CHAPTER 4

SHALE OIL & GAS - A GAME CHANGER OR OTHERWISE

How can the Shale Oil & Gas revolution become a game changer? Surely, for any phenomenon or trend to become a game changer, a number of conditions have to be met, or at least conducive for it to succeed. What could these conditions be? Worldwide use of fossil based energy has been one of the primary engines of industrial growth & sustenance. Petroleum based fuels have particularly pervaded all walks of life, and thus global demand of crude oil and gas will be the first determinant. Should global demand be buoyant and drive demand, this in turn will drive all sources of petroleum, to include Shale Oil & Gas.

The second condition is the nature of long term demand for oil & gas, in those regions, where the Shale revolution or Shale plays are currently being witnessed. This in effect is limited to North America right now, since the Chinese output of Shale Gas& oil has not yet reached significant levels. Accordingly, the need for additional oil production of oil & gas within the US / North America must exist, as a necessary condition for substantive long term investments, exploration & development of Shale Oil & Gas. What then are these conditions, that may exist or otherwise, that will drive Americans towards substantial Shale Oil & gas.

The third condition that will determine the impact of Shale Oil & Gas is the very availability of Shale / Tight Oil & Gas reserves, worldwide. This condition is also interlinked to another condition, and that is presence of the necessary

geographically located resources in the vicinity, i.e. primarily large quantities of water required for 'fracking'.

The next condition to be met is in the context of environmental impact of drilling for Shale Oil & gas/ tight oil/gas. All oil & gas drilling, conventional or unconventional has environmental costs. Over a period of time, some of these have become acceptable, whilst others have been declared as unacceptable. Going forward, in an immensely environmentally regulated scenario, the Shale revolution can only be successful, should its environmental footprint be acceptable to the regulatory environment of the country/ region. In effect, the regulatory framework of the country will predicate the possibility of a Shale revolution or otherwise.

Costs of extracting Shale/Tight Oil & Gas will be a key determinant. Thus the important link with international crude prices (conventional crude). In the event that conventional oil is priced lower than the average cost of Shale Oil, or that natural gas is cheaper to extract and supply over Shale gas, the future of Shale Oil & Gas hardly likely to be that of a 'game changer'.

The last condition, to be met for 'Shale plays' to become significant, is the level of production. In the event that significant production capacities get added, only then will it have the effect of impacting the global oil & gas dynamics.

An examination of each of these conditions follows, with a summary or pointer to the future of Shale Oil & Gas, as is evident today.

Global Demand For Oil & Gas

The analysis must start with looking at global demand for oil & gas. Using EIA data, sourced from the International Energy Outlook 2014, the global demand for oil (liquids) rose from 84.9 Million barrels/day in 2009 to 86.8 Million barrels/day in 2010. The consumption for 2014 is estimated at about 91.49 Million barrels/day in 2014.

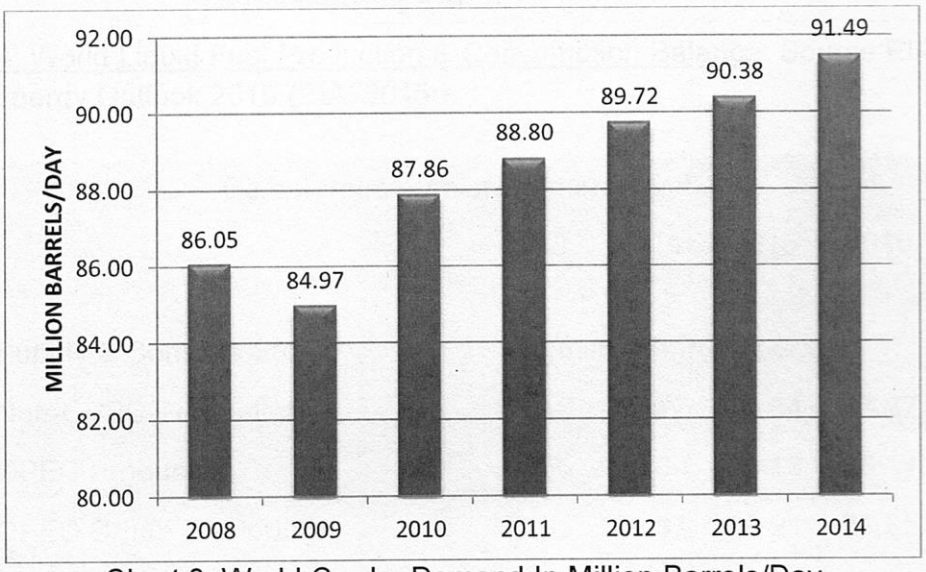


Chart 3: World Crude Demand In Million Barrels/Day
Chart prepared using data from EIA. Source (EIA, 2015c)

The IEA projections are 97.6 Million barrels/day in 2020, 101.8 Million barrels/day in 2025 and 107.4 Million barrels/day in 2030. They go upto 119.4 Million barrels/day in 2040. BP, in its long term forecasts, has indicated similar levels of demand, of between 108 to 109 Million Barrels/day in 2035. In effect, a clear, gradual growth in global demand.

