SHALE GAS IN INDIA: CHALLENGES AND PROSPECTS

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Energy Sector Overview

India is the third largest consumer of energy in the world after China and USA (Source: BP Statistical Review, 2016), but it is not endowed with abundant energy resources. High reliance on imported energy imperils fiscal stability given volatile energy prices, and also impinges adversely on energy security. Meeting the energy needs of achieving 8%-9% economic growth as also meeting the energy requirements of the population at affordable prices, therefore, presents a major challenge. It calls for a sustained effort at increasing energy efficiency to contain the growth in demand for energy while increasing domestic production as much as possible, to keep import dependence at a reasonable level.

The scope for containing the growth of demand for energy depends upon our ability to reduce the energy intensity of GDP taking account of both the need for energy as an input into production, and in direct final consumption in lighting/heating/cooling and transport. Energy intensity has special relevance in petroleum sector, as our import dependence is likely to rise from 73% in 2011-12 to more than 80% by the end of the 12th Plan (2016-17). This is accentuated by the fact that the use of petroleum products in several areas cannot be substituted by other fuels. Enhancing fuel efficiency of vehicles is vital for India, especially in Heavy Duty Vehicles (HDVs).

As India maintains its rate of economic growth, primary energy consumption is unlikely to abate. In the year 2015, the growth in the primary energy consumption in India over the previous year was 5.2 %, whereas China, US, Russia and Japan registered growth rates of 1.2%, -1.9%, -3.3%, and -1.2%, respectively. In petroleum, India registered nearly 11% growth rate in 2015, a historic high. It is expected that as has been the trend world over, the share of gas is likely to rise given increased availability and trade of gas and its environment friendly nature. As per International Energy Agency (IEA), if the industry abides by the ‘golden rules’ proposed by it, the share of gas in the global energy mix could rise from the present levels of 23% to 25% in 2035 overtaking coal (24%), to become the second largest primary energy source after oil (27%). This has even prompted IEA to suggest in a publication in 2012 that the world is entering a golden age of gas. The share of unconventional gas in natural gas could rise from 14% in 2010 to 32% by 2035. Consequently, the emergence of unconventional sources of gas, particularly shale gas, holds special relevance for India. Policy Planners are committed to evolving a conducive policy for harnessing modern technology in tapping this source of energy to augment domestic energy supply._

Global trends in Unconventional Gas Sources

Unconventional gas sources are the ones which exist in such reservoirs, that their production requires greater effort than the other kinds of sources. They also require specialized technology, depending on the nature of their presence in the specific situation. Traditionally, the following sources of gas have been categorized as un-conventional ones:

- Coal bed methane (CBM)
- Coal mine methane (CMM)
- Shale gas
- Tight gas

While the global gas demand is likely to go up by 50% between 2010 and 2035, one third of the above in the year 2035 is likely to come from unconventional sources. Internationally, unconventional gas has not played an important role in meeting the energy demand until some years back. The rapid rise in production of gas from shale in the US has led to renewed interest in unconventional gas sources globally. From virtually nil production in the year 2000 in US, shale gas production has reached a level of 23% in 2010 and is expected to comprise nearly half of total natural gas supply in 2035. This is likely to be supplemented by other unconventional gas sources, mainly coal bed methane and tight gas with all the unconventional gas sources to comprise 70% of total natural gas supply in US in the year 2035. The emergence of this new source of gas has already led to US becoming a net exporter of gas against being an importer. Barring shale gas, India has been familiar with all other sources of unconventional gas.

