

Shale gas development and opportunities in India

Written by : Pranjal Vagreacha, Laxman Kumar

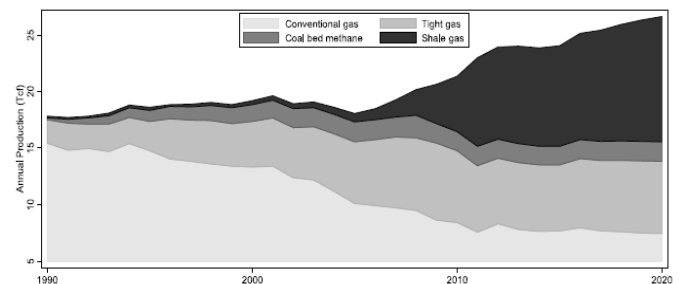
Abstract : The primary objective of this paper is to present the an overview of the Shale gas development and the opportunities it presents in India. The paper sheds light on the Shale gas scenario in the world and its impact on energy pricing and economics. This paper also focuses on *India specific issues surrounding the need for development of unconventional sources of gas*, its advantages, key capabilities required for developing domestic shale gas industry, its prospects in India and policy reforms required to achieve a thriving Shale gas industry.

Key Words - Policy, Research and Development, Shale Gas, Technology

Introduction According to the International Energy Agency (IEA), the volume of shale gas, tight gas and coal bed methane resources is currently estimated at 380,000 billion cubic meters (Gm³), equivalent to about 50% of global gas resources[1]. Shale gas accounts for the biggest share of these resources. The fact that gas -holding shales are much more extensive than traditional gas reservoirs and present on every continent considerably enhances the exploration outlook. The dramatic and swift turnaround in the energy dynamics of United States stemming from the sudden availability of unconventional Shale gas reserves has led to the expectation that the worlds' largest oil and gas importer could become energy independent within a decade or even a net exporter of gas giving rise to terms such as 'Saudi America'. Figure 1 shows that shale gas production accounted for only 1.6% of US natural gas production in 2000 which jumped to 4.1% in 2005 and is now more than 25% in 2013. This remarkable growth of US Shale gas production has aroused interest among several countries in exploring their own

shale gas reserves. A number of countries such as China, India, Mexico, U.K., Poland, Argentina, Australia are in the process of forming their Shale gas policies. As policymakers look to emulate the successful model of US, important parameters that they will need to consider would be government incentives, geology, local participation, water availability, pipe infrastructure and capital

Figure 1. Annual US Natural Gas Production and Projected Production by Gas Type, 1990–2020



Source: Energy Information Administration 2013.

Present Gas scenario in India

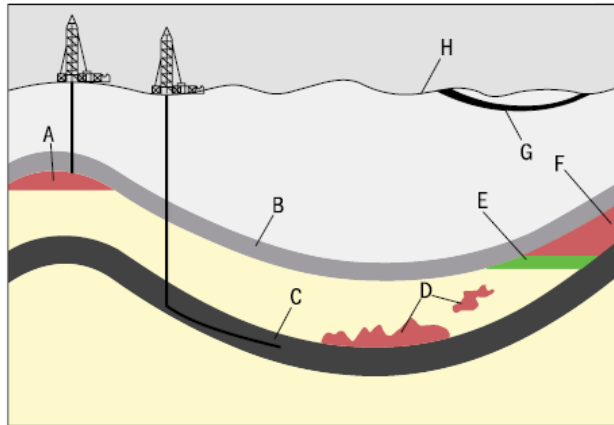
Compared to coal, the importance of gas will grow manifolds. Planners should capitalize on indigenous gas reserves believed to be considerably larger than India's oil endowment. There is skepticism in the predictions of an Indian shale-gas boom: the US government's Energy Information Administration found that India had just 96tcf(trillion cubic feet) of technically recoverable shale-gas resources (compared with China's 1,115tcf, for instance)[2][3]. However, large offshore finds have helped to boost India's reserves significantly assuming more discoveries are made. Present demand for Natural gas stands at 300 mmscmd(million metric standard cubic meters per day) while production is only 180 mmscmd[4]. Gas based power plants are operating at Plant Load Factor of 29% while many are lying idle for want of gas and can't operate because expensive LNG imports make electricity

