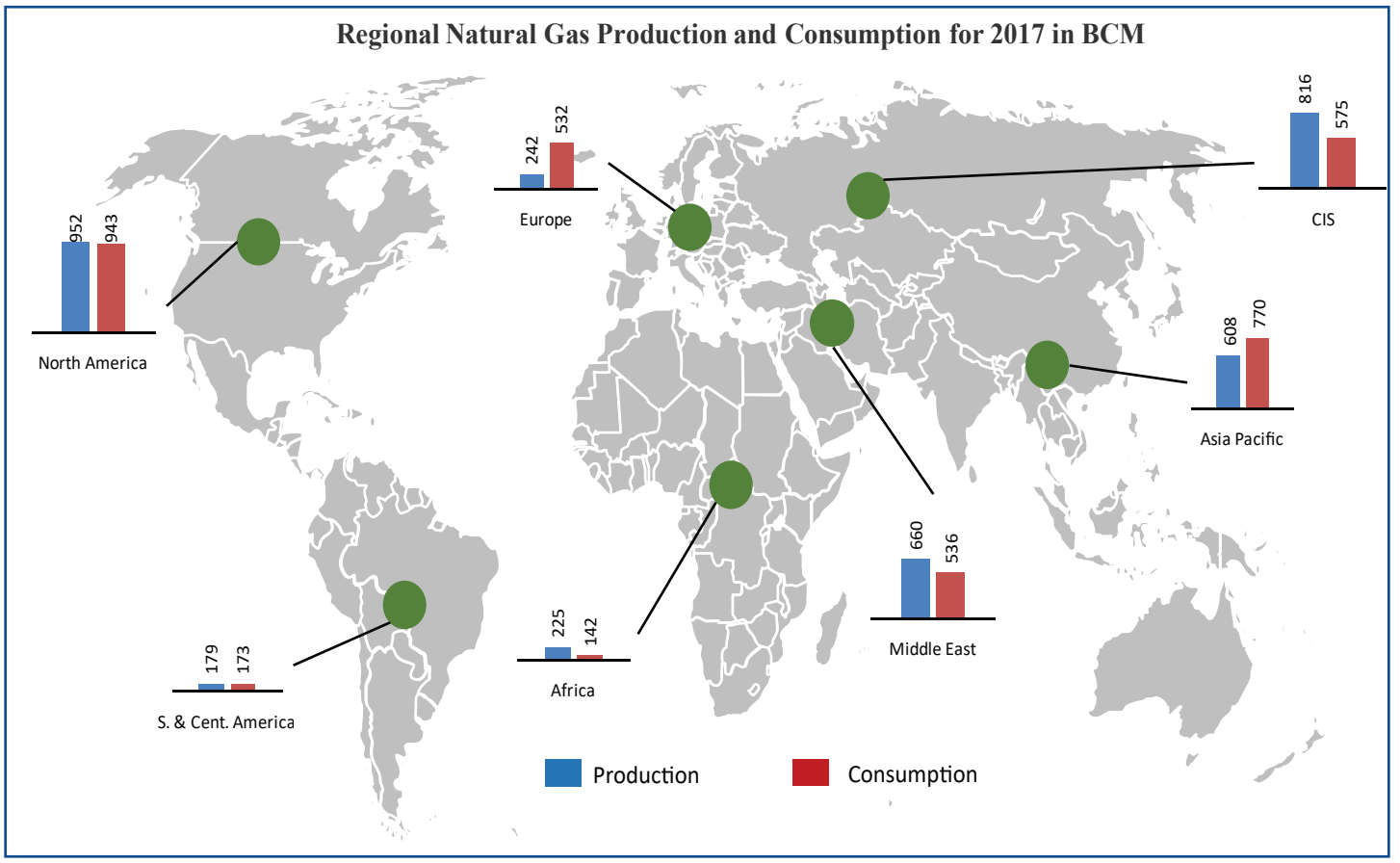


Figure 1.2Region-wise Natural gas production and consumption during 2017 (in BCM) (Source: BP Statistical Review of World Energy, June 2018 and analysis IRADe)

Table 1.2 Region-wise key Producers and Consumers of Natural Gas (Source: BP Statistical Review of World Energy, June 2018 and IRADe analysis)

Region	**Top Two Producers (in BCM)**	**Top Two** Consumers (in BCM)
North America	US (735), Canada (176)	US (739), Canada (116)
Asia Pacific	China (149), Australia (113)	China (240), Japan (117)
CIS	Russia (636), Turkmenistan (62)	Russia (425), Ukraine (30)
Middle East	Iran (224), Qatar (176)	Iran (214), Saudi Arabia (111)
Europe	Norway (123), United Kingdom (42)	Germany (90), United Kingdom (79)
S. & Cent. America	Argentina (37), Venezuela (37)	Argentina (48), Brazil (38)
Africa	Algeria (91), Egypt (49)	Egypt (56), Algeria (39)

Table 1.3 Top 10 countries in Natural Gas production and consumption in 2017 (Source: BP Statistical Review of World Energy, June 2018 and IRADe analysis)

Top 10 Natural Gas Producer (in 2017)			**Top 10 Natural Gas Consumers (in 2017)**		
Country	Region	BCM	Country	Region	BCM
US	North America	735	US	North America	739
Russian Federation	CIS	636	Russian Federation	CIS	425
Iran	Middle East	224	China	Asia Pacific	240
Canada	North America	176	Iran	Middle East	214
Qatar	Middle East	176	Japan	Asia Pacific	117
China	Asia Pacific	149	Canada	North America	116
Norway	Europe	123	Saudi Arabia	Middle East	111
Australia	Asia Pacific	113	Germany	Europe	90
Saudi Arabia	Middle East	111	Mexico	North America	88
Algeria	Africa	91	United Kingdom	Europe	79

Recently, the US changed its position from net importer to net exporter of Natural Gas as per the U.S. Energy Information Administration May 2019 article[4].

1.3 Natural Gas Trade via Pipeline

Globally, Natural Gas is transported via pipelines or through liquefaction into Liquefied Natural Gas (LNG). Out of the total global Natural Gas production of 3680 BCM in 2017, around 20% was traded through pipelines (741 BCM) and around 11% through LNG. Therefore, out of the total production, only 31% gas is traded and the rest is consumed within the gas producing countries. At the country level, Russia is the largest exporter of Natural Gas via pipelines, whereas Germany is the biggest importer. Table 1.4 provides a list of global top five Natural Gas exporters and importers via pipeline.

In the North American region, gas trade via pipeline is undertaken between US and Canada and US and Mexico, wherein Canada is an exporter of gas to US and US is an exporter to Mexico. Further, down in the South and Central American region, Bolivia is the major exporter of Natural Gas, exporting to Argentina and Brazil. The bulk of gas produced within the European region is consumed within the region. Within Europe, the major exporters of gas via pipeline are Norway, Netherlands and the United Kingdom. In addition, Russia (from CIS region) exports significant volume of Natural Gas through pipelines to European region. Small volume of the fuel is exported into the European region from African countries such as Algeria and Libya. In the Asia Pacific region, China is the largest importer of Natural Gas via pipelines from neighbouring countries such as Turkmenistan, Uzbekistan, Kazakhstan and Myanmar via pipelines. On the other hand, Myanmar is the largest exporter of Natural Gas via pipeline in the Asia pacific region, exporting gas to Thailand and China.

Table 1.4 Global Top 5 Natural Gas Exporters and Importers via Pipeline (Source: BP Statistical Review of World Energy, June 2018 and analysis IRADe)

Natural Gas Exporters via Pipeline	**BCM**	**Remarks**
Russian Federation	215	Exports major portion to European countries
Norway	109	All exports to European countries
Canada	81	Exports to US
US	66	Exports to both Canada and Mexico
Netherlands	43	All exports to European countries
Natural Gas Importers via Pipeline	BCM	Remarks
Germany	95	Imports from Russia and European countries
US	81	Imports from Canada
Italy	54	Imports from Russia, Africa region and Europe region
Turkey	43	Imports from CIS region and Middle East region
Mexico	42	Imports from US

[4] *https://www.eia.gov/todayinenergy/detail.php?id=39312*

1.4 Natural Gas Trade as Liquefied Natural Gas (LNG)

Liquefaction of Natural Gas is undertaken for easy transport of gas via sea route. In this process, the fuel is cooled to a liquid state at about -260°F for shipping and storage purposes. The volume of Natural Gas in its liquid state is about 600 times smaller than its volume in gaseous state. This process makes it possible to transport Natural Gas to places where pipelines are uneconomical to construct. Globally, around 393 BCM of Natural Gas was traded through in LNG in 2017. The top LNG exporting and importing countries are listed in Table 1.5.

Table 1.5 Global Top 10 LNG Exporters and Importers in 2017 (Source: BP Statistical Review of World Energy, June 2018 and analysis IRADe)

Top LNG Exporters	BCM	Top LNG Importers	BCM
Qatar	103	Japan	114
Australia	76	China	53
Malaysia	36	South Korea	51
Nigeria	28	India	26
Indonesia	22	Taiwan	23
US	17	Spain	17
Algeria	17	Turkey	11
Russian Federation	16	France	11
Trinidad & Tobago	13	Other EU	10
Papua New Guinea	11	Italy	8

At the regional level, the Asia Pacific region was the largest importer of LNG in 2017 with imports of 284 BCM, representing 72% of the global LNG imports. In addition to this, the Asia Pacific region is also the largest exporter of LNG with volumes of 155 BCM in 2017 (representing 39% of the global LNG exports). However all the export originating from the Asia Pacific region are consumed within the region itself. The Middle East is the second largest exporting region for LNG, exporting around 123 BCM of LNG to the Asia Pacific, European and African regions in 2017. The global LNG trade movement for year 2017 is provided in Figure 1.3. Globally, both the Asia Pacific and European region are net importers of Natural Gas via LNG. In future, the Asia Pacific region and the European region are expected to remain net importers of LNG due to rising demand and limited reserves respectively. On the other hand, the Middle East and CIS region are expected to remain net exporters of Natural Gas due to significant reserve potential.

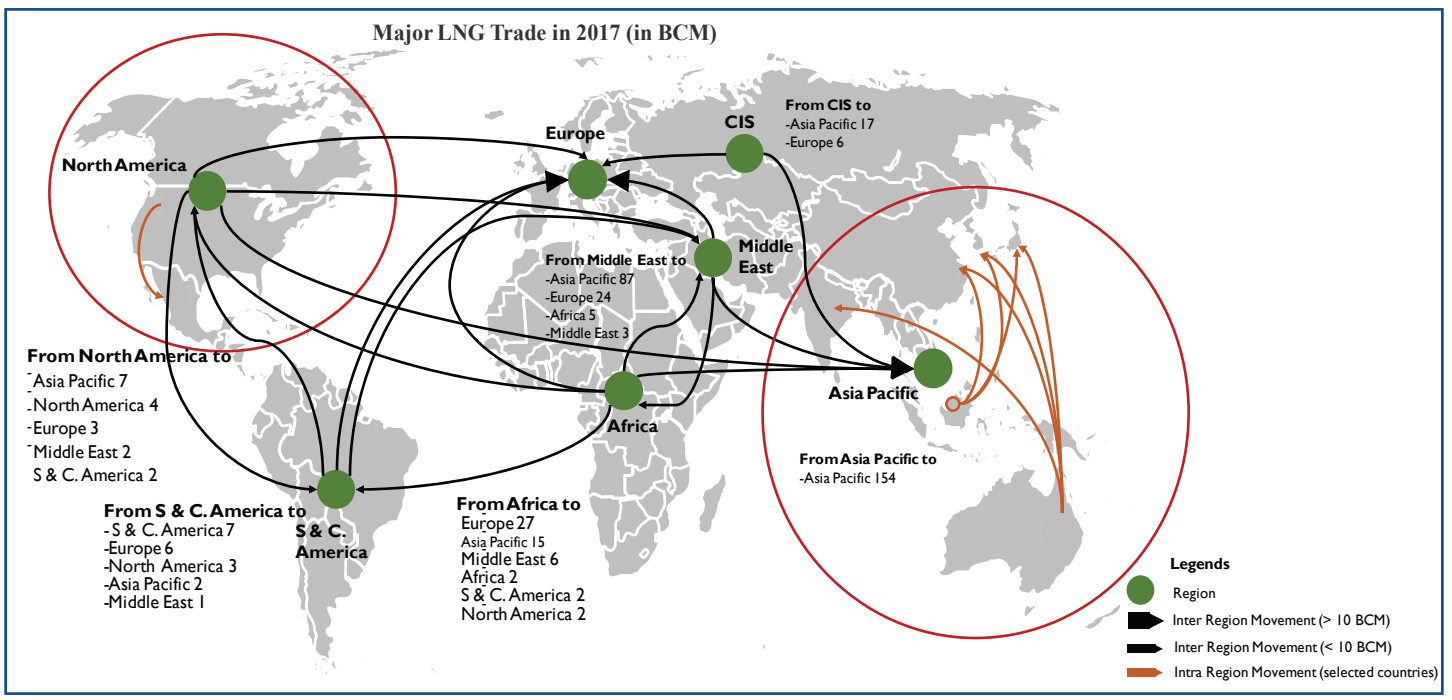


Figure 1.3 Global LNG Trade Movement in 2017 (Source: BP Statistical Review of World Energy, June 2018 and analysis IRADe)

1.5 Pricing

1.5.1 Pricing Mechanism

The price of Natural Gas is derived from the demand supply fundamentals of gas, and many a times from the price of crude oil. Table 1.6 shows the various mechanisms by which the pricing of Natural Gas is undertaken globally. As per the 2017 Wholesale Gas Price Survey, the Gas-on-Gas (GoG) competition has the largest share in the world gas market. Out of the total consumption of Natural Gas, around 46% is priced on GoG competition pricing mechanism. The share of oil price escalation or oil indexation is 19% in the Natural gas pricing. The regulated category (cost of service, social and political, and below cost) accounts for nearly 30% of the natural gas pricing. The share of GoG competition price has increased by almost 15% from 2005 to 2017, registering highest growth compared to the rest of the pricing mechanisms. The GoG competition pricing mechanism is more common in the European and North American region, whereas the oil price escalation is still common in the Asia Pacific region. The pricing mechanism is also impacted by the mode of Natural Gas transportation. In 2017 around 61% of the global natural gas pipeline imports are based on GoG competition pricing mechanism, 30% on oil price escalation and the rest based on bilateral monopoly. In contrast to pipelines, around 72% of the LNG based Natural Gas is priced on oil price escalation and rest 28% on GoG completion.