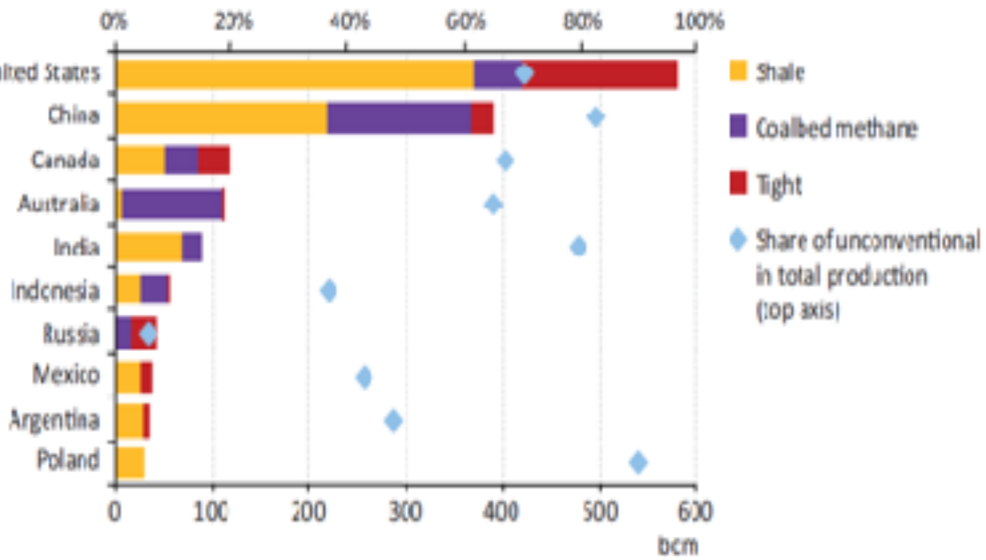
Throughout the world, different types of sedimentary rocks contain natural gas deposits, for example sandstones, limestones and shales. Sandstone rocks often have high permeability, which means that the tiny pores within the rock are well connected and gas can flow easily through the rock. In contrast, shale rocks where gas is trapped as a continuous accumulation throughout a large area usually have very low permeability, making gas production more complex and costly. The shale gas boom in recent years has been due to modern advancement in technology in hydraulic fracturing (fracking) to create extensive artificial fractures around well bores. Shale exists in sedimentary basins and typically forms about 80% of what a well will drill through. As a result, the main organic rich shales have already been identified in most regions of the world. Often, enough is known about the geological history to infer which shales are likely to contain gas or oil or a mixture of both. However, the potential zone within shale sequence, the amounts of gas present and what proportion of it that can be recovered technically and economically, cannot be known until a number of wells have been drilled and tested. The amount of condensate present in the gas can also vary considerably with important implications of economic production, as condensates command high price in energy markets.

Three factors have come together in recent years to make shale gas production economically viable:

- technological advances in horizontal drilling;
- hydraulic fracturing; and
- Increase in natural gas prices in the global market.

Horizontal drilling and hydraulic fracturing have dramatically improved daily production rates in USA and also increased the total ultimate recovery potential of individual wells to as high as 54%. The Figure 1 below provides the projected potential development of shale gas in the year 2035 in major countries:

Figure 1: Unconventional gas producers in 2035 (as per golden rule case of IEA)



According to the US Energy Information Administration (EIA), report, June 2013, the estimated world shale gas resources is 7576 trillion cubic feet (tcf) comprising of 48 countries across the world (as per updates in September, 2015 by EIA). In the Table-1 below (EIA Report, 2013 and update Sep, 2015) China leads the world in technically recoverable shale gas. US which was 2nd in order after China in terms of technically recoverable gas until last year has now slipped to 4th position.

Table 1: Leading Countries with Technically Recoverable Shale Gas Resources

Rank	Country	Technically recoverable Shale gas (trillion cubic feet)
1	China	1,115
2	Argentina	802
3	Algeria	707
4	U.S.A	623
5	Canada	573
6	Mexico	545
7	Australia	429
8	South Africa	390
9	Russia	285
10	Brazil	245
11	India	96
	World Total	**7576**

Chinese investments in joint ventures represent 20% of total foreign investment in U.S. shale plays. This has provided China with valuable expertise that can be applied to its own domestic production, helping to lower well development costs. In 2012, to encourage the exploration of shale gas, the Chinese government established a four-year, $1.80 per million British thermal units (MMBtu) subsidy program for any Chinese company reaching commercial production of shale gas. In mid-2015, these subsidies were extended to 2020, but at a lower rate.