generation at current prices unviable[5]. India's 26 sedimentary basins are relatively unexplored with potential reserves at 8935 million barrels of oil[6]. Even today, 15% of sedimentary areas remain unexplored which was 50% in 1996[7]. The fledgling KG-D6 block of Reliance is producing just 14 mmscmd against the envisaged 80 mmscmd. Rigid regulations and APM(Administered price mechanism) have kept foreign investors with expertise away from NELP(National Exploration and Licensing Policy) with major blocks going to ONGC and OIL. These state-run companies don't have incentive or the finances to innovate and expedite production with the result that their production levels have been stagnant in last 10 years and many new discoveries lagging years behind schedule making gas shortage chronic.

In the current scenario, India needs to tap foreign expertise to exploit hard-to-reach hydrocarbons. A generally problematic environment for foreign investors in India, however, means that joint ventures are likely to be vulnerable to bureaucratic delays. A cap on retail prices for fuel will continue to discourage investment and hamper production growth. Gas demand will outstrip domestic supply. As industry's needs grow and gas displaces coal in the power sector, consumption of natural gas will grow by 9% annually to 109.7 mtoe(million tones oil equivalent) in 2020[8]. The shortage of gas supplies is likely to continue during FY13–FY22. It is estimated to average around 72 mmscmd per annum[8]. While the deficit as a percentage of demand is likely to decrease from 38.2% in FY12 to 12.4% in FY22, the country's dependence on imported gas is likely to increase considerably[8]. The share of imported gas in India's total gas supplies is likely to increase from 22.5% in FY12 to 54.2% in FY22[8]. More gas imports will be needed, heightening energy-security worries. Out of this, LNG is likely to account for a

major share, with LNG imports increasing from 38.5 mmscmd in FY12 to 258 mmscmd in FY22[8]. This high dependence on imported gas could have significant implications on India's energy security and the overall trade deficit of the country. Although the global LNG liquefaction capacity is projected to increase significantly over the next few years, gas prices under new LNG supply contracts are likely to remain high given the forecast of high crude oil prices. The sourcing of fresh LNG supplies at competitive rates has been a challenge on account of the intensifying competition among Asian companies. Competition is likely to further intensify due to an increased Japanese appetite for LNG for power generation after the shutdown of most of the country's nuclear power plants along with China's plans to augment its LNG imports. LNG supply projections for India depend upon the timely commissioning of the proposed LNG terminals (Ennore, Mundra, Paradip, Vizag, Mangalore and Dhamra).

On the bright side, India benefits from relative proximity to Australia, a burgeoning LNG provider. India is also exploring its pipeline gas options, although the outlook is challenging. Construction of the Turkmenistan-Afghanistan-Pakistan-India(TAPI) gas link could be undermined by instability along the route. India cannot count on TAPI to shore up its gas security. More gas imports and expanded domestic production will expand the proportion that natural gas claims in India's energy consumption to 9.4% at decade's end from around 6.7% in 2011[8]. That is still a long way behind coal and oil.



A- Conventional non-associated gas E- Oil
 B- Seal F- Conventional associated gas
 C- Gas-rich shale G- Coalbed methane
 D- Tight sand gas H- Land surface

Fig:2 Source: US Energy Information Administration (2011): www.eia.gov

Benefits of Shale Gas in India

Given the state of the wobbly supply and heavy dependence on imports, it becomes imperative for India to harness all its energy resources, including shale gas and Coal Bed Methane (CBM), appropriately. The unlocking of domestic shale gas can help India meet its growing energy demand, besides reducing its dependence on expensive energy imports and the energy import bill. Taking a note from the impact of shale gas development in the US, the development of the sector can help increase economic activity in the country, thereby boosting government revenues and creating new jobs. After the Shale gas bonanza, companies such as Dow Chemicals, ExxonMobil and Conoco Phillips are moving manufacturing to the US for manufacture of ethylene and propylene[8]. Additional gas supplies can also spur investments in associated downstream segments, which cater to significant latent gas demand in the country. A case in point is Gujarat where the development of gas infrastructure led to the application of gas in new sectors such as industrial and commercial establishments in the ceramics, glass, chemicals, textiles, pharmaceuticals and diamond industries, among others. With just 5% of population, the