Short term projections reinforce the long term projections that global oil demand is gradually growing. Estimates generally converge around 1.3 to 1.4% growth in global demand per annum.

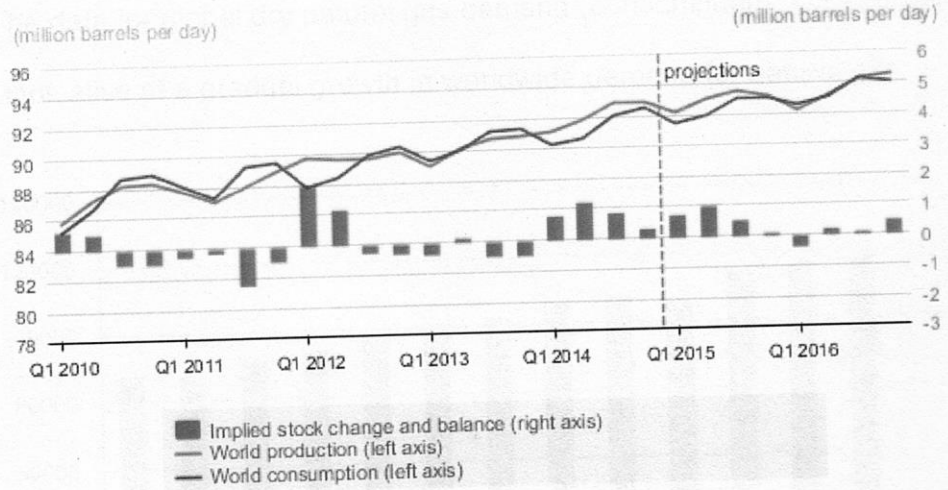


Chart 4: World Liquid Fuel Production & Consumption Balance. Source EIA Short Term Energy Outlook 2015 (EIA, 2015d)

Global Petroleum and Other Liquids				
	2013	2014	2015	2016
Supply & Consumption	(million barrels per day)			
Non-OPEC Production	54.15	56.17	56.84	57.37
OPEC Production	36.03	36.00	36.13	36.14
OPEC Crude Oil Portion	29.92	29.87	29.91	29.65
Total World Production	90.18	92.18	92.97	93.51
OECD Commercial Inventory (end-of-year)	2550	2708	2775	2791
Total OPEC surplus crude oil production capacity	2.13	2.05	2.26	2.73
OECD Consumption	46.07	45.79	45.93	45.87
Non-OECD Consumption	44.41	45.60	46.46	47.55
Total World Consumption	90.49	91.39	92.39	93.42

Table 2: World Petroleum and Other Liquids Production
Source: EIA Short Term Energy Outlook, 2015. (EIA, 2015d)

It becomes clearly evident, that crude oil demand will grow, due to strong global demand, in the future. So there is a clear case for increased oil production, to include Shale/tight oil.

The data for global dry natural gas demand (consumption), from 2000 to 2012 is indicative of a gradual growth in worldwide demand for natural gas.