Table 1.6 Types of Price Formation Mechanism (Source: Wholesale Gas Price Survey 2018 Edition, June 2018)

Types of Price Formation Mechanism	
Oil Price Escalation (OPE)	The price is linked, usually through a base price and an escalation clause, to competing fuels, typically crude oil, gas oil and/or fuel oil. In some cases, coal prices can be used as electricity prices.
Gas-on-Gas Competition (GoG)	The price is determined by the interplay of supply and demand gas-on-gas competition and is traded over a variety of different periods (daily, monthly, annually or other periods). Trading takes place at physical hubs (e.g. Henry Hub) or notional hubs (e.g. NBP in the UK), with possibility of developed futures markets (NYMEX or ICE). Since not all gas is traded on a short-term fixed price basis, there will be longer-term contracts but these will use gas price indices to determine the monthly price, for example, rather than competing fuel indices. Also included in this category are any spot LNG cargoes, any pricing which is linked to hub or spot prices, as well as bilateral agreements in markets with multiple buyers and sellers.
Bilateral Monopoly (BIM)	The price is determined by bilateral discussions and agreements between a large seller and a large buyer, with the price fixed for a period of time – typically one year. There may be a written contract in place but often the arrangement is at the Government or state-owned company level. Usually there would be a single dominant buyer or seller on at least one side of the transaction, to distinguish this category from GOG, which has multiple buyers and sellers.
Netback From Final Product (NET)	The price received by the gas supplier is a function of the price received by the buyer for the final product. This may occur where the gas is used as feedstock in chemical plants, such as ammonia or methanol, and is the major variable cost in producing the product.
Regulation: Cost Of Service (RCS)	The price is determined, or approved, by a regulatory authority, or possibly a Ministry, but the level is set to cover the "cost of service", including recovery of the investment and a reasonable rate of return.
Regulation: Social And Political (RSP)	The price is set on an irregular basis, probably by a Ministry, on a political/social basis, in response to the need to cover increasing costs, or possibly as a revenue raising exercise – a hybrid between RCS and RBC.
Regulation: Below Cost (RBC)	The price is intentionally set below the average cost of producing and transporting of the gas, often as a form of state subsidy to the population.
No Price (NP)	The gas produced is either provided free to the population and industry, possibly as a feedstock for chemical and fertilizer plants, or in refinery processes and enhanced oil recovery. The gas produced maybe associated with oil and/or liquids and treated as a by-product.

1.5.2 Pricing Indexes/Hubs

A Natural Gas hub is a platform where the title or ownership of gas molecules is exchanged between a number of buyers and sellers. It may be an actual physical location such as a physical hub or just a trading platform as in the case of a virtual hub. The hub is used as a central pricing point for the network's Natural Gas. The key elements of a natural gas hub are the presence of a number of suppliers, traders, consumers, storage capacities and pipeline network to avoid domination by a few producers. Following are some of the key gas pricing hubs:

a) Henry Hub in United States: It acts as a benchmark price for the North American Region's Natural Gas resource. It is interconnected with 13 different intra- and interstate pipelines. Because of its central location and high degree of interconnectedness, Henry Hub is used as the delivery point for the New York Mercantile Exchange's (NYMEX) Natural Gas futures contracts.

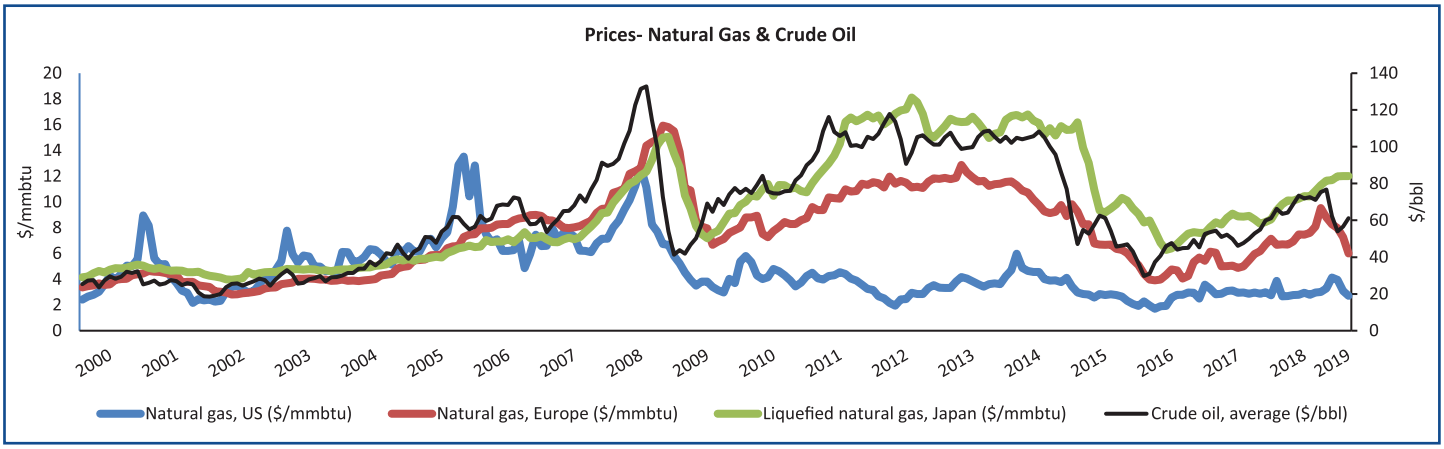
b) National Balancing Point (NBP): NBP is a virtual trading point operated by the transmissions system operator called the National Grid, UK. The NBP price is used in the wholesale gas market in Britain as the uniform price for gas irrespective of where the gas comes from.

c) Dutch Title Transfer Facility (TTF): The Dutch Title Transfer Facility (TTF) is a virtual market place offering market parties the opportunity to transfer gas that is already present in the National Gas system ('entry-paid gas') to another party. Using the TTF, gas that is brought into the national grid via an entry point can change owner before it leaves the grid at an exit point. Gasunie Transport Services (GTS), a transmission system operator in the Netherlands, operates the TTF.

Asia: There is no gas pricing hub in the Asia Pacific region, though there are discussions of developing gas pricing hubs in China, India and Japan.

1.5.3 Pricing Trends

Prices for natural gas vary with respect to demand and supply situations of both Natural Gas and crude oil. Figure 1.4 shows the trends in Natural Gas prices in three major markets (North America, Europe and Japan) with respect to crude oil and coal prices.



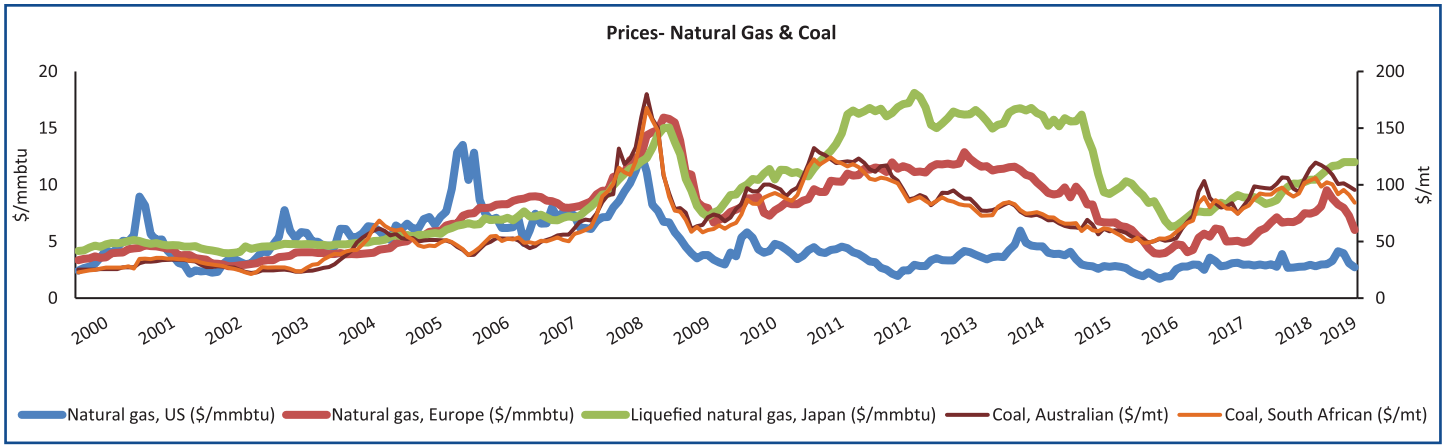


Figure 1.4 Trends in Natural Gas Prices (Data Source for Prices: World Bank Commodity Price Data (The Pink Sheet))

In the North American region, Natural Gas pricing has shifted away from the influence of crude oil pricing due to GoG competition based pricing mechanism as well as the boom in gas production from hydraulic fracturing of shale. Shale gas is a type of Natural Gas that is trapped underground in shale deposits[5]. The shale boom happened in 2007, after which there was a significant increase in Natural gas production in America. This helped in decoupling of Natural Gas prices from crude oil prices. This is evident from Figure 1.5 that compares the Natural Gas prices at the US henry hub with US crude oil prices of West Texas Intermediate (WTI).

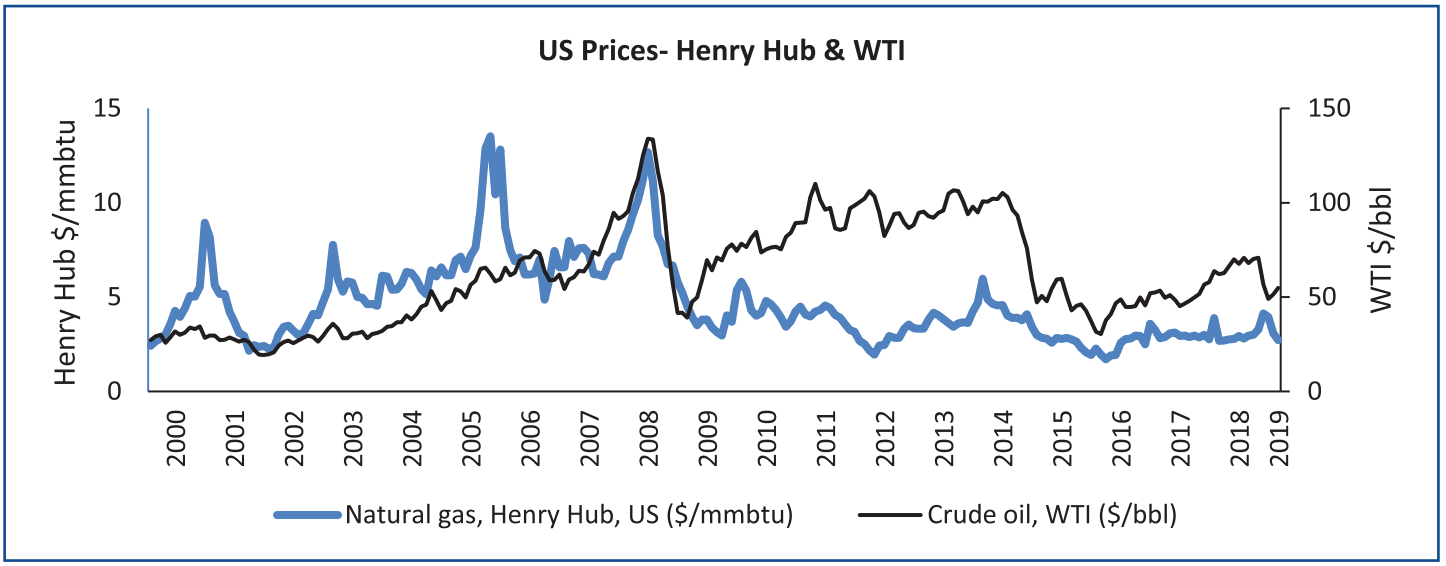


Figure 1.5 Henry Hub US Natural Gas Prices versus West Texas Intermediate US Crude Oil Prices (Data Source for Prices: World Bank Commodity Price Data (The Pink Sheet))

The correlation between US Henry Hub price of Natural Gas and WTI price of crude oil during 2000 to 2007 was 0.70, which indicates a high correlation between the two commodities. However, with the shale boom, the prices of the two commodities decoupled, which is evident from the decrease in correlation value to 0.53 during 2007 to 2019. The correlation of Natural Gas prices with crude oil prices is highlighted in Table 1.7. The table clearly shows the decoupling of Natural Gas prices from crude oil prices. The reason for decoupling in the European and Japanese markets is the increased use of GoG competition pricing mechanism compared to Oil Price Escalation.