Major challenges in shale gas exploitation – Global Experience

Exploitation of shale gas poses bigger challenge than other sources of gas. They are different from conventional gas sources, also because being completely onland, shale gas exploitation leaves greater footprints. Even technologically, producing this source is very challenging. Due to the tightness of the reservoirs, these require hydraulic fracturing horizontally to cover a large part of the reservoir and sometimes require multi-stage fracturing and frequent stimulation. The typical flow rates of a shale gas well is very high in the first 1-2 years, and then tapers to a much slow rate extended over many years. This requires drilling of a large number of wells leading to greater interface with the communities, environment and effort.

The various phases of the shale gas development, life cycle and their associated issues have been organized for assessment as follows:

- Drill Pad construction and Operation
- Hydraulic Fracturing and Flowback Water Management
- Groundwater Contamination
- Blowouts and House Explosions
- Water consumption and Supply
- Spill Management and Surface Water Protection
- Atmospheric Emissions
- Health Effects

The biggest apprehension in exploitation of shale gas is the hydraulic fracturing job wherein large amount of water mixed with fracturing fluids/proppants is injected at high pressure into the reservoirs. The horizontal drilling within the shale gas bearing zones has to be enabled to receive gas trapped in the horizontal shales. The use of sand/ceramic with high pressure water helps to fracture the shales and the resultant deposits of sand in the fractures, keeps the pores open for the gas to leak into the horizontal wells. A mixture of chemical is also used to give such properties to the fluid that are needed for fracturing. It is these sands and fractures which are apprehended from the point of view of contamination of aquifers which support life. If these fractures were to take place along a fault, they could result in shallower levels being affected, with resultant mixing of chemicals. Even the fear of gas escaping thorough these fractures and contaminating the ground water has been a cause of concern.

Apart from the main concern of water contamination, there are other multiple challenges while exploring and producing shale gas. A large amount of water, from few thousands to 20 thousand cubic metres per well is required for hydraulic fracturing. Local environmental challenges and issue of water availability and water disposal after fracturing jobs pose serious threats to the environment. Shale requires a vast land cover in comparison to conventional oil and gas, which is also a challenge especially for countries like India which have a heavy pressure on land. While one well in a conventional field may drain hydro carbons from an area of 10 sq. km and may require a 100 – 500 sq. km licensing area, those of shale may require many times over, as has been seen with Marcellus shale in US which covers over 25000 sq. km. Multi-stage fracturing (10-20 stages) may require from 1000 to 4000 tonnes per well of proppants. Such high injection in the wells has also been feared with earthquake risks. This has led to country concerns in approving shale exploitation, and as per one Report, has resulted in natural gas production in Germany to fall by about 6% in the past year. Controversy over shale gas and hydraulic fracturing is blocking conventional gas production as well. For more than 3 years, the ongoing discussion on shale gas has prevented projects from being approved that require the use of hydraulic fracturing even for conventional gas production.

In the light of the above, every country which embarks on shale gas exploitation regime must plan adequate regulatory regime and environmental standards to safeguard against any long term damage to the environment. Water being a scarce resource in India, particularly calls for strengthening of the local institutions in undertaking baseline studies, monitoring of water quality and water balance.

<u>Shale Gas Resource in India</u>

Having understood that shale rocks, which are the original source rock, have now also become a reservoir or a producing formation, it naturally follows that in every hydro carbon producing country, there is every likelihood of shales holding hydro carbons in varying degrees. It is interesting to note, that shales even in non-producing basins could be holding hydrocarbons, opening up a potential in not only the 7 producing sedimentary basins, but in all the 26 basins. It has already been mentioned earlier that the task before exploration and production companies is basically to visualize/learn geological properties of shales to be able to produce oil/gas from them

India, too, has a long experience of exploring and producing oil and gas from on-land sources, and the presence in-depth of shale rocks is largely known more in the 7 producing basins, basically due to the vast exploration already done in these basins. There are no firm estimates of Shale oil/gas in the country. Several agencies have provided different estimates as per Table-2.