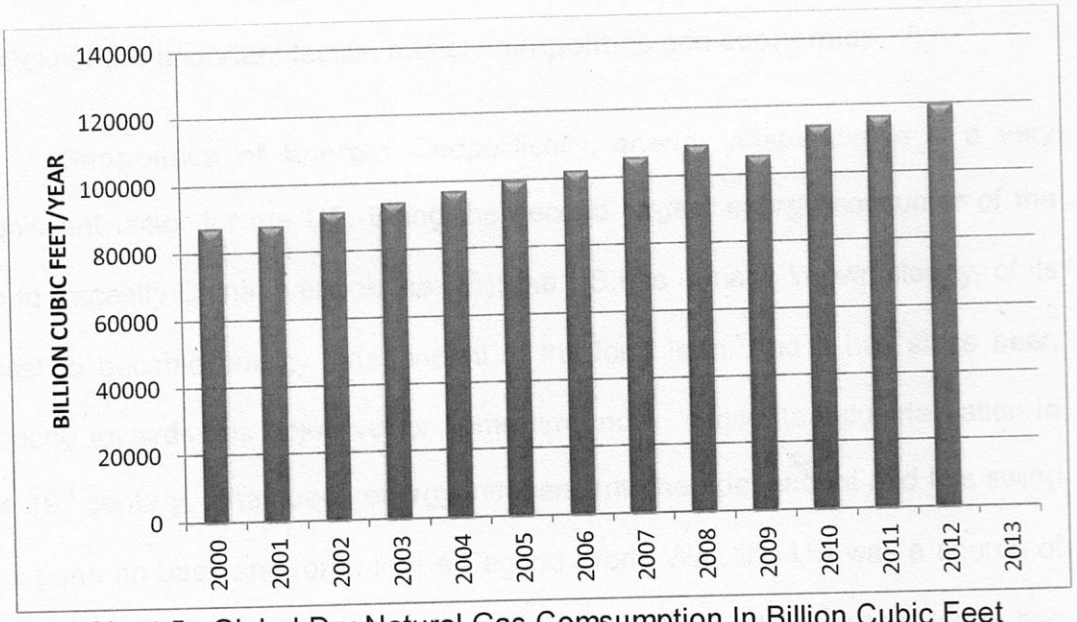


Chart 5: Global Dry Natural Gas Comsumption In Billion Cubic Feet
Chart prepared using data from International Energy Statistics (EIA, 2015c)

Forecast estimates by energy major BP, in 2014 indicate that gas demand is projected to go up from the 330 Bcf/day in 2014 to 500 Bcf/day in 2035. Past data from EIA, future short term projections as well as long term projections fit in with the trends of the growing world economy, thus a greater need & reliance on energy to power such economic growth. Apropos, the very first condition, that of adequate sustainable demand, for oil & gas is extant.

Does America Require Increases In Its Oil & Gas Production?

The next condition that merits a review is whether America requires increases in its oil & gas production? This condition has to be analysed in the context of two important facets, namely **geopolitics** and **economics**.

Geopolitics of Energy: Geopolitically, energy independence is a very significant factor for the US. Being the second largest energy consumer of the world (recently China overtook the US); the US has it made known clearly, of its quest to become energy independent in the long term. And it has since been working towards this objective for some time now. Since its industrialisation in the 19th century, it has been energy independent, then dependent and this swing has gone on back and forth. In the Second World War, the US was a source of petroleum; coal etc, for all the other allies. In fact, up to 1940, when Japan had not yet attacked the US, Japan too was importing aviation gasoline from the US! It was only with increasing demand, due to rapid growth in motoring (number of vehicles on the road as well as increase in engine size and specific fuel consumption; growth of motorways /roads in the US) and increase in wealth, that the indigenous production within the US was unable to meet increased oil demand, and import of oil started. This import was sourced from the Middle East, as well as neighbouring Canada, Mexico and from countries in South America, e.g. Venezuela etc.

However, successive US Presidents, have laid emphasis on improvements in efficiencies, alternate fuels and energy sources, to make the US less dependent on external sources of energy, as important constituents of its energy security. President Nixon in 1974, as a part of his 'Project Independence' goals,

had said "the United States will not be dependent on any other country for the energy we need". On 15 July 1979, said "I am setting a clear goal for the energy policy of the US. Beginning this moment, this nation will never use more foreign oil than we ever did in 1977. From now own, every new addition to our demand for energy will be met from our own production and our own conservation".

Ronald Regan, who succeeded Carter, laid even greater emphasis on domestic resources and increasing productivity. Since, focus on increased domestic production has continued. However, by 2001, when George Bush took over, US oil imports had increased, aggravating concerns of America's energy dependence on the Middle East, in the backdrop of the 9/11 attacks. This once again prompted the US to secure its energy needs and energy flows. As a direct consequence, the National Energy Policy, also called as the Cheney Report was prepared & released. President Barak Obama too has, since 2009, encouraged energy security, clean energy and has exhorted investors to invest in newer forms of energy, rather than in conventional. Clearly the current US energy policy is one of energy independence.

Economics of Energy : Economically too, increased oil & gas, as well as other forms of clean, renewable energy will stand to benefit the US. Increased economic activity, more jobs, lower energy costs, higher standards of living etc are obvious spinoffs. Investments in new forms of energy have spurred academic research, education and industrial development. New industries have come up, in a host of renewable energy (RE) areas, like solar, photovoltaic, wind energy, etc. In this context, unconventional oil & gas (Shale, Tight Oil & Gas) have emerged amongst the largest beneficiaries of this surge of American research &

investment into the unconventional energy sector. These initiatives by the US have had the effect of ever increasing oil & gas production, over the last few years (EIA, 2014d).

Economically, 'oil shocks' have made for unpleasant experiences, the world over, to include the high energy consumer, i.e. the US citizen. So a larger, indigenous source of petroleum is a great comfort, a security in comparison to the erstwhile dependence on middle Eastern on South American oil. Long term energy independence as well as economic benefits, point to the ever increasing thrust towards increased energy independence in the US. Such a prevalent scenario is very conducive for Shale Oil and Gas production to increase in the long term and it is already driving down pump prices for oil / feedstock costs and residential prices for gas consumers, as a part of the overall oil & gas pricing matrix in the US.