state of Gujarat accounts for a mammoth 32% of India's gas consumption[9]. With some degree of intervention from the judiciary and local state governments, the household and automobile segments have the potential to further boost city gas demand as well. This will result in saving of cost involved in packaging of LPG cylinders and reduction in the subsidy bill. Initially, the prices of shale gas may not be economically viable for industries, such as power and fertilizers, where the prices of end products are regulated or price hikes are difficult to pass on to customers. However, it could be a viable alternative for meeting the needs of peak and captive power units and other sectors such as transportation, refineries and steel where it can substitute expensive liquid fuels. During FY13– FY22, gas demand from these sectors is estimated to increase at a CAGR (Cumulative Annual Growth Rate) of 7.6%, accounting for around 30% of the total gas demand in the country[8].

KEY POLICY REQUIREMENTS FOR DEVELOPING SHALE GAS

For real boom to occur, private sector needs to play the key role. As evident by the success stories of Cairn and Reliance, private oil companies must play the leading role if India is to truly revolutionize its gas story.

Government incentives

The seed for shale boom was planted by the US in 1970's during the oil crisis which provided tax incentives and government funded R&D programs since private sector companies can't carry the load of risky and large research programs for exploration of unconventional gas. Oil and Gas sector is single largest contributor to the national exchequer. Therefore, government must make reforms in Oil and Gas sector a priority including incentives, abolishing duties and tax holidays. Establishing a research centre for

development of shale gas technologies for the Indian geology should be the first step. Secondly, for existing companies to make investment in Shale gas, government could move to Revenue sharing contracts rather than Production Sharing contract(PSC) with 60-40% or 75-25% revenue sharing. Thirdly, since this is a capital intensive sector, liberal FDI regimes and increased participation from large global oil companies such as BP, ConocoPhillips, BHP Billiton etc should be encouraged since they will also bring with them modern technology and technical know-how to ramp up the gas production with ease. Fourthly, Indian government must try and engage USA for sharing of technical data on shale gas and its prospects in India. Fifth, joint ventures between National Oil companies and foreign private sector operators such as Bakers field, Halliburton with EPC contracts can help firms such as ONGC and OIL to complete their work on time. e.g. contracts given by OIL to Schlumberger for development of shale in Assam-Arakan region[10]. And sixth, there is a need for favorable pricing mechanism for shale gas operations due to the initial high costs of production. The International Energy Agency (IEA) estimates shale gas production costs between US\$3/mmbtu and US\$7/mmbtu in North America. Production costs in India are likely to be higher, given the relatively unknown geological terrain, water disposal costs, inadequate domestic service industry and other expenses. Gas gathering and processing costs are also likely to be on the higher side. However, operational costs have substantially reduced in the US with the application of new and advanced technology. For instance, breakeven costs have reduced by around 40% during the past few years and a similar trend could be expected in India, with the implementation of advanced technology.

INDIAN BASINS

The Ministry of Petroleum and Natural Gas(MoPNG) has identified 6 basins as potentially shale gas bearing. These are Cambay, Assam-Arakan, Gondwana, Krishna-Godavari, Kaveri and Indo-Gangetic plane.