[5] *For more details on Shale gas, refer to section 1.6*

Table 1.7 Correlation of Natural Gas Prices with Crude Oil Prices (Data Source for Prices: World Bank Commodity Price Data (The Pink Sheet))

Commodity		Correlation Value	
A	**B**	**2000- 2007**	**2007-2019**
Henry Hub, US (Gas)	WTI, US (Crude Oil)	0.70	0.53
	Europe Prices (Gas)	0.63	0.52
	Japan Prices (Gas)	0.65	0.04
Europe Prices (Gas)	Average Price* (Crude Oil)	0.93	0.72
Japan Prices (Gas)	Average Price* (Crude Oil)	0.94	0.70

** Crude oil, average spot price of Brent, Dubai and West Texas Intermediate, equally weighed.*

1.6 Unconventional Gas

Unconventional gas is a classification of Natural Gas that is more difficult and expensive to exploit than conventional deposits, until recently. It includes shale gas, tight gas, coal bed methane and methane hydrates. Figure 1.6 shows the classification of unconventional and conventional gas based on their reserves types.

Shale Gas: The term 'Shale Gas' refers to Natural Gas that is trapped underground in shale deposits. Shale is a fine-grained, porous rock. While shale deposits have many empty spaces to store Natural Gas, these empty spaces are not well connected which makes it difficult to extract the trapped gas.

Tight Gas: Similar to Shale Gas, Tight Gas is a form of Natural Gas, trapped in a rock that does not allow the gas to easily move through.

Coal Bed Methane: When coal forms, various gases are created, including Methane Gas. This gas is absorbed into the buried coal, and is referred to as Coal Bed Methane, which can only be extracted if the coal is depressurized.

Gas Hydrates: Gas hydrates are gas molecules encased in ice. These are naturally occurring structures that can be found in permafrost sediments in the Arctic, or buried in sediment deep under water.

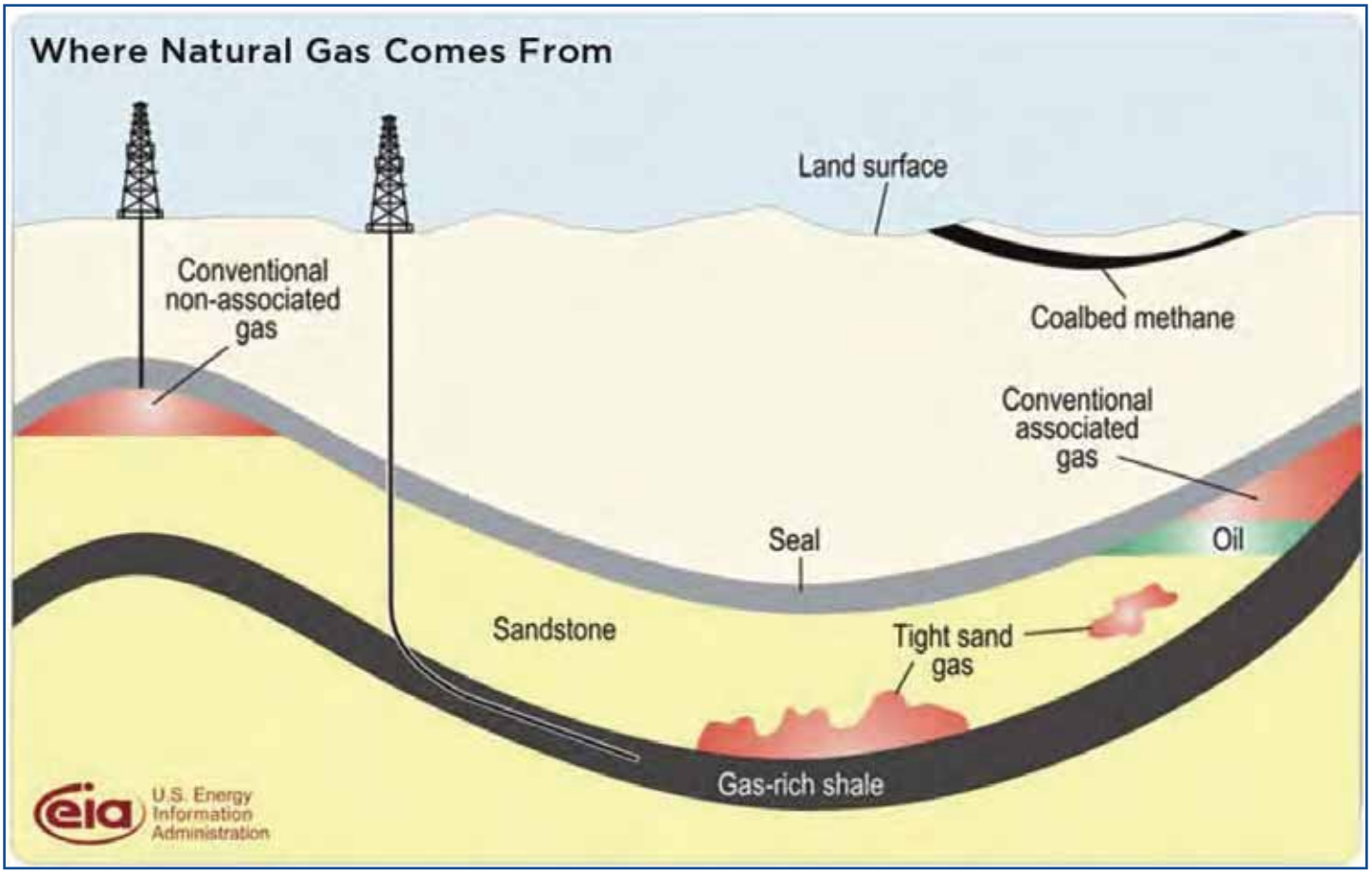


Figure 1.6 Unconventional versus Conventional Natural Gas Resources (Source: U.S. Energy Information Administration

1.6.1. Production

As per the International Energy Database[6] , the global Shale Gas production in 2014 was 386 BCM, wherein US accounted for 98 percent (379 BCM) in the total production, followed by Canada with a share of 2 percent (6 BCM). Similarly, US was also the highest producer of Tight Gas in 2014 with production of 128 BCM out of the total global production of 245 BCM. Canada was the second largest producer of Tight Gas globally in 2014 with production of 73 BCM with share of 30 percent in global tight gas production. The global coal bed methane gas production was 68 BCM wherein US accounted for 37 BCM (54 percent) in 2014. The US was followed by China with production of 14 BCM. Table 1.8 highlights the unconventional gas production in 2014 and list top three producers.

[6] *https://www.iea.org/ugforum/ugd/*

Table 1.8 Unconventional Gas Production in 2014 (Source: Unconventional Gas Database, International Energy Agency)

	Shale Gas	**Tight Gas**	**Coal Bed Methane**
Total Production	386 BCM	245 BCM	68 BCM
Country-Volume (% share)	US- 379 BCM (98%)	US- 128 BCM (52%)	US- 37 BCM (54%)
Country-Volume (% share)	Canada- 6 BCM (2%)	US- 73 BCM (30%)	China- 14 BCM (21%)
Country-Volume (% share)	China- 1 BCM (0.3%)	Russia- 21 BCM (8%)	Australia- 8 BCM (11%)

1.7 Global Gas Demand

As per the BP Energy Outlook 2019, the global gas demand is expected to grow robustly, supported by broad demand and the increasing availability of gas, aided by the continuing expansion of liquefied natural gas (LNG). The key results on gas from the outlook are summarised in Table 1.9. It is to be observed that as per the BP outlook the global gas demand is expected to increase in the range of CAGR 1.4 to 1.7% during 2017 to 2040. Similarly, the IEA's World Energy Outlook 2018 also predicts gas sector to grow with a CAGR of 0.4 to 1.5% under different scenarios during 2017 to 2040. Table 1.10 summarises the key results for gas sector from World Energy Outlook 2018, IEA. Therefore, gas demand is expected to grow in long-term.

Table 1.9 Key Results on Gas from BP Energy Outlook 2019 (Source: BP Energy Outlook 2019, BP)

	Actual	**Scenario**			
		Evolving Transition*		**Rapid Transition****	
	2017	**2040**	**CAGR 2017-40**	**2040**	**CAGR 2017-40**
World Total Primary Energy Consumption in MTOE	13511	17866	1.2%	16390	0.8%
World Gas Consumption in MTOE [BCM]	3156 [3670 BCM]	4617 [5370 BCM]	1.7%	4343 [5051 BCM]	1.4%
Share of Gas in Total Fuel Consumption	23%	25.8%		26.5%	

** Evolving transition (ET) scenario, which assumes that government policies, technology and social preferences continue to evolve in a manner and speed seen over the recent past.*

*** Rapid transition (RT) scenario combines all the policy measures in the lower-carbon scenarios for industry and buildings; transport and the power sector in one single scenario.*

Table 1.10 Key Results on Gas from World Energy Outlook 2018 (Source: World Energy Outlook 2018, IEA)

	Actual	**Scenario**			
		New Policies Scenario*		**Sustainable Development Scenario****	
	2017	2040	CAGR 2017 -40	2040	CAGR 2017 -40
World Total Primary Energy Demand in MTOE	13618	17715	1.2%	13720	0.03%
World Gas Demand in MTOE	3107	4436	1.5%	3438	0.4%
Share of Gas in Total Primary Energy Demand	23%	25%		25%	

**New Policies Scenario (NPS) incorporates existing energy policies as well as an assessment of the results likely to stem from the implementation of announced policy intentions.*

***Sustainable Development Scenario (SDS) outlines an integrated approach to achieving internationally agreed objectives on climate change, air quality and universal access to modern energy.*

1.8 Conclusion

Globally, Natural Gas is expected to remain one of the key energy resources. On a regional level, the Middle East region, CIS region, Africa, and North and South America region will continue to contribute in global Natural Gas trade, whereas the Asia Pacific region and European region will remain the importers. Out of the total global production of Natural Gas, only 31% is traded (20% via pipeline and 11% via LNG) and the rest consumed within the producer country. With increase in LNG trade, the volume of gas traded will increase, which will shift the gas market prices more towards GOG competition based pricing mechanism. Hence, the market is expected to decouple its pricing from oil prices.

CHAPTER 2:
BBINS REGION GAS OUTLOOK

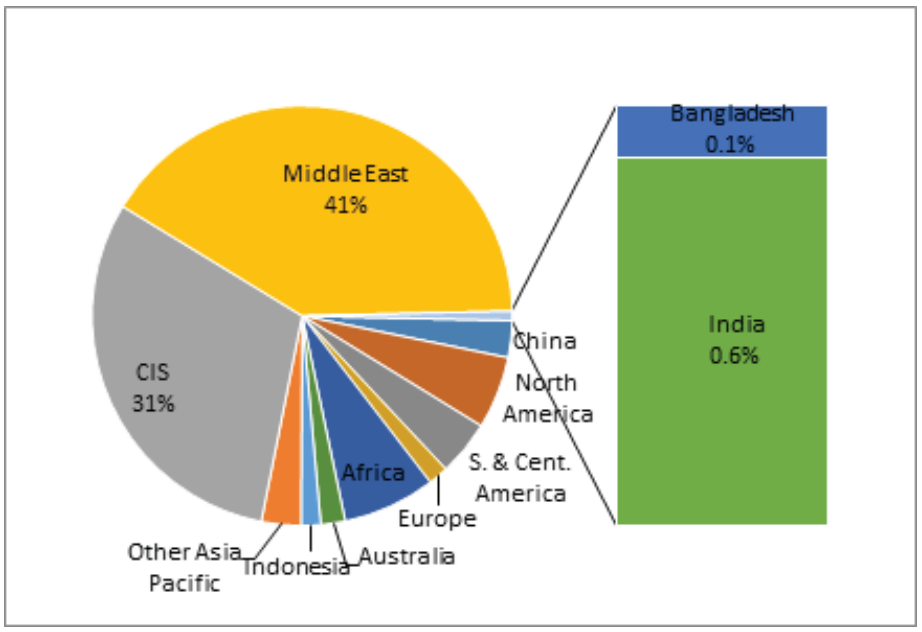
The BBINS region comprises of Bangladesh, Bhutan, India, Nepal and Sri Lanka. BBINS countries lie in the South-Asian region, situated on the Indian continental plate. The region is covered by the Himalayas on the top and surrounded by sea from the southern side. The climate of the region is majorly defined as the monsoon type.

BBINS countries are all rapidly growing economies with mounting population. Energy security is one of the main concerns in the region. Natural gas may thus play an important role in future in promoting energy security and diversity in the region.

2.1 Reserves and Potential

South-Asian region is not geographically blessed with the treasure of Natural Gas reserves. The BBINS region holds only 0.7% of world's total Natural Gas reserves[7], out of which Nepal, Bhutan and Sri Lanka do not have any proved natural gas reserves. Figure 2.1 shows the share of BBINS region in global natural gas reserves.

Figure 2.1Proved Natural Gas Reserves in 2017 (Source: BP Statistical Review of World Energy, June 2018 and IRADe analysis)



As of 2018, India Contained 340 BCM[8] of proven reserves of Natural Gas. The estimated reserves increased by 3.7% over the previous year. Of these reserves, 61.4% (i.e. 823 BCM) are offshore reserves and the rest are onshore reserves.

Bangladesh has recoverable Natural Gas reserves of 337 BCM[9]. The total estimated reserves of Bangladesh (proven plus probable) were 768 BCM, but as much as 430 BCM had been extracted until December 2017.