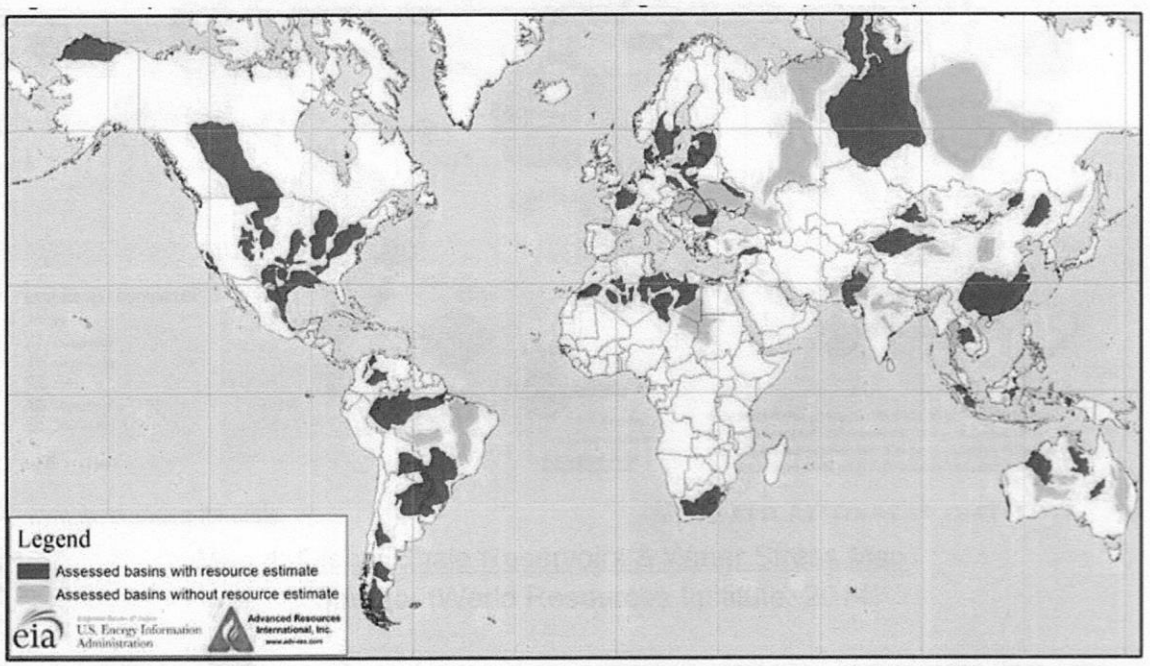
Global Need for Alternate Sources of Oil & Gas

Globally too, as the world gradually depletes its known reserves of conventional oil & gas, the impetus towards finding new sources of oil & gas, unconventionally will continue incessantly. China has already invested into Shale technologies for the long term. Other countries are also exploring Shale Oil & Gas extraction. Canada is already a major player in Tight Oil as well as extraction of oil from tar sands, especially from its tar sand regions in Alberta. Europe too, is keen to mitigate its dependence on the Russians for its requirements of gas and oil. Further, in the quest for shifting over to clean energy, coal as feedstock being replaced by gas. Thus, European dependency on gas is on the increase. In fact,

all projections indicate greater increase in gas consumption, as compared to increases foreseen in oil consumption, globally in the long term.

Global Availability of Shale Reserves

At this stage, it may be appropriate to look at the global availability & distribution of Shale reserves. EIA came out with its first report on global Shale resource estimates in 2011. This report covered 32 countries, and largely looked at Shale Gas. It estimated that technically recoverable estimates of Shale Gas at about 6,622 Trillion cubic feet and about 32 Billion barrels of Shale Oil. The next report, covering a much larger number of countries worldwide, and also estimating Shale Oil in greater detail, has upped the quantum of Shale Gas to be around 7,299 Trillion cubic feet; Shale Oil has increased substantially to 345 Billion Barrels. (EIA and Advanced Resources International, 2013)