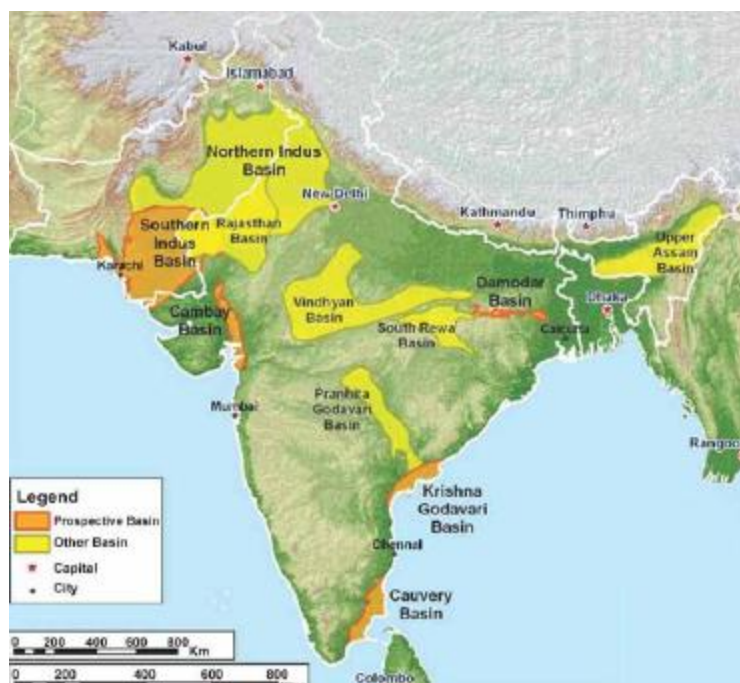


Figure 3: Shale gas sedimentary basins in the Indian sub-continent
 Source: Adapted from <http://suvratk.blogspot.in/2011/05/india-basin-wise-shale-gas-estimates.html> (Mr Suvrat Kher, Sedimentary Geologist)

OTHER FACTORS AFFECTING SHALE GAS DEVELOPMENT

The history of shale gas development suggests that a multitude of factors played a dominant role for the shale gas boom in USA. These factors include technology innovation, government policy, private entrepreneurship, private land and mineral ownership, high natural gas prices, favorable market structure, conductive geology, water availability, natural gas pipeline infrastructure and a host of other factors. The key question of policymakers in India is to create an environment which incentivizes companies to make investments and eventually find it profitable to produce

shale gas. The current glut of policy paralysis and flip-flops with a haunting tax department make India a unfavorable investment destination.

- Land and mineral ownership : Unlike the United States where mineral rights are with the owner of the land, in India, all minerals found under the surface belong to the government. Government may tend to auction shale bearing blocks and impose requirements that a certain amount of investment be made in a certain period of time. This policy will force firms to drill but it's not clear how large incentive this provides for firms to innovate relative to those that come with leasing of private property. A key issue would also be for the firms to secure large enough acreage from auctions to reap benefits of their R&D investments.
- Pricing : In the US, deregulated Natural Gas prices provided stimulus for shale gas. Importantly, before deregulation there was chronic shortage of gas reflecting reluctance of firms to invest in new exploration since price was below market value which is exactly what is happening in India. Price regulation discourages investment not only in shale gas but also uncertainties created by price regulation.
- Pipelines network : US has a large grid of pipelines for natural gas transportation since any private operator can set it up after necessary approvals. In India, the nodal agency for pipelines is the state-owned GAIL. Several projects of GAIL are lagging behind schedule because of land acquisition problems and order backlog. Private operators with open access policy should be allowed to spread the pipeline network and intra-state connectivity should be promoted.
- Water availability : Each well requires 3-14 million gallons of water[11]. India suffers from physical and economic water scarcity whereas US and Europe have plenty of water. It's estimated that water demand in the country will rise by 50% in next 10 years whereas supply will rise by mere 10%[11]. India is fast approaching the 1000 cubic meter per capita water scarcity mark with increased farm irrigation and industrialization. The Indo-Gangetic plane, Gondwana, Cambay and Damodar basin will all be severely water stressed by 2030. Focus of companies should be on maximizing rain water harvesting and recycling of used water.
- Land acquisition : Though the draft policy of the government does not include land acquisition, this will be a major obstacle in future as each site requires around 80-160 acres of land and previous experiences suggest locals will be agitated at being displaced from their land[12]. A comprehensive land lease program with effective rehabilitation and resettlement with adequate compensation is necessary.
- Environmental concerns : Environmental issues that have become prominent elsewhere will doubtlessly be mirrored in India. Controversy chiefly stems from the use of chemicals to fracture shale bearing rocks deep within the surface and non-disclosure of these chemicals by companies. These issues can be addressed by full transparency, measuring, monitoring and controlling environmental impacts; and early and sustained engagement. Careful choice of drilling sites can reduce the above-ground impacts and