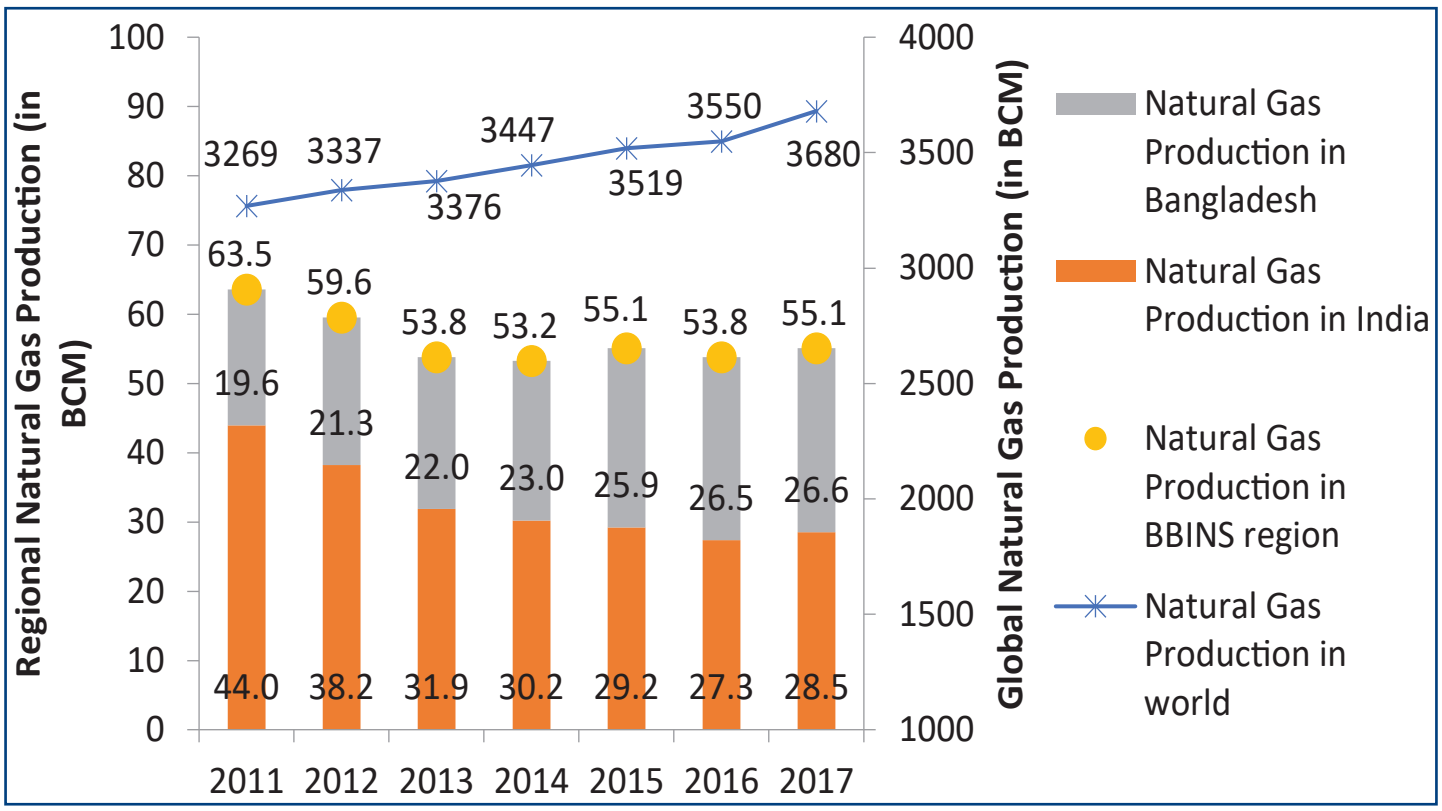
[7] *BP Statistical Review of World Energy, June 2018 and IRADe.*
[8] *India Petroleum and Natural Gas Statistics 2017-18.*
[9] *Petrobangla Annual Report, 2017.*

Nepal has 0.316 BCM[10] of gas reserves but it is still in the exploration phase in Kathmandu Valley. Whereas in Bhutan, there has been no such discovery yet. Sri Lanka too does not have any proven gas reserves, though exploratory drillings have indicated reservoir capacities in excess of 1 TCF (28.3 BCM)[11].

2.2 Production and Consumption

Presently, Natural Gas production is taken up by only India and Bangladesh within the BBINS region. Nepal, Bhutan and Sri Lanka do not produce Natural Gas, as there are no potential reserves for extraction. Total production of Natural Gas by the region in 2017 was 1.5% of the world's total, as shown in Figure 2.2. All the gas produced within the region is used for domestic consumption purposes. The region accounted for 2.2%[12] of the total Natural Gas consumption in the world, as shown in Figure 2.3.

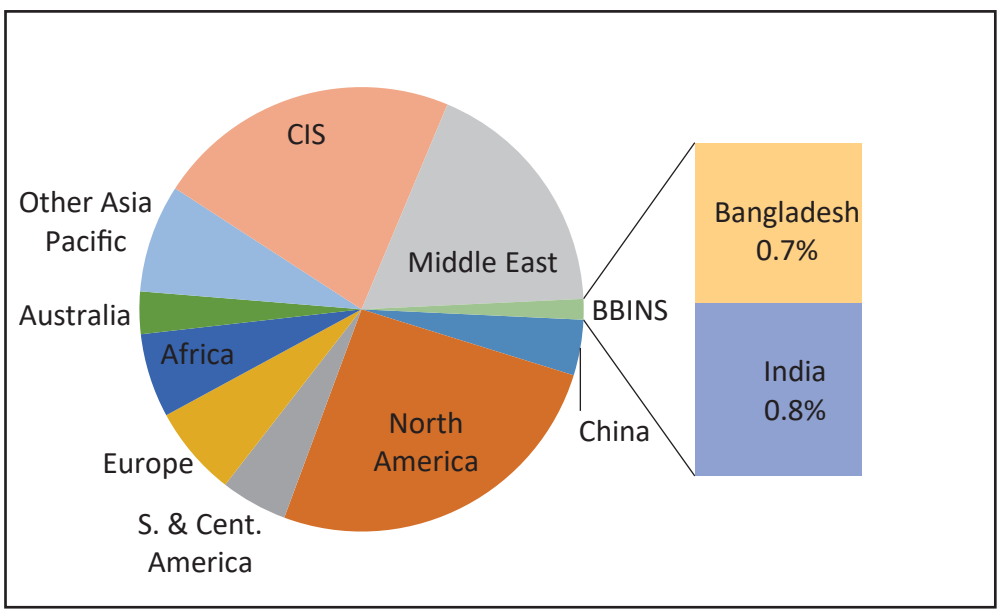
Figure 2.2Trends in Natural Gas Production in 2017(Source: BP Statistical Review of World Energy, June 2018 and IRADe analysis)

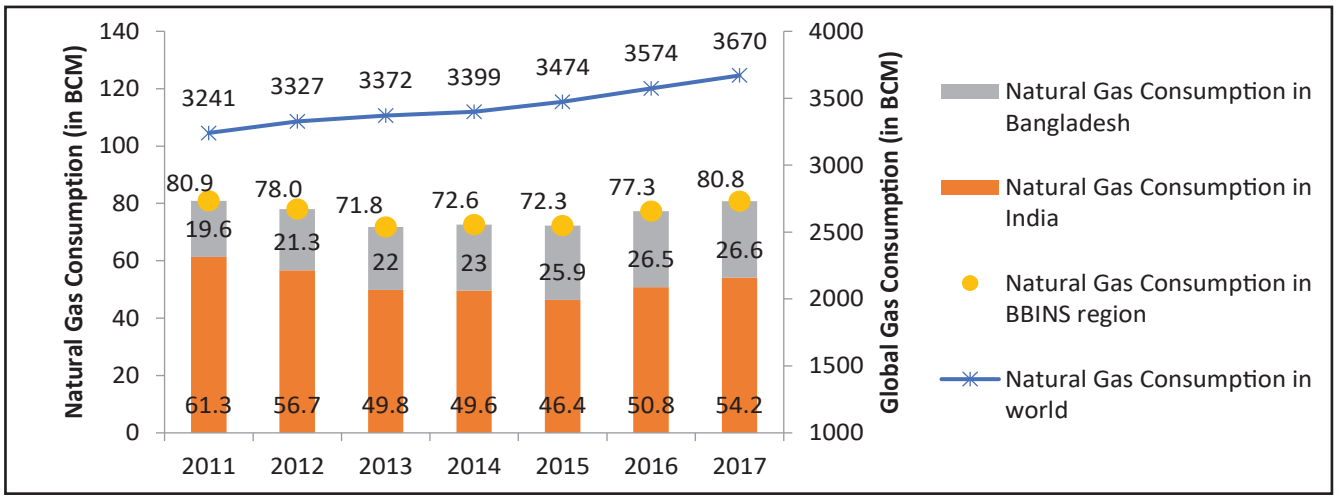


[10] *Economic Survey 2016-17, Ministry of Finance, Nepal*

[11] *Public Consultation Document, National Policy on Natural Gas, Sri Lanka*

[12] *BP Statistical Review of World Energy, June 2018 and IRADe analysis*





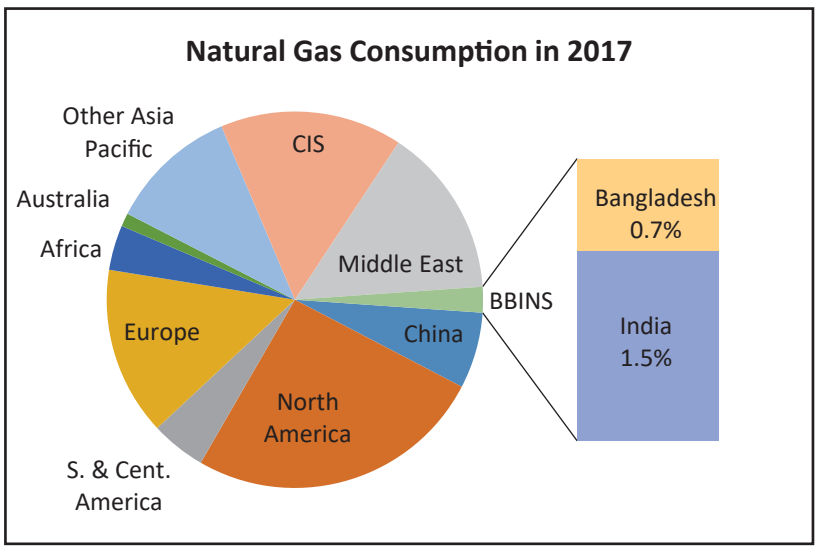
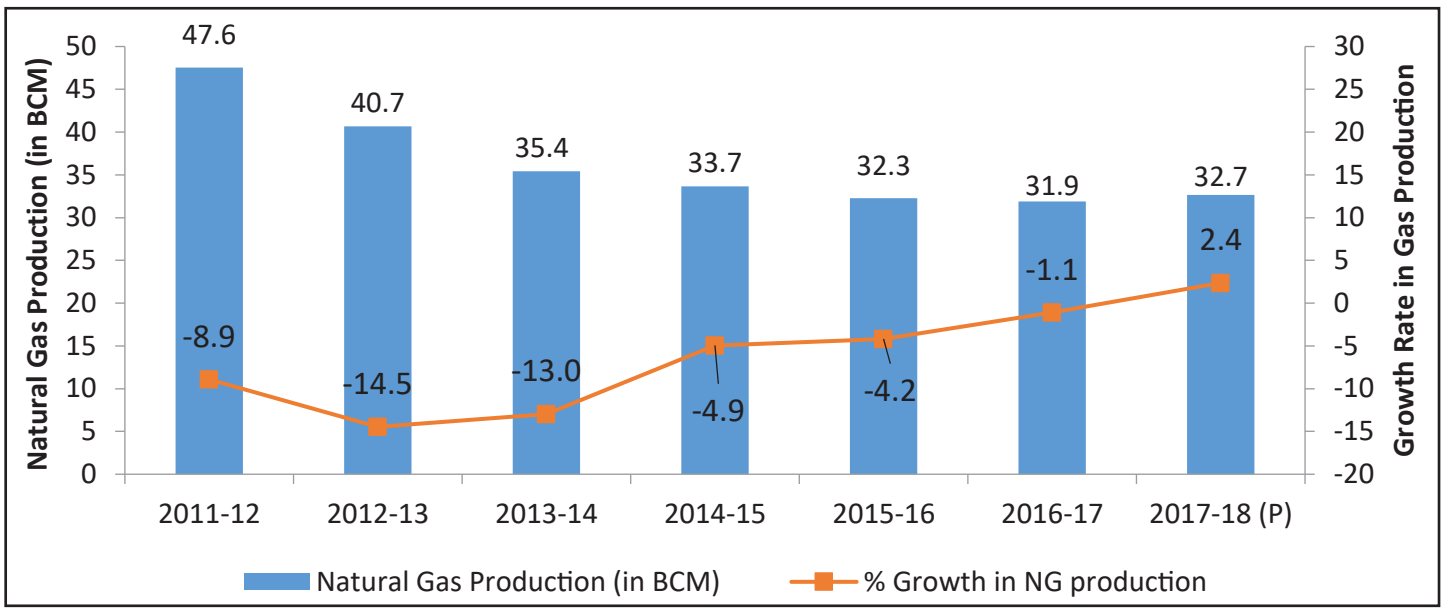


Figure 2.3 Trends in Natural Gas Consumption in 2017
(Source: BP Statistical Review of World Energy, June 2018 and IRADe analysis)

2.2.1 India

During FY 2017-18, domestic gas production in India stood at 32.6 BCM[13]. Domestic gas production has seen constant decline since FY 2011-12, due to ageing of fields and lower production from the Krishna Godavari Basin. However, a slight increase of 2.36% was seen in FY 2017-18 over 2016-17 due to increased production from onshore blocks. CBM (Coal Bed Methane) production played a major role in this increase. Figure 2.4 depicts the trends in Natural Gas production in India.