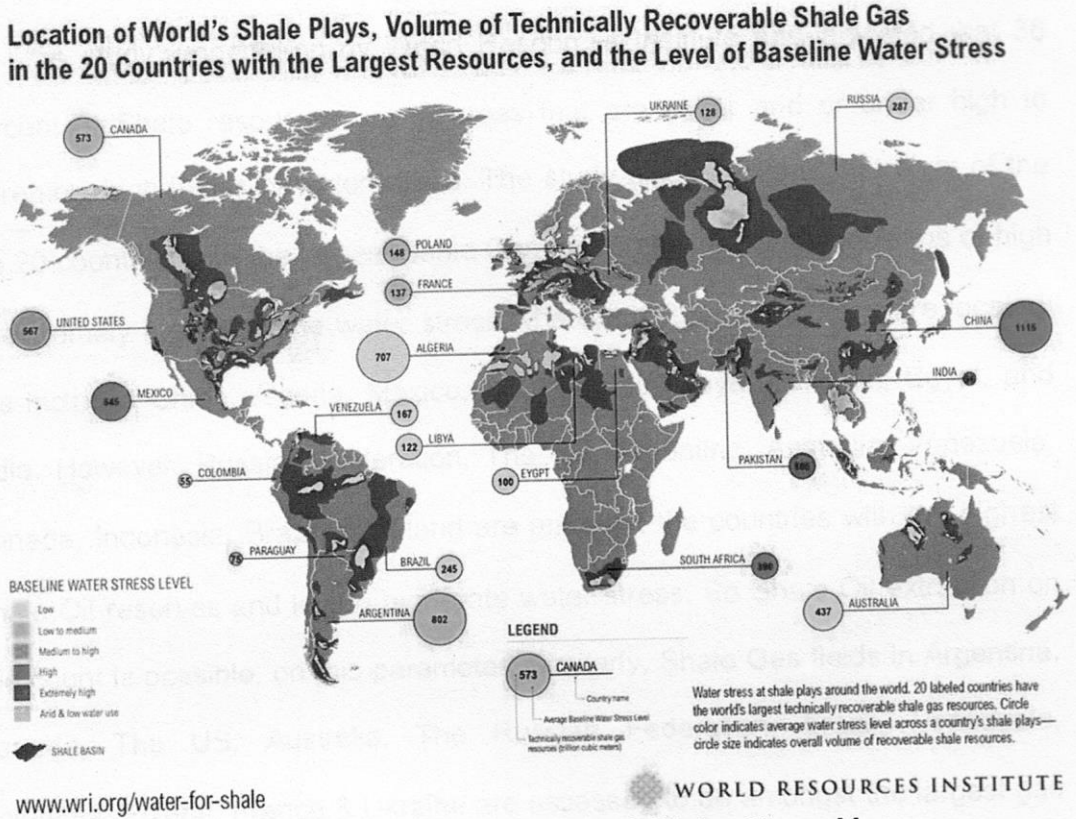


Source: United States basins from U.S. Energy Information Administration and United States Geological Survey; other basins from ARI based on data from various published studies.

Map 3: Global Assessments of Shale Oil & Gas Formations Source: (EIA and Advanced Resources International, 2013)

The Shale resource map above, based on the study done jointly by EIA along with Advanced Resources International (ARI), and indicates the estimated Shale Oil & Gas reserves. Clearly, these are widely distributed widely, all over the world. The white portions in the map are areas that have not been looked at in detail. In effect, there may be more. However, these estimates of Shale Oil & Gas effectively increase the global estimated reserves of oil & gas by 11% and 47 % respectively. This increase in global oil & gas resources is considered substantial.

Availability of Water: Critical to Extraction of Shale Oil/Gas



Map 4: Global Shale Reservoirs & Water Stress Map
Source: (World Resources Institute, 2014)

An important requisite for extraction of Shale Oil & Gas is the availability of large quantities of water, which is pumped down, to push out the oil or gas.

Commercially, fracking of Shale reservoirs is carried out using large quantities of water and other chemicals & materials. A number of organisations, governmental and in the private sector are in the process of doing such studies to determine the availability of water and its environmental impact, should Shale development in the region be undertaken, using available sources of water. Clearly, American success in Shale field development and ever increasing outputs there from are in part because of the adequacy of water for recovering Shale Oil & Gas. But is it possible the world over? The global water stress map, with overlaid Shale reserves, sourced from World Resources Institute, Washington DC, indicates areas that are conducive to Shale development and those that are not.

A study, undertaken by World Resources Institute has indicated that 38 percent of Shale resources are in areas that are either arid or under high to extremely high levels of water stress. The study also highlights that eight of the top 20 countries with the largest Shale Gas resources face arid conditions or high to extremely high baseline water stress where the Shale resources are located; this includes China, Algeria, Mexico, South Africa, Libya, Pakistan, Egypt, and India. However, Russian Federation, The US, Argentina, Australia, Venezuela, Canada, Indonesia, Brazil, & Poland are amongst the countries with the highest Shale Oil reserves and low to moderate water stress. So Shale Oil extraction on this count is possible, on this parameter. Similarly, Shale Gas fields in Argentina, Canada, The US, Australia, The Russian Federation, Brazil, Venezuela, Columbia, Poland, France & Ukraine are assessed to be amongst the largest gas fields, with low or moderate water stress. This augurs well for Shale Gas (World Resources Institute, 2014).