most effectively target the productive areas, while minimizing any risk of earthquakes or of fluids passing between geological strata. Sound management of water resources should be the basis for rules of engagement. Alongside robust rules on well design, construction, cementing and integrity testing to prevent leaks from the well into aquifers, this requires rigorous assessment, monitoring and handling of water requirements (for shale and tight gas) and of waste water. Unconventional gas has higher production-related greenhouse-gas emissions than conventional gas, but the difference can be reduced and emissions of other pollutants lowered by eliminating venting and minimizing flaring during the well completion phase. Releases of methane, wherever they occur in the gas supply chain, are particularly damaging, given its potency as a greenhouse gas.

- **Overcome talent shortfall:** The oil and gas industry is facing a dearth of talent, which could delay projects and impact production. According to estimates, approximately 50% of the current oil and gas workforce has more than 20 years of experience and the majority of them may retire within the next five to ten years[13]. The attrition levels are high, as 7% of the current workforce may leave the industry in the next five years[13]. To address these issues, there is a need for significant efforts to attract new talent.

Shale gas prospects in India

According to estimates by EIA, India has 96 tcf of recoverable shale gas reserves; however limited exploration has been carried out so far. It is quite possible that similar to the

US, India's shale gas reserve potential could be upgraded with further exploratory drilling. The Cambay, Krishna Godavari, Cauvery and the Damodar Valley are the most prospective sedimentary basins for carrying out shale gas activities in the country. The Cambay basin in Gujarat is the largest basin in the country, spread across 20,000 gross square miles, with a prospective area of 1,940 square miles[14]. Around 20 tcf of gas has been classified as technically recoverable reserves in the basin[14]. It is estimated that the Krishna Godavari basin, located in eastern India, holds the largest shale gas reserves in the country. It extends over 7,800 square miles in gross area, with a prospective area of around 4,340 square miles. The basin encloses a series of organically rich shales, containing around 27 tcf of technically recoverable gas[14].

Latest developments

The Government of India, along with Indian companies, is undertaking various initiatives to accelerate the development of shale gas reserves in the country. India is likely to launch the bidding for shale gas exploration toward the end of 2013[15]. As a part of this initiative, the government has set up a multi-organizational team (MOT) comprising the Directorate General of Hydrocarbons (DGH), Oil and Natural Gas Corporation (ONGC), Oil India Limited (OIL), and GAIL (India) Limited for analyzing the existing data set and suggesting a methodology for shale gas development in the country[16]. Further, in April 2012, the DGH submitted its draft policy on exploitation of shale gas to the Ministry of Petroleum and Natural Gas (MoPNG)[17]. ONGC and OIL are aggressively implementing pilot projects to assess the shale gas potential in the country. In addition, Reliance Industries Limited (RIL) and GAIL

have entered the US shale industry to gain technical expertise and may apply that expertise in developing shale gas reserves in India.

- In January 2011, ONGC discovered shale gas in its first pilot shale gas drilling venture in the Damodar basin. Further, the company plans to explore shale gas potential in other promising basins in the country. To gain expertise in this emerging industry, the company signed an agreement with ConocoPhillips in March 2012, for cooperation in the exploration and development of shale gas resources in India and other regions[18]. The company will drill 4 gas wells in Cambay basin at estimated cost of 150-200 Crores in 2013 with ConocoPhillips[19].
- OIL has hired Schlumberger to conduct a feasibility study of shale gas potential in the Assam-Arakan and Rajasthan basins.[10] OIL has acquired 20% stake in Carrizo Oil and Gas Inc's liquid rich state assets in the Denver-Julesburg Basin in Colorado, USA in 2012[20].
- RIL has signed three upstream joint ventures (Chevron, Pioneer Natural Resource and Carrizo Oil & Gas) and a midstream JV (Pioneer) for carrying out operations in the US. RIL has invested a total of US\$5.7 billion. More than a third of gas production of Reliance is expected to come from Shale in 2013[21].
- GAIL signed an agreement with Carrizo Oil & Gas to acquire a 20% stake in the latter's Eagle Ford acreage for US\$95 million[22]. GAIL has also signed a 20-year agreement with Cheniere Energy for the supply of 3.5 million tons per year of LNG[23].