Table-2: Estimates of shale gas for Indian sedimentary basins

1	M/s Schlumberger	300 to 2100 TCF
2	Energy Information Administration (EIA), USA (4 baisns- Cambay Onland, Damodar, Krishna Godavari Onland & Cauvery Onland),)	584 TCF
3	ONGC 6 basins	187.5 TCF
4	Central Mine Planning and Design Institute (CMPDIL) 6 sub basins	45 TCF
5	United States Geological Survey (USGS) in 3 basins	6.1 TCF

The US Geological Survey (USGS) has released a lower estimate of 6.1 tcf in 3 basins. As per published report of EIA, June 2013, the risked shale gas in-place is 584 tcf and the technically recoverable shale gas is about 96 tcf (Cambay, Krishna-Godavari, Cauvery, Damodar Valley, Upper Assam, Pranhita-Godawari, Rajasthan and Vindhyan basins). The vast difference in the estimates of the two US agencies has confused Indian administrators and is yet to be resolved. It may, however, be borne in mind that the two reports cannot be compared as USGS reports undiscovered gas resources, while US EIA reports total recoverable resources. The latter differs from undiscovered, by proven reserves and discovered - but - undeveloped resources. It may also be added that as in the case of unconventional gas, there is no real discovery process but merely an appraisal process, as a result, the difference between undiscovered, and discovered but not developed is blurred.

In India, the national oil companies had undertaken a large amount of on land exploration during the last several decades, which has now been supplemented both by them and private companies after the launch of the Production Sharing Contracts (PSC) regime. It is believed that they have drilled several thousand wells, particularly in Cambay, KG and Cauvery basins. These wells had yielded a wealth of data regarding the extent, depth and nature of shale formations in the different sedimentary basins. However, in most other on-land basins details of the shale deposits is yet to be fully ascertained. Even the cores of the wells may not have been preserved properly for an analysis of kerogen content. It is also well-known that under the New Exploration Licensing Regime (NELP) and pre-NELP contracts a large number of on-land wells have been drilled whose data is available with Directorate General of Hydrocarbons (DGH) for unhindered usage in promotion of the nation's acreage. This data has to be suitably scrutinized and a full picture developed on the prospectivity of shale gas in the country. We are also aware that the EPINET, the corporate data repository of ONGC (and similar one of Oil India Ltd.) has already hosted a large amount of data on their respective networks. The above data banks need to be networked with active involvement of the NOCs for the shale gas exploitation programme to be implemented on fast track basis.

The big issue of diversity of shale and key is finding the correct fracturing technique. Shale gas reservoirs are referred to as statistical plays, as many wells are needed to understand the play and assess the recoverable resource. Moreover, as unconventional gas has a higher cost of production per unit (due to lower overall recovery rate of less than 35-40% and high cost of well, some of the wells in US have recovery rates varying from 8% to 19%), the economic size of reserves is also an exercise of both technology and pricing. However, a challenge still remains as to how to assess shale deposits especially for the purpose of carving out of blocks for bidding programme.

Preparedness in India to mitigate shale gas challenges

As shale gas exploitation raises a large number of challenges which are specific to this resource due to specialized technological interventions, viz., hydraulic fracturing. These challenges begin from resource assessment, regulatory and environmental framework, availability of open land, water availability, seismic as well as encouraging shale gas regime. These also need to be seen in the light of the fact, that while shale gas success has been reported in the US, the landscape being vastly different in our country, the US practices cannot be directly replicated. However, we already have a successful policy of exploiting an unconventional gas resource, viz., CBM, which provides us enough experience in this area.

The starting point of addressing the shale gas challenge is interpreting the statutory framework and the existing policy for exploration of oil and gas, to find out as to applicability of the regime on shale gas. It may be noted that under the Oil Field Regulation and Development Act, 1948 and Petroleum and Natural Gas Rules, 1959 the definition of natural gas includes all ‘naturally’ occurring gas. It was due to this statutory interpretation that coal bed methane, which is a naturally occurring gas, came in the domain of MoPNG and not Ministry of Coal. Even when offering oil and gas blocks under NELP, it was perhaps acknowledged that CBM would also get covered under the NELP PSC. As a separate regime was being proposed for CBM, the production sharing contracts of NELP specifically excluded coal bed methane out of the PSC. In 2013, the Government allowed public sector oil companies to explore and produce shale gas from their blocks under the nomination regime - the blocks which were given to companies such as ONGC and OIL before the launch of the NELP. However, in the case of competitively awarded NELP blocks, the contractors have to abide by the exploration related contractual provisions, particularly those related to exploration phases. If the blocks have moved out of exploration phase, then they cannot initiate exploration of shale gas. In the recently approved Hydrocarbons Exploration Licensing Policy (HELP), a unified exploration license will be granted which will allow exploration of hydrocarbons, which is a significant improvement over the earlier regime.