Regulatory Environment for Development of Shale Oil & Gas

An important condition that will determine whether Shale Oil or gas can become a game changer is whether regulatory, legislative & environmental frameworks of the countries in question encourage or discourage Shale production. The United States of America, having recognised the need for energy independence and its unique approach to land ownership rights, which also bestow the rights of sub-terrain mineral wealth to the land owner, unlike most others is uniquely positioned. The regulatory framework is extremely conducive to Shale development. Environmental concerns have been voiced equally in the US as much as in Europe or elsewhere, but the regulatory mechanism has kept pace, reviewing a number of regulation etc, and while laying down strict standards to be complied with, has encouraged Shale Oil & Gas production. Similarly, the UK has commenced a series of actions, and is actively encouraging Shale development within the UK. Poland too has taken a number of steps to undertake Shale development and work is in progress to that end. UK is estimated to hold 26 trillion cubic feet of potential Shale Gas reserves and Poland, 148 trillion cubic feet, according to the US Energy Information Administration.

Some countries in Europe, on the other hand, like France continue to ban Shale development. Germany, which is estimated to hold up to 2.3 trillion cubic metres of Shale gas, the equivalent of up to 23 years of domestic energy supply based on current demand, is still debating upon the matter. Denmark is still deciding on the issue, although Frederikshavn City Council in Denmark has decided to allow Shale Gas test drilling to take place, recently, in June 2014.(Shale Gas Europe, 2014)

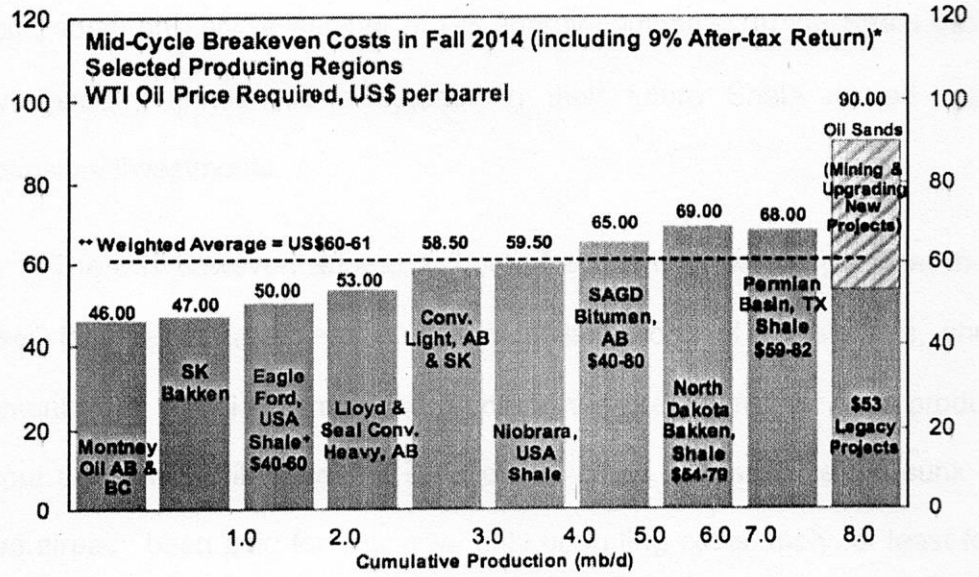
Shale Gas development in China is being undertaken by two state oil companies, Sinopec and China National Petroleum. Regulatory constraints on Shale development have not been observed so far, although only one Shale Gas field, at Fuling district, in Sichuan Province has a commercially significant Shale-gas project being run by Sinopec.

The foregoing analysis points to a fairly positive environment for Shale development. While some European countries are taking their time thinking about environmental impacts and legislative interventions with the exception of France, a number of these have already empowered Shale Gas& oil development and production is underway.

Production Cost of Shale Oil & Shale Gas

Present production costs of Shale Oil/Gas vis-à-vis prevalent prices of crude oil, or natural gas, as the case is are a key condition, to propel Shale Oil & Gas into the league of a 'game changer' or otherwise. It is well established, that Shale development and extraction of oil or gas is resource intensive. So what is the cost of such oil/ gas production? As per various published sources, the costs vary by field.

In terms of prices per barrel, for oil, the following, obtained from Scotia Bank Equity Research & Scotia Bank Economics is illustrative.