CONCLUSION

For the financial year 2012, crude oil with \$140 billion was the single largest item on the import basket affecting the CAD(current account deficit) badly[24]. Since 2000, India's

crude oil imports in the oil mix have risen considerably from 60% to 80% with increased demand and insufficient domestic supplies[25]. Buying oil assets abroad has not yielded good results yet. Meanwhile, Gas supplies are dwindling as well. If gas along with coal and oil are imported at the current rate, India will head into a major energy crisis along with a economic crisis. India's sedimentary basins do not have sufficient crude oil to support 3.6 mb/d(million barrels per day) of oil demand[26]. But there is the possibility of prolific unconventional gas deposits in the country. We need to grab this opportunity of higher domestic gas production by its horns. India being new to the shale gas game enjoys the advantage that state-of-the-art shale gas technologies are already present in the United States and its global oil companies. The existing technologies can jump start our shale gas development. However, a great deal of innovations will be needed to adapt to new terrain and modify technologies to profitably exploit shale gas resources where geology and water availability is significantly different. Indian companies are already involved in shale gas business in the United States and will readily invest in Indian shale gas auctions if a liberal and conducive policy is adopted. Global oil majors with India operations could participate as well bringing in the technologies and capital required. Moreover, with increased gas operations, government too would extra revenue for its social programs. Indian industry will mature and bring more business into India in the form of foreign contracts and turn-key projects. All these activities will result in significant savings of foreign exchange and lift GDP growth and engineering exports. Development of cutting edge technologies and the talent pool created in association with this industry will create world class opportunities for R&D work and technical institutes. In the process, we will be creating a truly global gas industry and with increased ability to buy assets and businesses

abroad in relatively unexplored areas such as Africa. Increased gasification of the economy will reduce our emissions from coal fired plants and petroleum driven vehicles till renewables such as solar and wind become economical. Meanwhile, sound environmental regulations(double steel casing, cementing etc) are required to make shale boom sustainable and acceptable to people.

Authored by :

Pranjal Vagrecha

4th year Bachelor of Chemical Engineering

Department of Chemical Engineering,

Manipal Institute of Technology

pranjalvagrecha@gmail.com

Manipal, India

+91-8971020896

Laxman Kumar

Assistant Professor,

Department of Chemical Engineering

Manipal Institute of Technology

laxman.kumar@manipal.edu

Manipal, India

+91-8867666522

References

- [1] Report by 'Total' (Exploration and Production Dept) company titled 'Growth sectors Unconventional Gas Resources of the Future', <http://total.com/en/energies-expertise/oil-gas/exploration-production/strategic-sectors/unconventional-gas/challenges>
- [2] Report by US Energy Information Administration titled 'Technically Recoverable Shale Oil and Shale Gas Resources : An Assessment of 137 Shale formations in 41 countries.' Chapter 24. Published on 10 June,2013.
- [3] Report by US Energy Information Administration titled 'Technically Recoverable Shale Oil and Shale Gas Resources : An Assessment of 137 Shale formations in 41 countries.' Chapter 20. Published on 10 June,2013.
- [4] 'Detailed report on Natural Gas Scenario MoPNG - 12th:13th Five Year Plan' Infraline Energy Database <http://www.infraline.com/ongsector/#Natural-Gas-Scenario-XIIth-XIIIth-five-year-plan-161586.htm>
- [5] Central Electricity Authority Website http://www.cea.nic.in/reports/monthly/elec_review/jun13.pdf June 2013
- [6] <http://world.bymap.org/OilReserves.html> Established January 2012
- [7] Directorate General of Hydrocarbons <http://www.dghindia.org/SedimentaryBasins.aspx#>
- [8] Report by Ernst and Young 'Shale gas - global experience and key learning', released at the International Congress on Shale Exploration India August 30th,2013.
- [9] Gujarat Infrastructure Development Board http://www.gidb.org/cms.aspx?content_id=145
- [10] Chairman's address, OIL website <http://oil-india.com/CAddress.aspx>, 24th September 2011 ; "OIL hires Schlumberger for Shale gas foray", Accord Fintech 17 June 2011 via Factiva
- [11] Report by Energy and Research Institute, TERI 'Shale Gas : Look before you leap' June 2013
- [12] Land, a key issue in tapping shale gas potential : ONGC Chief in interaction with Bengal Chamber of Commerce and Industry on 17th May 2013