Figure 2.4 Trends in Natural Gas Production in India (Source: India Petroleum and Natural Gas Statistics 2017-18)



Currently, Natural Gas contributes approximately 7%[14] to India's energy mix. Gradual increase in consumption of the gas has been observed in India since FY 2016-17. The most substantial consumer within India is the fertilizer industry, consuming approximately 30% of the total Natural Gas. The industry enjoys priority supply of domestically produced gas. It is followed by the power generation sector, with 23% share of consumption[15]. Figure 2.5 shows the share of various sectors in Natural Gas consumption in India. In coming years, rapid urbanization and growing population is expected to boost gas consumption in City Natural Gas Distribution Network, registering highest growth in the sector. Of all the states in India, Gujarat is leading the Natural Gas revolution with its extensive infrastructure, accounting for 43%[16] of all the domestic connections in the country.

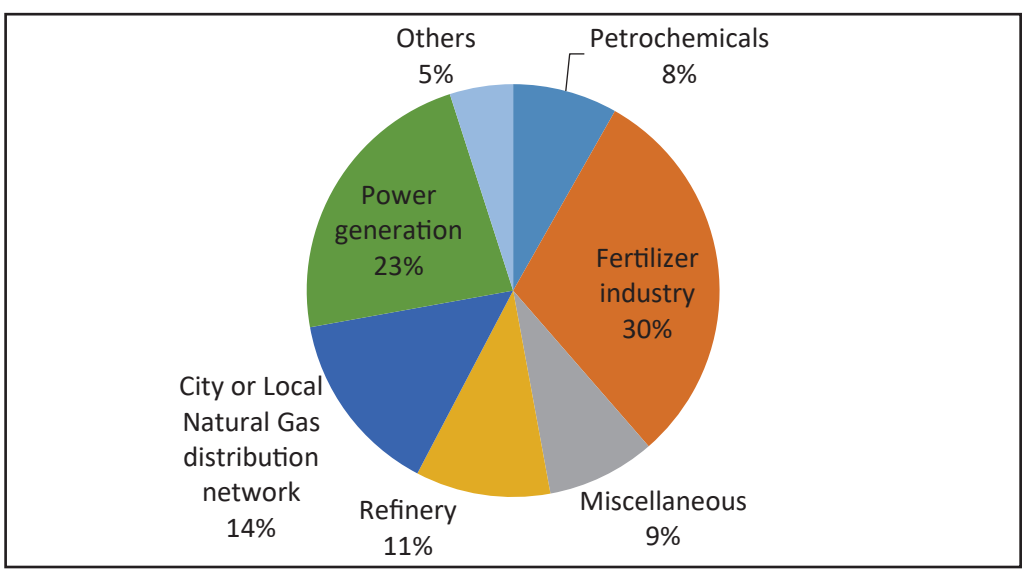
[13] *India's Hydrocarbon Outlook 2017-18.*

[14] *India Energy Statistics, 2018*

[15] *India Energy Statistics, 2018*

[16] *India Petroleum and Natural Gas Statistics 2017-18 and IRADe analysis.*

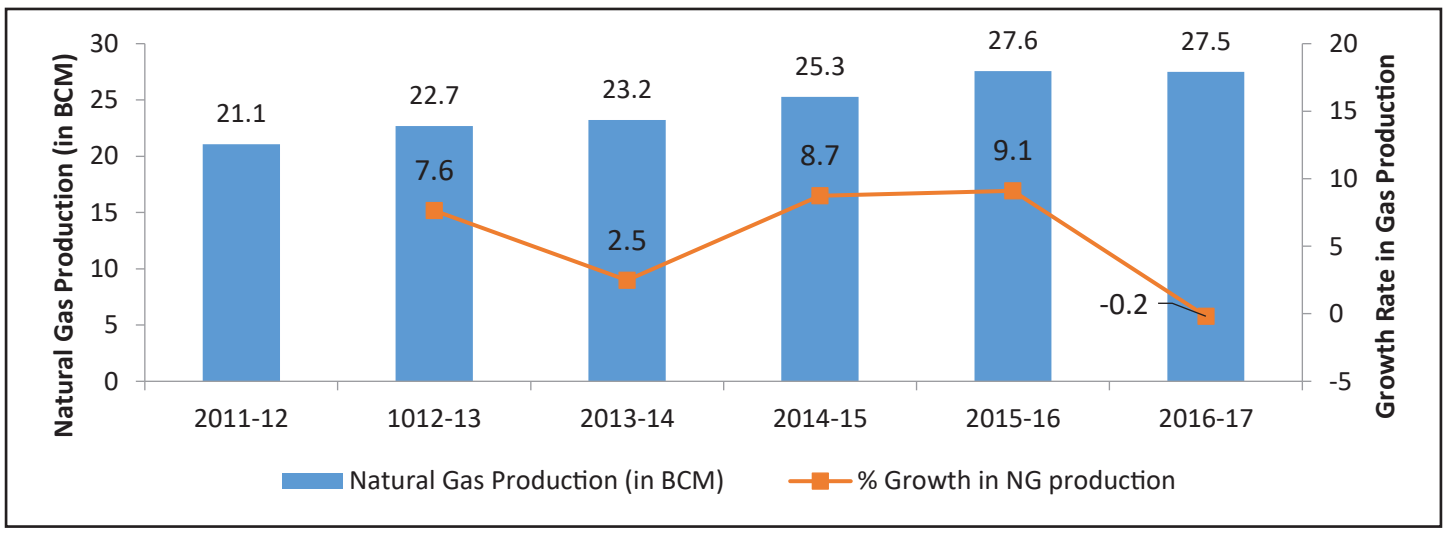
Figure 2.5 Industry-wise take-off of Natural Gas in India in 2016-17 (Source: India Energy Statistics 2018)



2.2.2 Bangladesh

Bangladesh produced 27.51 BCM[17] of Natural Gas in FY 2016-17. While the numbers had been constantly rising in the past, they are now flattening out, as shown in Figure 2.6. These are expected to further decrease in the future due to ageing of fields. The Reserve to Production ratio of Natural Gas in Bangladesh comes out to be approximately 12 years[18]. This number is worrisome and indicates urgent need for the country to find other sources to satiate their energy needs[19].

Figure 2.6 Trends in Natural Gas Production in Bangladesh (Source: Petrobangla Annual Report, 2017)



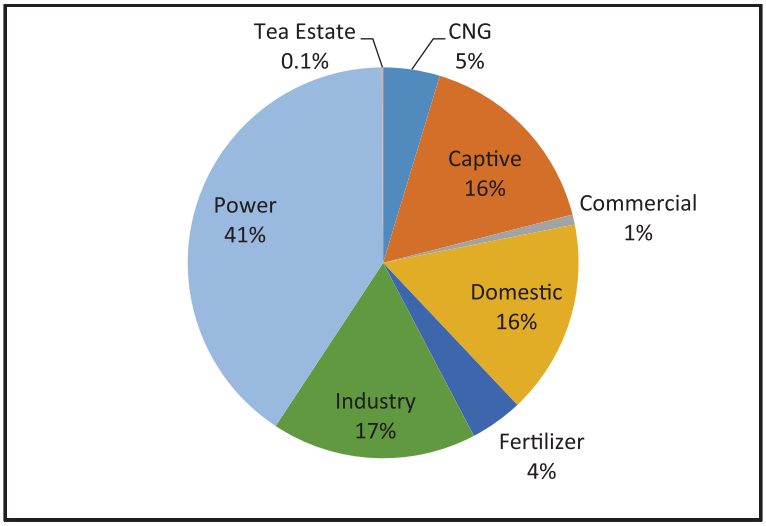
[17] *Petrobangla Annual Report, 2017.*

[18] *Petrobangla Annual Report, 2017 and IRADe analysis (Considering proven plus probable reserves).*

[19] *Bangladesh Power Sector Master Plan 2016*

The economy of Bangladesh is heavily reliant on Natural Gas. Power sector accounted for approximately 41%[20] of all Natural Gas consumed in FY 2017-18. Natural Gas contributed to 69%[21] of all the power generated in the country. Industries (20%), Captive Generation (16.4%) and Domestic sector (16%) were other major consumers of Natural Gas in FY 2017-18 in the country[22]. Figure 2.7 shows the share of different sectors in Natural Gas consumption in the country.

Figure 2.7 Industry-wise take-off of Natural Gas in Bangladesh in 2017-18 (Source: Petrobangla.org)



2.2.3 Sri Lanka

Although at present, consumption of Natural Gas in the country is nil, the country plans to develop gas based power plants in the near future to provide electricity to its citizens.

2.3 Gas Import Capacities- LNG

Limited reserves, high demand and lower production levels have forced the BBINS region to rely on imports to fill their gas demand and supply gap. Natural Gas has emerged as a viable alternative fuel as it is a cleaner fuel and will help in combating urban air pollution that plagues our cities. The region has an existing LNG capacity of approximately 50.02 mmtpa[23]. As of yet, only LNG capacities are operational in the region, there are no transnational pipelines operational in the region.

2.3.1 India

India has an existing LNG based capacity of 42.5 mmtpa[24]. Another 14 mmtpa is currently planned or under construction. All the existing capacities are in the form of land based LNG terminals, mostly situated on the western coast of the country, as can be seen in Figure 2.8. However, Jaigarh and Jafarabad LNG terminals are to be Floating Storage Regasification Units (FSRU).

[20] *Retrieved from: https://petrobangla.org.bd/?params=en/gasproductiondistributionpipeline/distribution/*
[21] *The Alternative Power and Energy Plan for Bangladesh, July 2017.*
[22] *Retrieved from: https://petrobangla.org.bd/?params=en/gasproductiondistributionpipeline/distribution/*
[23] *42.5 mmtpa for India and 7.52 mmtpa for Bangladesh*
[24] *As on 07/08/2019.*

Figure 2.8 Existing and Upcoming LNG terminals in India

As for the transnational pipelines in India to import Natural Gas, there have been discussions on TAPI (Turkmenistan-Afghanistan-Pakistan-India) pipeline and IPI (Iran-Pakistan-India) pipeline, but nothing has been materialized as of yet due to geo-political reasons.

2.3.2 Bangladesh

Bangladesh has also invested in Natural Gas import capacities to fill the supply and demand gap. The capacities are all FSRU based LNG terminals. At present, two such terminals have been commissioned, each with a capacity of 500 MMSCD[25] at Moheshkhali.

The Government of Bangladesh had planned four additional LNG terminals, which are currently shelved due to slower than expected demand growth, high costs and infrastructural constraints[26].

[25] *RupantaritaPrakritik Gas Company Limited (RPGCL) Annual Report 2017-18.*
[26] *Retrieved from: https://www.spglobal.com/platts/en/market-insights/latest- news/natural-gas/111418-bangladesh-shelves-another-lng-project-amid-infrastructure-constraints-low-demand*

Figure 2.9 Moheshkhali LNG terminal in Bangladesh

2.3.3 Nepal

Nepal intends to import Natural Gas from India for its fertilizer plants and industries. Possibilities are being explored for laying a gas pipeline between the two nations[27].

2.3.4 Sri Lanka

The Government of Sri Lanka has approved setting up of two LNG terminals to import Natural Gas. The first LNG terminal will be built by a joint venture of Petronet LNG Ltd, Mitsubishi and Sojitz Corp along with a Sri Lankan entity[28]. The terminal is to be set up at Kerewalapitiya near Colombo, with a proposed capacity of 2.6-2.7 MTPA[29]. The second terminal is planned to be set up at Hambantota by China Machinery Energy Corporation[30].

[27] *Retrieved from: https://energy.economictimes.indiatimes.com/news/oil-and-gas/india-nepal-discuss-possibilities-of-laying-pipelines-for-lpg-natural-gas/66002043*
[28] *Retrieved from: https://www.lngworldnews.com/sri-lanka-decides-on-lng-import-terminal/*
[29] *Retrieved from: https://economictimes.indiatimes.com/industry/energy/oil-gas/petronet-japanese-company-to-set-up-300-million-lng-terminal-in-sri-lanka/articleshow/62871145.cms*
[30] *Retrieved from: https://www.lngworldnews.com/sri-lanka-approves-chinese-led-lng-terminal-development/*

Figure 2.10 Proposed LNG terminals in Sri Lanka

2.4 Current Market Players

The Natural Gas industry is composed of three sectors- upstream, midstream and downstream.

2.4.1 Upstream sector

Upstream sector is the one that is responsible for Exploration and Production (E&P) activities.

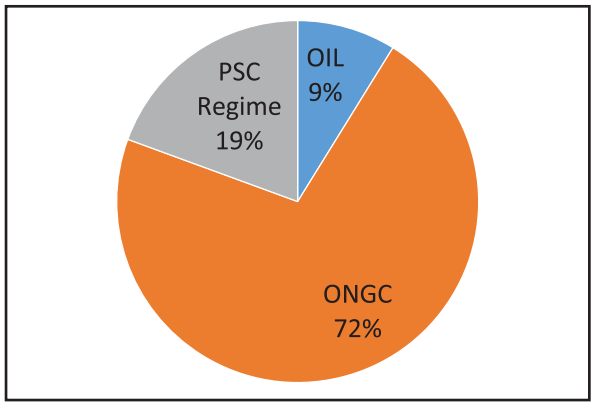
India, historically has favoured Public Sector Undertakings (PSU's) for upstream activities as is evident from the policies of Nomination era and Pre-NELP[31] era. This is reflected by higher share of PSU's (81%)[32] in Natural Gas production in India. The two major PSU's involved in E&P activities are Oil and Natural Gas Corporation Ltd. (ONGC) and Oil India Ltd. (OIL). Figure 2.11 depicts the share of different entities in Natural Gas production in India in 2017-18.