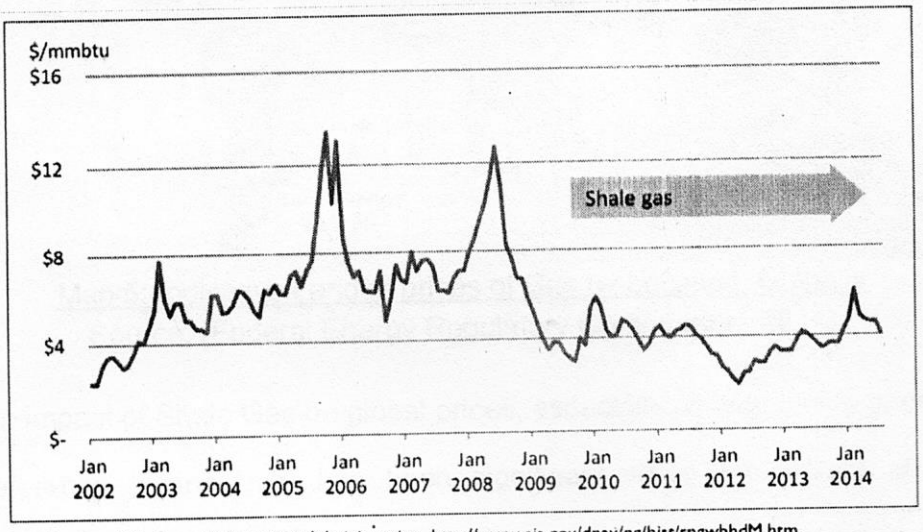
* Excludes 'up-front' costs (initial land acquisition, seismic and infrastructure costs): treats 'up-front' costs as 'sunk'. Rough estimate of 'up-front' costs = US$5-10 per barrel, though wide regional differences exist. Includes royalties, which are more advantageous in Alberta/Saskatchewan.
+ Liquids-rich Eagle Ford plays, assuming natural gas prices of US$3.80 per mmbtu.
++ Weighted avg. = US$60-61 including existing Integrated Oil Sands at C$53 per barrel.
Saudi Arabia: US$10-25 per barrel.
Data source: Scotiabank Equity Research and Scotiabank Economics.

Chart 6: Cost of Production of Shale Oil in US & Canada Source (Plumer, 2014)

Scotiabank economist Patricia Mohr has calculated that the average breakeven price in the Bakken and Permian oilfields is $69 and $68 per barrel, respectively (Mohr, 2014). However, the 'liquids-rich' Eagle Ford Basin will break even at cost averaging only US $ 50 per barrel. In this context, it is pertinent to examine the current oil prices, in the near term. The spot price of Brent Crude on 23 June 2014 was 113.62 US $ per barrel; on 15 Feb 2015, it was 62.15 US $ per barrel (EIA, 2015e). In such a volatile pricing environment, any further development of Shale Oilfields is likely to get inhibited somewhat. In the event that crude prices recover from their historic fall, of over 50%, in the last few months, it is likely to provide a fillip to Shale Oil exploration. Otherwise, till international oil prices remain below US $ 65-70 per barrel, the probability that further investments in Shale Oil and consequent oil production increases may

occur, seem unlikely. A number of US energy companies in the Shale business have already announced a cutback in their future Shale related capacity expansion/ investments.

There is however, another school of economists who argue that the last three four years have seen billions of dollars worth of investments, and the momentum of such investment led production is likely to further drive production output and Shale Oil growth, in spite of low crude prices, since the sunk costs have already been paid for. For now, only operating costs apply, at least for the new unamortised oil wells in the short term. If so, Shale Oil production may well continue, unabated. The uncertainty, due to lower than foreseen oil prices does remain, for sure. On the other hand, due to the Shale Gas revolution, due to which the production of natural gas, especially in the US has dramatically increased, gas prices have come down considerably, as indicated in the chart below.