The second major challenge relates to availability of land and water. It is well known in US, private land owners, State Governments and the Federal Government have full ownership of minerals vested in respective lands. The situation being different in India, while on one hand it is easy for the Union Government to authorize shale gas exploitation by grant of a license at its level, the disincentive to the occupier of the land becomes a stumbling block. The encouragement given by the land owners in USA to oil and gas companies in shale gas operations due to monetary incentives reaped by the land owners gave a big push to this programme. Nevertheless, the vast population cover and agricultural pursuit in the Indian condition will pose a challenge to shale gas exploitation. The same will be true for availability and supply of water. In this regard a way forward would be as adopted in the Sichuan Basin of China, where they took up that region first, which was rich and closer to water resources. On the issue of water contamination and injection of hydraulic fluids as well as any other area of environment, a significant distinction needs to be appreciated between India and the West. In the US, federal laws are aimed at environment protection, and they allow states to promulgate additional regulations. Most oil and gas specific Acts/regulations are left to States with regulatory bodies being responsible for licensing and enforcing regulations specific to oil and gas production as well as environmental loss. E&P regulation primarily encompasses well fencing, standard procedures in well construction, hydraulic fracturing, waste handling and well blocking as well as chemicals and water spills. These regulations along with federal environment regulations provide a comprehensive statutory and regulatory framework. Along with the above, industry bodies like the American Petroleum Institute (API) have also developed shale specific operating standards. Therefore, in India, while developing a framework of regulation and statutes in environmental area is a challenge, but due to the existing framework in other parts of the world, it would not be difficult to develop a similar one suited to our needs. The 'Golden Rules' which have been discussed in a dedicated publication by IEA exhaustively cover the recommendations which are necessary in the area of shale gas exploitation.

While many challenges to shale gas exploitation, viz., the nature of hydraulic fluids, threat of seismic activity, contamination of water, methane emissions, etc., can be addressed by greater transparency in the operations of this industry, these threats are not unique to shale gas exploitation. Even in CBM exploitation where a lot of water activity takes place at a shallow depth (which is more risk prone than shale gas), a decade long experience in India has not been negative. One recommendation which will go down well for India is that the Government itself needs access to scientific and credible knowledge base before widely spreading shale gas development. Australia in 2011 established an Expert Scientific Committee federally funded with $150 million over four years to address CBM related environmental and other issues.

In conclusion, India needs to pay special attention to the environmental safeguard issues of the shale gas programme. Due to heightened public activism, strong judicial supervision and scarce land/water issues, shale gas exploration will be subjected to close scrutiny. While the Indian environmental laws at the national level are also on the lines of US federal laws – prescribing specifications for discharge of air, water etc. from industrial uses, in the case of shale gas, even processes will have to be prescribed. In the West, a robust industry standards compliance is also an accepted form of conducting business, unfortunately the confidence levels in India are not too high, and compliances are more rule/regulation driven. Further, as it may not be possible for the states to promulgate regulations due to the complex nature of shale gas industry, the Central government may need to issue these regulations.

However, the concerns being local – land and water issues, the state machinery alone will be able to enforce the regulations. Prior to regulations, it will be essential to develop baseline water data, both the stock as well as the characteristics, at the local level. Hence, a lot of capability building in the manpower resources at the State/district level may be required to assure the local communities of their health and well- being. Shale gas exploration, hence, will not only have contractual, fiscal and technical challenges, but also those related to environment and capacity building. In view of stagnant oil and gas production and rising import dependency in India, it will be well worth the effort to address the above challenges to exploit our shale gas prospects.

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