With the advent of New Exploration Licensing Policy (NELP) in 1997-98, the sector saw complete deregulation, thereby garnering the interest of private entities in the sector. This introduced PSC (Production Sharing Contract) regime in the sector. Currently, PSC regime accounts for only 19%[33] share in production of Natural Gas. Nevertheless, this share is expected to increase in future as the PSC regime has largest share (49%)[34] in balance recoverable reserves of Natural Gas. Major private sector companies active in the sector are Reliance Industries Limited (RIL), Cairn Energy, Focus Energy etc.

Indian PSUs i.e. OIL and ONGC Videsh Limited (OVL) have also expanded their reach to international markets like Colombia, Bangladesh and Russia etc. by acquiring stakes in fields on PSC basis.

[31] *NELP stands for New Exploration Licensing Policy*
[32] *India Petroleum and Natural Gas Statistics 2017-18.*
[33] *India Petroleum and Natural Gas Statistics 2017-18.*
[34] *India Petroleum and Natural Gas Statistics 2017-18.*

Figure 2.11 Share of entities in Natural Gas Production in India in 2017-18 (Source: India Petroleum and Natural Gas Statistics 2017-18)



Upstream sector in Bangladesh is dominated by International Oil Companies (IOCs) on PSC basis. During FY 2016-17, around 60%[35] production of Natural Gas in Bangladesh came from Chevron Bangladesh Limited and Tullow Bangladesh Limited. Rest 40%[36] came from public sector companies namely Bangladesh Gas Fields Company Ltd. (BGFCL), Sylhet Gas Fields Ltd. (SGFL) and Bangladesh Petroleum Exploration and Production Company Limited (BAPEX). PSCs have been signed with OIL, OVL, Santos and Kris Energy for exploration activities in 2012.

2.4.2 Midstream and Downstream Sector

Midstream and downstream companies in the gas industry are not clearly segregated, generally operating in both. Midstream and Downstream activities include processing of the fuel (includes activities like liquefaction of gas and re-gasification of LNG), transportation, and retail selling. Major midstream and downstream companies in the India and Bangladesh are listed in Table 2.1.

Table 2.1 Major Midstream and Downstream companies in India and Bangladesh

Country	Company
Bangladesh	Titas Gas Transmission and DistributionCompany Ltd. (TGTDCL)
	Bakhrabad Gas Distribution Company Ltd. (BGDCL)
	Jalalabad Gas Transmission and Distribution Company Ltd.
	Pashchimanchal Gas Company Limited (PGCL)
	Karnaphuli Gas Distribution Company Ltd. (KGDCL)
	Sundarban Gas Company Ltd.(SGCL)
	Gas Transmission Company Ltd. (GTCL)
	Rupantarika Prakritik Gas Company Ltd. (RPGCL)

[35] *Petrobangla Annual Report, 2017.*
[36] *Petrobangla Annual Report, 2017.*

Country	Company
India	Gas Authority of India Ltd. (GAIL)
	Petronet LNG Limited
	Indian Oil Corporation Limited (IOCL)
	Gujarat State Petroleum Corporation Ltd. (GSPC)
	Assam Gas Company Limited (AGCL)
	Duliajan Numaligarh Pipeline Ltd. (DNPL)
	Reliance Industries Ltd. (RIL)
	Oil and Natural Gas Corporation Ltd. (ONGC)
	Indraprastha Gas Limited
	Gujarat Gas Limited
	Mahanagar Gas Limited
	Adani Gas Limited

2.5 Future Demand Scenarios

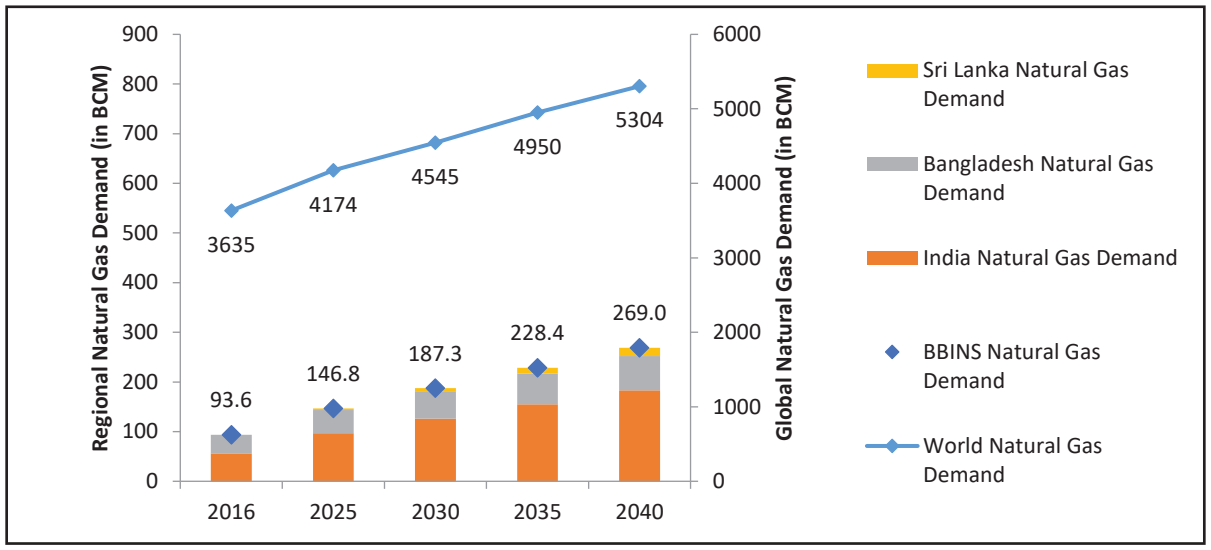
Limited recoverable Natural Gas reserves in the BBINS region has certainly affected the scope of the region to depend upon Natural Gas as a major fuel for the future. However certain advantages such as higher efficiency and lesser emissions over other fossil fuels contribute to increased demand projections in the region. These include the fact that this fuel is cleaner, more environment friendly and more efficient. Additionally, gas based power plants are highly flexible, i.e. it takes lesser time to start and stop. This flexibility allows gas fired power plants to be a great companion to renewable power.

In addition to this, BBINS region is composed of rapidly growing economies, which aim to increase their energy access over the coming years. Natural Gas may play an important role in achieving this aim.

Despite the fact that Bhutan and Nepal have not included Natural Gas in their future energy projections[37], the demand growth of the gas in BBINS region is projected to be higher than that of rest of the world. (as depicted in Figure 2.12).

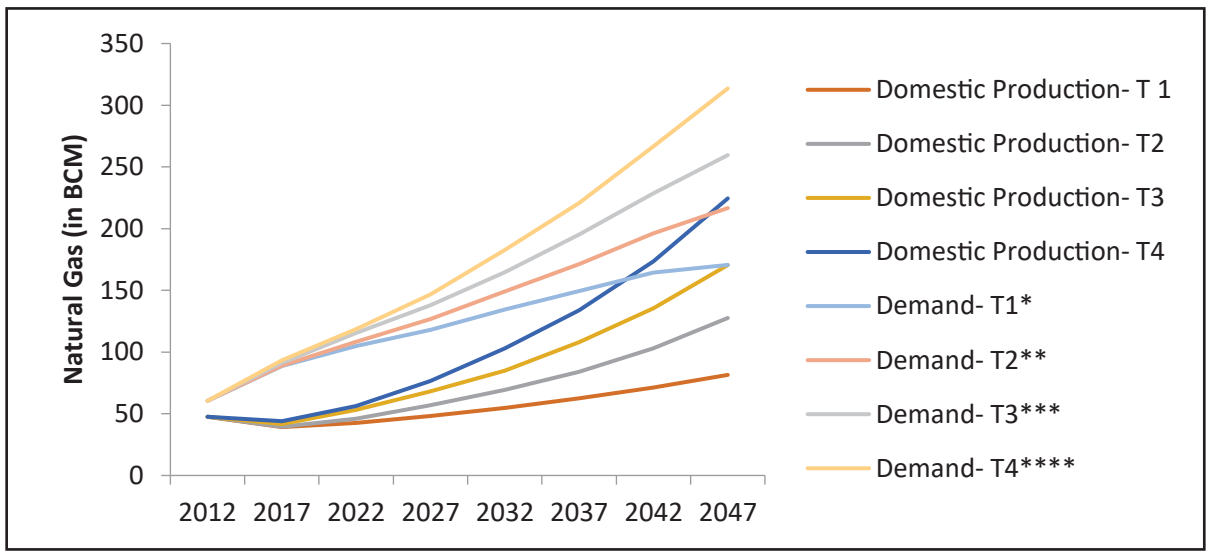
[37] *Nepal Energy Sector Assessment, Strategy and Roadmap, March 2017 and Bhutan Energy Data Directory, 2015.*

Figure 2.12 Natural Gas Demand Projections (Source: Outlook for Natural Gas, International Energy Agency 2018; Phase 1- Initial Natural Gas Utilization Road Map, Sri Lanka, October 2014 and Gas Sector Master Plan Bangladesh, 2017 and IRADe analysis[38])



For India, demand for Natural Gas is projected to more than triple between 2012 and 2042. Figure 2.13 show projections of Natural Gas demand and domestic production. Increasing population, rapid urbanization and high GDP growth rate are some of the factors contributing to this boom. Industrialization and increase in share of manufacturing will also augment the cause of increased Natural gas consumption in India. However, this increased demand also entails to increased imports for India. Import dependence for Natural Gas, which was 21% in 2012, is projected to increase to 47% and 41% in 2042 and 2047 respectively[39].

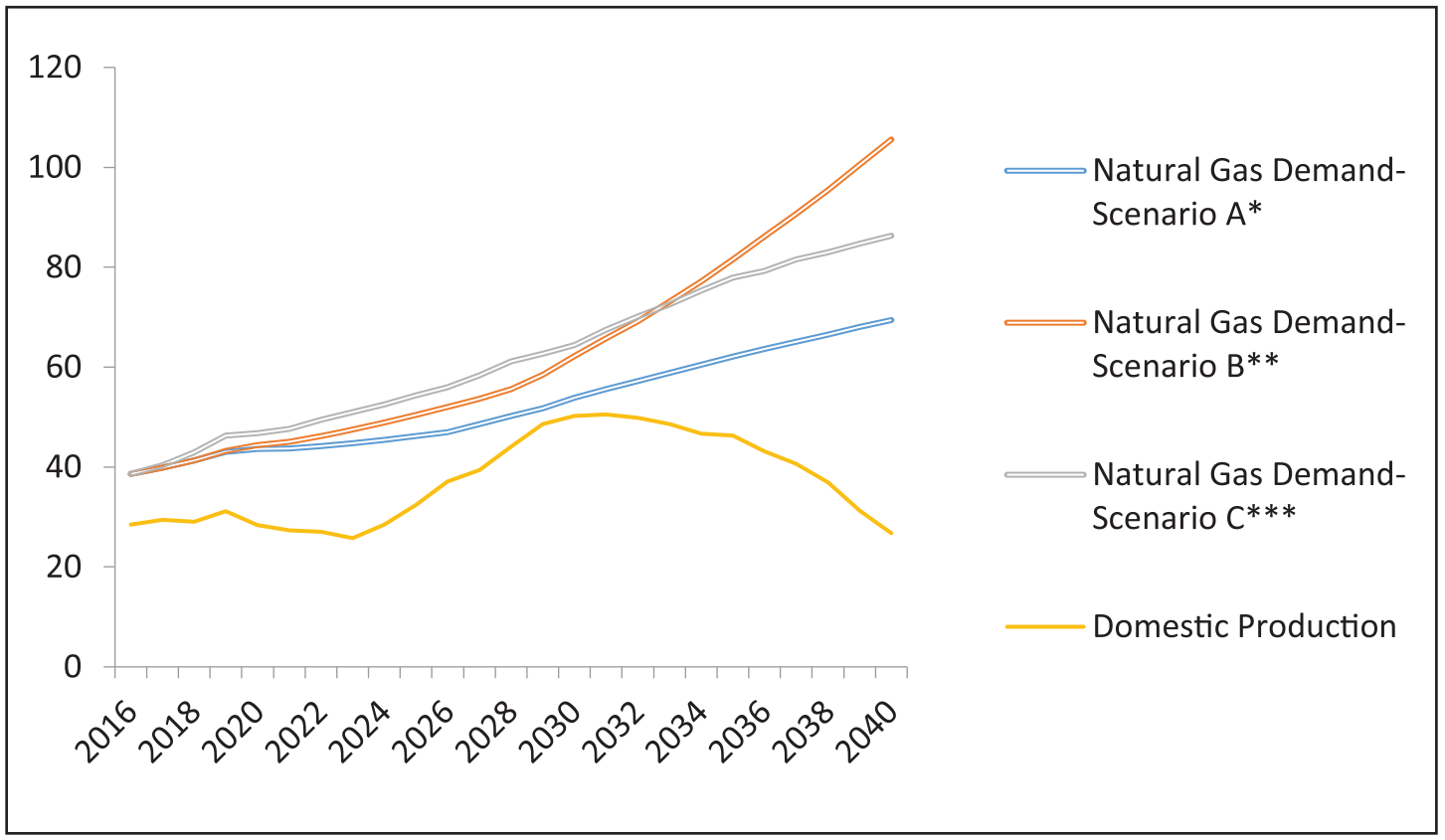
Figure 2.13 Natural Gas Demand Projections in India (Source: IESS v2.2)



[38] World Natural Gas Demand and India's Natural Gas Demand figures taken from IEA Outlook of Natural Gas, 2018 in new policy scenario. Bangladesh Natural Gas Demand figures taken from GSMP Bangladesh 2017 in scenario A and Sri Lanka's Natural Gas Demand figures taken from Phase 1- Initial Natural Gas Utilization Road Map, Sri Lanka, October 2014 in Scenario NG-1.
[39] IESS v2.2 and IRADe analysis (Considering trajectory 2).