- <http://www.thehindu.com/business/Industry/land-a-key-issue-in-tapping-shale-gas-potential-ongc-chief/article4724917.ece>
- [13] "Final Report on Unconventional Gas in Europe" Philippe and Partners, http://ec.europa.eu/energy/studies/doc/2012_unconventional_gas_in_europe.pdf, 8 Nov 2011
 - [14] "World Shale Gas Resources: An Initial Assessment of 14 regions outside United States," EIA website, <http://www.eia.gov/analysis/studies/worldshalegas/>, April 2011.
 - [15] "India's first ever shale gas exploration bidding by 2013-end:PM" The Press Trust of India Ltd, 23 March 2012, *The Economic Times* http://articles.economictimes.indiatimes.com/2012-03-23/news/31230446_1_shale-gas-conventional-oil-and-gas-coal-bed-methane
 - [16] "Energy, Infrastructure and Communications," Chapter 11, India Budget 2011-12 <http://indiabudget.nic.in/es2011-12/echap-11.pdf>, March 2012
 - [17] "DGH drafts new policy on exploitation of shale gas," *The Indian Express* 4 May 2012 <http://www.indianexpress.com/news/dgh-drafts-new-policy-on-exploitation-of-shale-gas/945129/>
 - [18] "ONGC MoU with ConocoPhillips," ONGC press release, <http://www.ongcvidesh.com/NewsContent.aspx?ID=901>, 30 March 2012
 - [19] "ONGC to start drilling shale gas in Gujarat next month", *The Business Standard* 25th September 2013 http://www.business-standard.com/article/companies/ongc-to-start-drilling-for-shale-gas-in-gujarat-next-month-113092500848_1.html
 - [20] "Oil India and Indian Oil acquire Houston-based Carrizo oil and gas shale asset for \$82.5 million", 4th October 2012 *The Economic Times* http://articles.economictimes.indiatimes.com/2012-10-04/news/34260444_1_oil-india-chairman-shale-asset-carrizo-oil-gas
 - [21] "Reliance Industries sees shale gas production to be a third of total", *Reuters* India edition June 6,2013 <http://in.reuters.com/article/2013/06/06/reliance-shareholders-shalegas-idINDEE95506Z20130606>
 - [22]"Carrizo strikes deal with India's Gail to monetize producing Eagle Ford Shale assets", September 29, 2011 <http://www.ogfj.com/articles/2011/09/carrizo-strikes-deal.html>
 - [23]"GAIL signs deal to source 3.5 mt of LNG annually from Cheniere arm", December 11, 2011*The Business Line* <http://www.thehindubusinessline.com/companies/gail-signs-deal-to-source-35-mt-of-lng-annually-from-cheniere-arm/article2706684.ece>
 - [24] "India's high trade deficit due to oil, not gold import: HSBC", *The Economic Times* February 5,2013 http://articles.economictimes.indiatimes.com/2013-02-05/news/36764873_1_gold-import-fiscal-deficit-current-account-deficit
 - [25] "Nearly 80% of India's crude oil needs imported", M Veerappa Moily in Written reply to Parliament, *dnaindia* 27 August 2013 <http://www.dnaindia.com/money/1880629/report-nearly-80pct-of-india-s-crude-oil-needs-imported>
 - [26] US Energy Administration department <http://www.eia.gov/countries/index.cfm?view=consumption>