In Bangladesh, where Natural Gas is a primary fuel, expanding population and growing economy will be the major drivers for gas demand growth. Increasing electrification in rural areas and escalating standards of living in urban areas will contribute to this demand growth. In contrast, domestic production of gas in the country is expected to diminish after 2030, resulting in huge roadblock for the growing energy requirement of the country. Figure 2.14 depicts domestic gas production and demand in various scenarios.

Figure 2.14 Natural Gas Demand Projections in Bangladesh (Source: Gas Sector Master Plan Bangladesh, 2017)



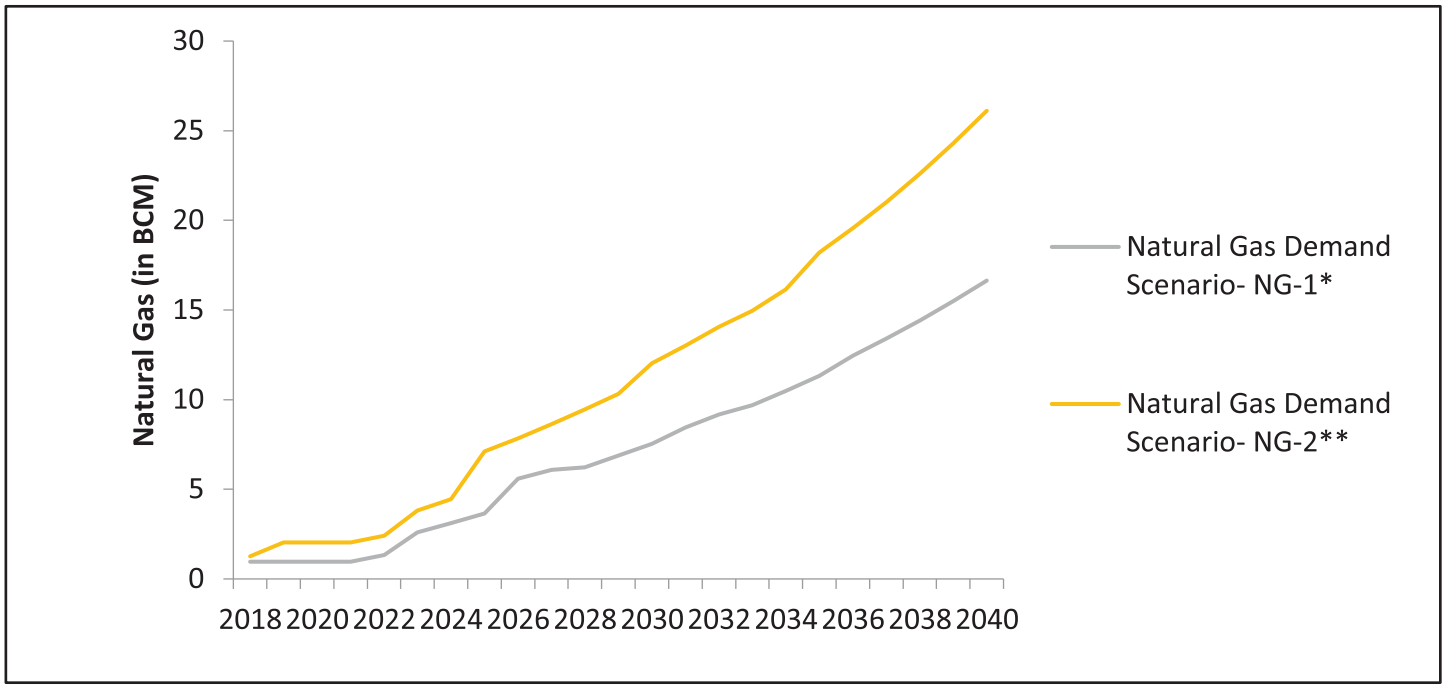
** Scenario A assumes GDP growth rate of 8% till 2020 which gradually declines to 4.3% in 2041.*

***Scenario B is high growth scenario, with GDP growth rate declining to 7% by 2041.*

****Scenario C is climate change scenario with lesser focus on coal power plants and more focus on other sources of energy.*

In Sri Lanka, even though commercial production of domestic gas and LNG imports have not started yet, the demand projections as shown in Figure 2.15 give the impression that the country is keen to include Natural Gas as a major energy source in its energy mix.

Figure 2.15 Natural Gas Demand Projections in Sri Lanka (Source: Phase 1- Initial Natural Gas Utilization Road Map, Sri Lanka, October 2014)



** NG-1 scenario assumes low penetration of gas with CCGT[40] power plants to be converted first.*

***NG-2 scenario assumes high penetration of gas with coal power plants being replaced, and double the penetration of gas in other sectors as against NG-1 scenario.*

From the various scenarios, it is estimated that the demand for Natural Gas in the BBINS region would be around 187 BCM to 255 BCM by 2030.

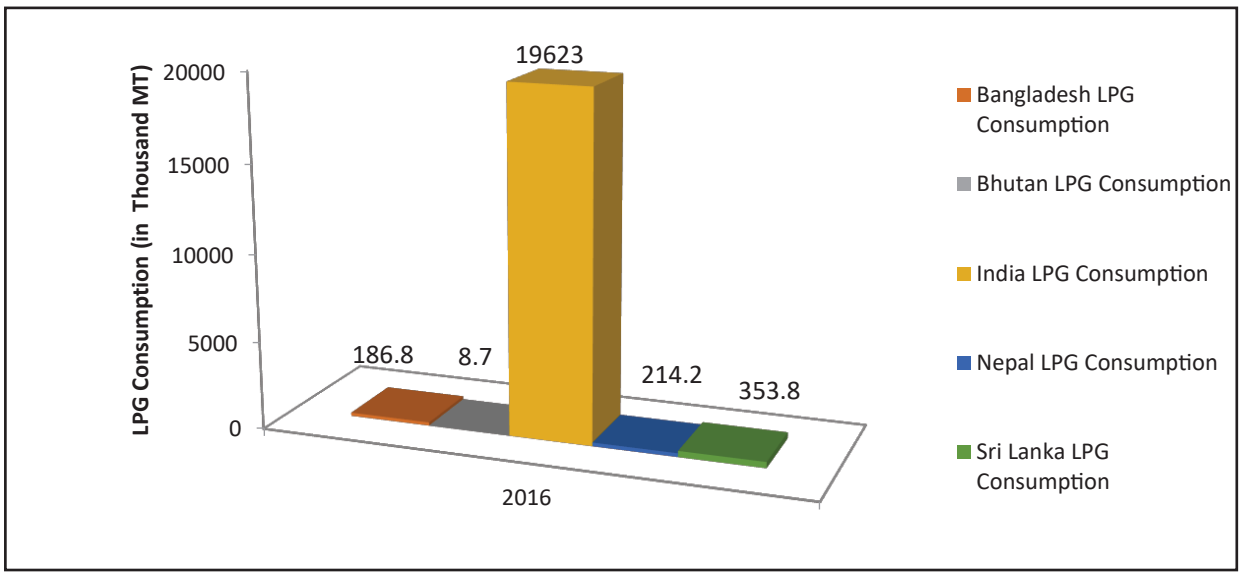
2.6 Natural Gas vs. Liquefied Petroleum Gas (LPG)

The basic constituent of Natural Gas is methane and that of LPG is propane, butane and iso-butane. These two are major competitors for cooking gas in the domestic sector. LPG is supplied through cylinders, whereas Natural gas is supplied as PNG (Piped Natural Gas).

Not only is PNG more convenient than LPG, it is also safer in cases of leaks due to its high dispersion rate. Thus, it seems wise to transition towards PNG instead of LPG. The consumption pattern of LPG in the BBINS region is shown in Figure 2.16.

[40] *CCGT stand for Combined Cycle Gas Turbine*

Figure 2.16 LPG consumption trends in BBINS Region (Source: Energy Scenario Bangladesh 2017-18; Environmental Accounts Statistics 2018, Bhutan; Nepal Oil Corporation Limited; Petroleum Planning and Analysis Cell, GoI; Monthly Bulletin April 2018, Central Bank of Sri Lanka; factfish.com[41] and IRADe analysis)



2.7 Unconventional Gas Potentials

Unconventional Gas resources typically include Coal Bed Methane (CBM), Shale Gas and Gas hydrates etc. The South-Asian region has some prospective shale formations, but they are mostly limited to India and Pakistan. These include Krishna-Godavari Basin, Cauvery Basin, Cambay Basin, Assam Basin and Indus Basin etc.

2.7.1 Shale Gas

The Government of India has approved policy framework for exploration and exploitation of unconventional hydrocarbons to unlock the potential of these resources in existing contract areas. Presently, ONGC and OIL have initiated exploration of Shale Gas. ONGC has drilled five exclusive Shale Gas wells OIL has drilled one well[42]. Other BBINS members i.e. Bangladesh, Bhutan, Nepal and Sri Lanka do not have any prospective Shale Gas reserves.

2.7.2 Coal Bed Methane (CBM)

India is rich in coal reserves and thus the prospects for CBM are bright in the country. India has prognosticated CBM resources amounting to 92 TCF in 12 states of India. In fact, as of March 2018, commercial production of CBM is done from 3 blocks – Raniganj (South), Raniganj (East) and Sohagpur (West)[43]. Bangladesh initiated exploration of CBM in January 2016 from their largest coal deposits in Jamalganj[44], though the results have not been satisfactory till now. No known attempts have been made by Bhutan and Nepal to explore their CBM potential. Sri Lanka, in turn, has no known coal reserves.

[41] Sri Lanka's LPG Consumption was calculated by adding local production of LPG and imports.
[42] India's Hydrocarbon Outlook 2017-18.
[43] India's Hydrocarbon Outlook 2017-18.
[44] Retrieved from: http://energybangla.com/start-exploration-of-coal-bed-methane-from-bangladesh/

2.7.3 Gas Hydrates

Gas hydrates are a promising source of Natural Gas for countries with oceanic boundaries. Production of gas from gas hydrates is in the R&D phase all over the world. In India, the presence of gas hydrates is established in Krishna Godavari, Mahanadi and Andaman Basins[45]. Exploration and production activities are being carrying out under the National Gas Hydrate Program (NGHP), but the production is still in R&D phase. To best of our knowledge, no source of gas hydrates has been identified in Bangladesh and Sri Lanka.

2.8 Pricing regime

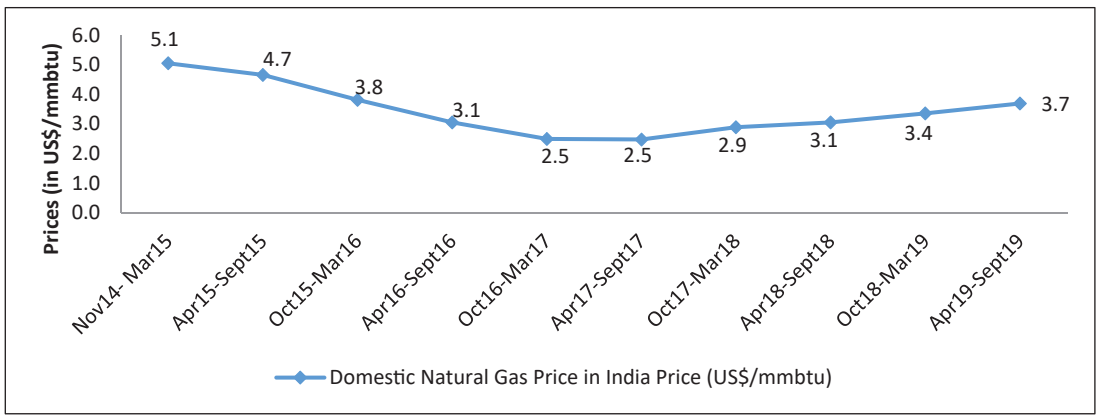
Natural Gas Pricing Regime varies widely in the BBINS countries. While the prices are completely regulated by the government in Bangladesh, India has set up a mechanism to determine the prices of domestically produced gas, which is linked to international prices and updated every six months[46].

In India, as per the "New Domestic Gas Pricing Guidelines, 2014", domestic gas price is calculated based on a formula considering the volume and prices prevailing at major international market hubs - Henry Hub (USA), National Balancing Point (UK), Alberta Hub (Canada) and Russia. The price of domestic gas for April 2019 to September 2019 was US$ 3.69/MMBTU on GCV basis. The price is renewed every six months . With new guidelines, distinction between Administrative Price Mechanism (APM) pricing and non-APM pricing has been removed and there is uniform price for domestic gas.

In addition to this, Government of India (GoI) has also introduced marketing including pricing freedom on gas produced from discoveries in Deepwater, Ultra-Deepwater and High Pressure-High Temperature areas that is to be capped by a gas-ceiling price. The gas price ceiling is based on landed price of alternative fuels[47]. The gas price ceiling for April 2019 to September 2019 was US$ 9.32/MMBTU on GCV basis[48].

For imported LNG prices, GoI has no interference and the buyer can negotiate prices with the exporter directly. Distribution of domestic gas is done on priority basis, with the priority sectors being CGD, Power, Fertilizer etc[49].

Figure 2.17 Domestic Natural Gas Prices in India (Source: Petroleum Planning and Analysis Cell and IRADe analysis)



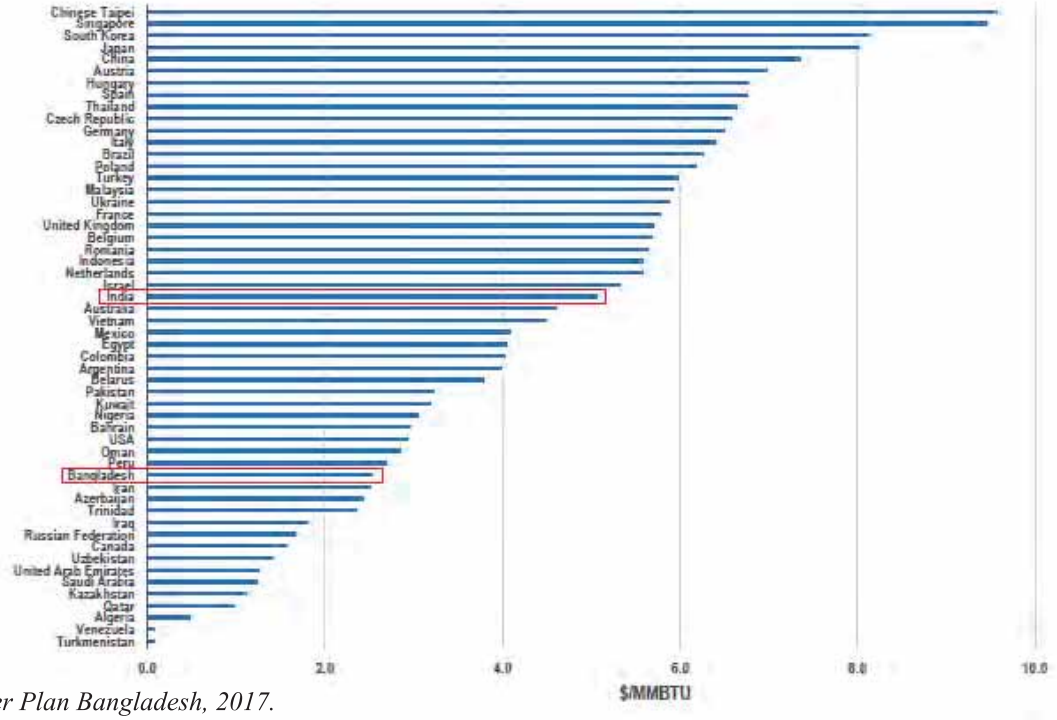
[45] *India's Hydrocarbon Outlook 2017-18.*
[46] *Petroleum Planning and Analysis Cell, India.*
[47] *Ministry of Petroleum and Natural Gas, Government of India.*
[48] *Petroleum Planning and Analysis Cell, India*
[49] *Order of priority as given in the text.*

Bangladesh has set up Bangladesh Energy Regulatory Commission (BERC) to regulate downstream gas tariffs. Though Gas companies can request tariff revisions, the final decision lies in the hands of BERC. Differential pricing regime is followed in the country, wherein sectors such as CNG, commercial, industry and captive power pay much more as against power stations and fertilizers[50].

Table 2.2 Natural Gas Tariffs in Bangladesh (Source: Gas Sector Master Plan Bangladesh, 2017)

Sector	Price (US$/**mmbtu**)[51]
Power	1.43
Fertilizer	1.23
Industry	3.53
Commercial	7.74
Tea estate	3.37
Captive power	4.37
CNG	18.15
Residential (metered)	5.08
Residential (unmetered)	Monthly payment per burner (US$)
Single burner	11.67
Double burner	12.32

Figure 2.18 Wholesale gas prices by country 2017 (Source: IGU: Wholesale Gas Price Survey 2018 Edition, June 2018)



[50] *Gas Sector Master Plan Bangladesh, 2017.*
[51] *1Mcf = 1.037 mmbtu*

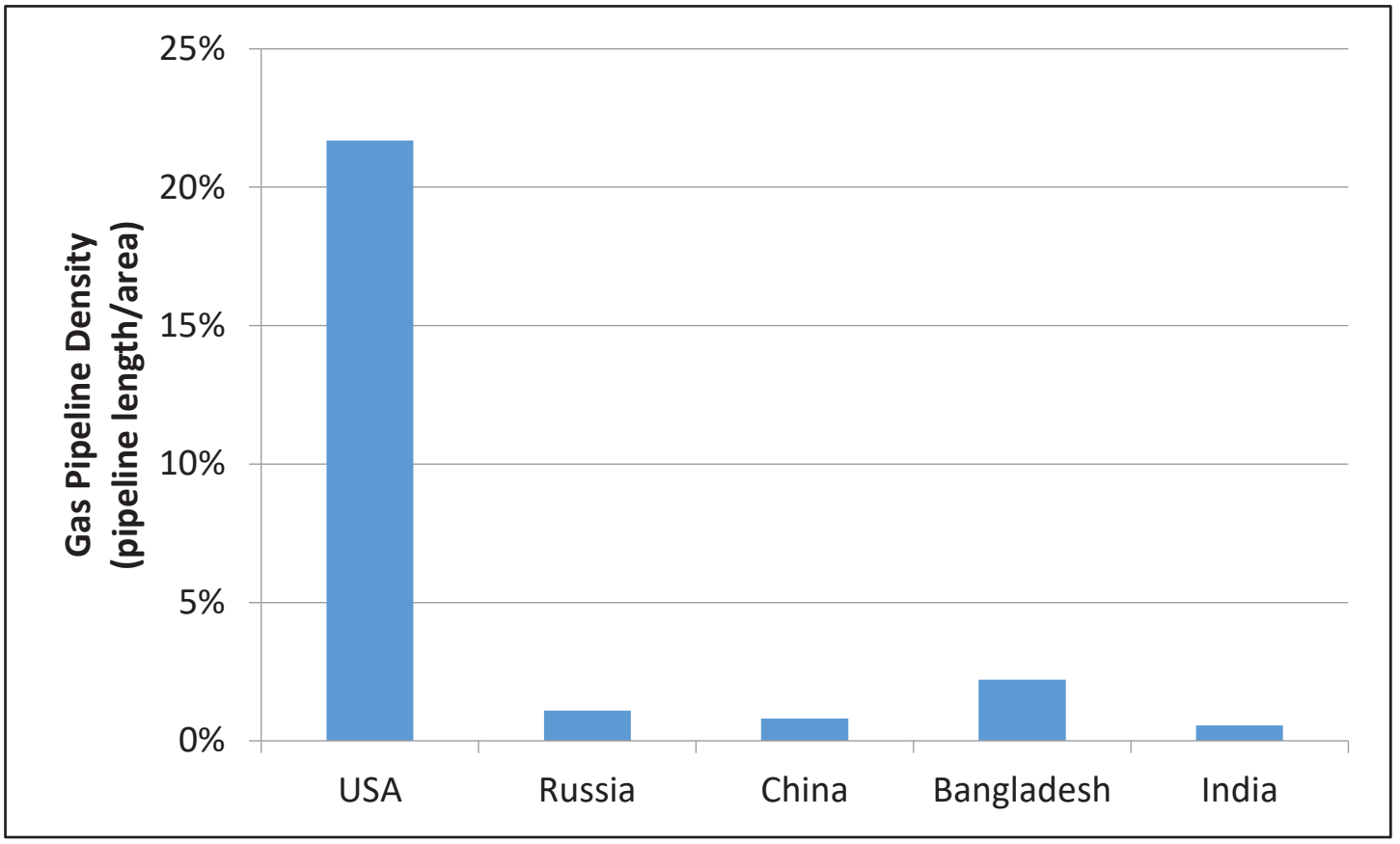
While Indian gas prices are moderately located in the world chart shown in Figure 2.18, those for Bangladesh lie in the lower spectrum. In case of the latter, this is due to complete regulation of prices and heavy subsidies by the government. In order to ease the load on the government and profitability of the sector, bold steps regarding pricing reforms may be required.

2.9 Bottlenecks and Challenges

The primary challenge for the sector is the limited domestic availability of the fuel in the region. The prospect of increased import dependence has generated reluctance among the BBINS members, despite countries like Japan and Germany being heavily dependent on imported gas.

Increasing capacities intend to increase the share of Natural Gas in the energy mix of India, though numerous bottlenecks exist. Absence of a centralized gas network planning is quite visible. Further, there exists a mismatch between the supply infrastructure, pipelines and customer's demand. The Kochi terminal is ready but the pipelines from the terminal is not, leading to underutilization of the terminal and economic losses. Similarly, Reliance India Limited's East-West pipeline is ready, but there is no gas at the supply end. Pipeline density in India is very low, as can be seen in Figure 2.19, thus hindering effective distribution of gas in the country.

Figure 2.19 Gas Pipeline Density of different countries (Source: The World Factbook, CIA; world.bymap.org and IRADe analysis)[52]



[52] *The length of gas pipeline is taken from The World Factbook, CIA and Land Area of countries from world.bymap.org*

Numerous practical problems such as difficulty in land acquisition for laying of pipelines and difficult terrain, lack of consensus between the centre and state governments, hinder the pace of infrastructural development.

Availability of domestic coal also possesses a threat to the gas market, especially in India, which holds the fifth largest reserves of coal in the world. The utilization of domestic coal is much cheaper than that of Natural Gas, making gas fired power plants and steel plants unviable. Consequently, many of the gas power plants are of capacity around 8,000 MW now stranded.

Unavailability of gas to power plants and their underutilization further increase the cost of electricity produced from them.

In Bangladesh, majority of the gas fired power plants are old and inefficient. Moreover, they are underutilized due to unavailability of gas, further decreasing the efficiency of plants and increasing the costs of power generated. Import capacities have been installed in recent years to address this demand. However, whether the imported gas will be able to fill the demand and supply gap is still questionable.

The country is rapidly growing in terms of both population and GDP, and thus has seen increased demand for gas. With production in older fields declining, there is a need to develop new fields. Although efforts have been made, IOCs have shown limited interest in the matter[53].

As for Sri Lanka, although development of a Natural Gas market in the country has been initiated, the major challenge for the country remains its lack of experience in the sector. A careful planning and implementation is thus required for a smooth transition towards Natural Gas.

2.10 Conclusion

Comprising rapidly developing economies, the BBINS region is striving hard to achieve energy security. Natural Gas is a potential alternative that can be instrumental in achieving this goal due to its advantages over other conventional fuels. While gas is the primary fuel in Bangladesh, other BBINS members are less dependent on this resource. In fact, Nepal and Bhutan do not have any contribution of gas in their present energy mix.

Though future scenarios project an increasing demand for Natural Gas in the region, the domestic production wouldn't suffice to fulfil it. Thus, imports would have to be stepped up to meet this demand.

In the BBINS region, import through pipelines is not feasible due to geopolitical issues. Any pipeline reaching India has to pass through Pakistan, Afghanistan or China. Since China has high energy requirement for itself pipeline cannot come through that route. In case of Pakistan and Afghanistan, there are security issues which hinder the successful commissioning of a gas pipeline. LNG trade thus presents great potential for the region.

Varied problems affect the gas market in the BBINS region. Thus, region specific solutions will be required to develop gas as a major and reliable energy source in the region. In order to get constant supply and fair prices for the source, a mature market for natural gas has to be developed.

[53] *Gas Sector Master Plan Bangladesh, 2017.*

2.11 Way Forward

The report captures the role of Natural Gas in at the global and regional level. Going forward the role of Natural Gas in the BBINS region is going to be undeniably crucial. To deal with the regional level Natural Gas potential, status and issues of Natural Gas value chain, this study will be expanded at country level. The country level study of BBINS region will capture the following:

- Different energy sources available in each country of the BBINS Region and potential for energy consumption based on demographics, GDP Growth and energy environment, bringing out the role of Gas /RLNG.
- Complete value chain and the future investments in each country in the RLNG and downstream infrastructure.
- Mapping the projections of production of conventional and Non-conventional gas in each of the country.
- Gas import capacities including current re-gasification capacity and the future capacities to be added (including FSRU).
- Capacity utilization index of the existing gas pipelines including the current state of ongoing pipeline projects and the planned ones. Providing the present status of pipeline connectivity and accessibility to the consumers in each country.
- Aspects of long-term pricing for contracted RLNG including the terms and conditions of international contracts, contractual risks and their likely mitigations.
- Availability of 'Spot' cargoes and its impact on bridging the demand, taking into account the relevant regulations related to tariff structure for gas in each country.
- The value proposition about the Gas 'Hubs' as well as trends and the drivers towards delinking crude-linked pricing for the region.
- Relative pricing of prevailing energy substitutes for different sectors in each country and feasibility of using gas in different sectors. Highlighting sector-wise bottlenecks and challenges for realization of expected potential in each country.
- Economic potential of gas-turbine based power as balancing power for intermittent type of renewable energy, i.e. wind and solar generation, considering alternatives such as energy storage devices for the same use.
- Policies for promoting cross border trade for gas and gas based products in the region (including electricity, fertilizers, petrochemicals etc.).

Recent Update

With PM Modi's latest visit to USA in September 2019, an LNG trade trade deal was signed between india's Petronet LNG ltd. and Houston's Tellurian inc.

As per the report of Houston Chronicles, Petronet obtained import rights of 5 mmtpa of natural gas per year in exchange of an investment of $2.5 billion in tellurian's proposed driftwood LNG export terminal.

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For more information on the South Asia Regional Initiative for Energy Integration (SARI/EI) program, please visit the project website:

www.sari-energy.org