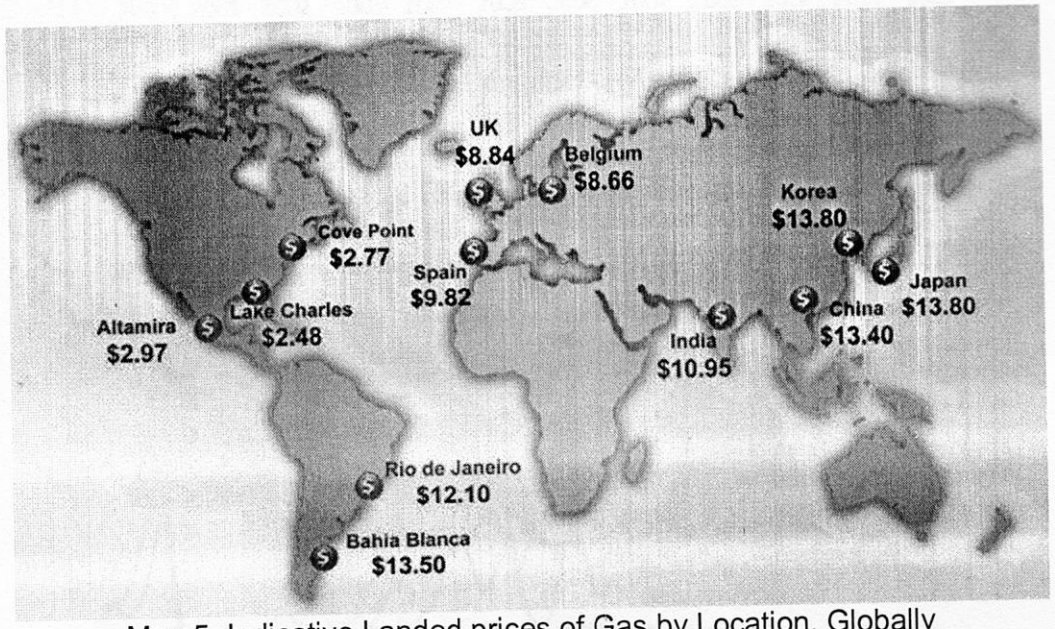


Source: U.S. Energy Information Administration, http://www.eia.gov/dnav/ng/hist/rngwhhdM.htm.

Notes: Units = nominal dollars per million British thermal units (mmBtu). Data for 2014 are through July.

Chart 7: Gas Prices In US After Increased Shale Gas Outputs
Source: (Michael Ratner & Mary Tiemann, 2014)

Since the cost of Shale Gas is profitable at the prevalent Henry Hub prices ranging between US $ 2.8 -3.5 per Million British Thermal Unit (MMBtu), no adverse impact is seen on the long term growth possibilities of Shale Gas. The Henry Hub spot price for Natural gas as on 12 January 2015 was 2.90 USD/MMBtu. In fact, Shale Gas production in the US and Canada has emerged as the most significant reason for low Henry Hub prices, in comparison to the gas prices prevalent in Japan, which are hovering around US $ 11 -14 per Million BTU and Europe, where these are in between the US and American prices. (Reuters, 2015). A map below is indicative of liquefied natural gas landed prices in important world markets, as of September 2014.



Map 5: Indicative Landed prices of Gas by Location, Globally
Source: (Federal Energy Regulatory Commission, 2014)

The impact of Shale Gas on global prices, especially on Henry Hub prices (the US reference pricing hub) has been significant since the advent of Shale revolution. It is interesting to note that post the increased production of natural gas within the US, due to Shale driven gas, the Henry Hub price has remained moderate, and is in sharp contrast to the Japanese Crude Cocktail (JCC) price

and the European market prices, which are significantly higher. The divergence is clearly evident in Chart 8, sourced from BP Global Energy Outlook 2014.

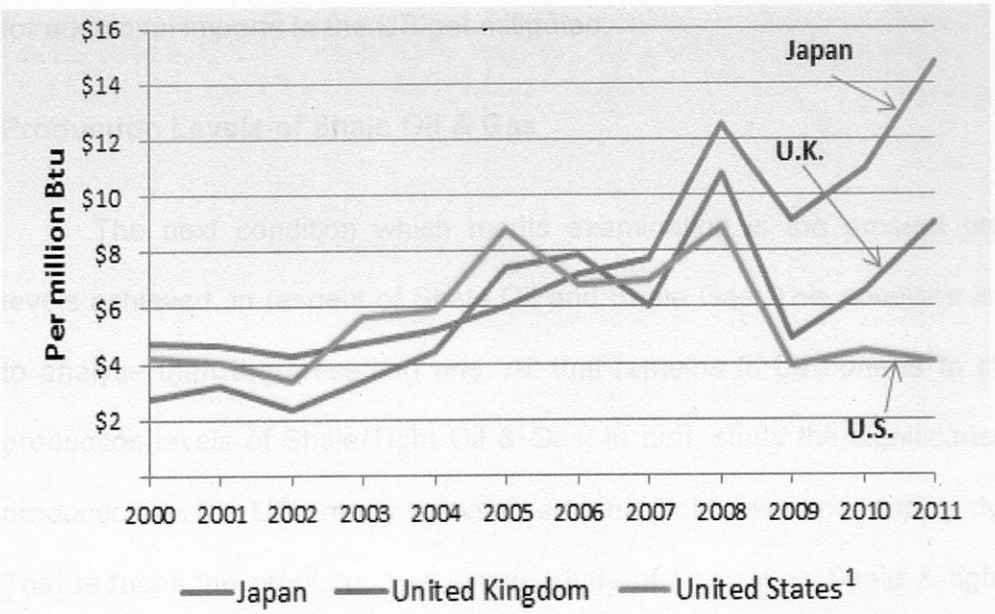


Chart 8: Comparison of Natural Gas Prices by Country
Source: BP Statistical Review of World Energy 2014 (BP, 2014)

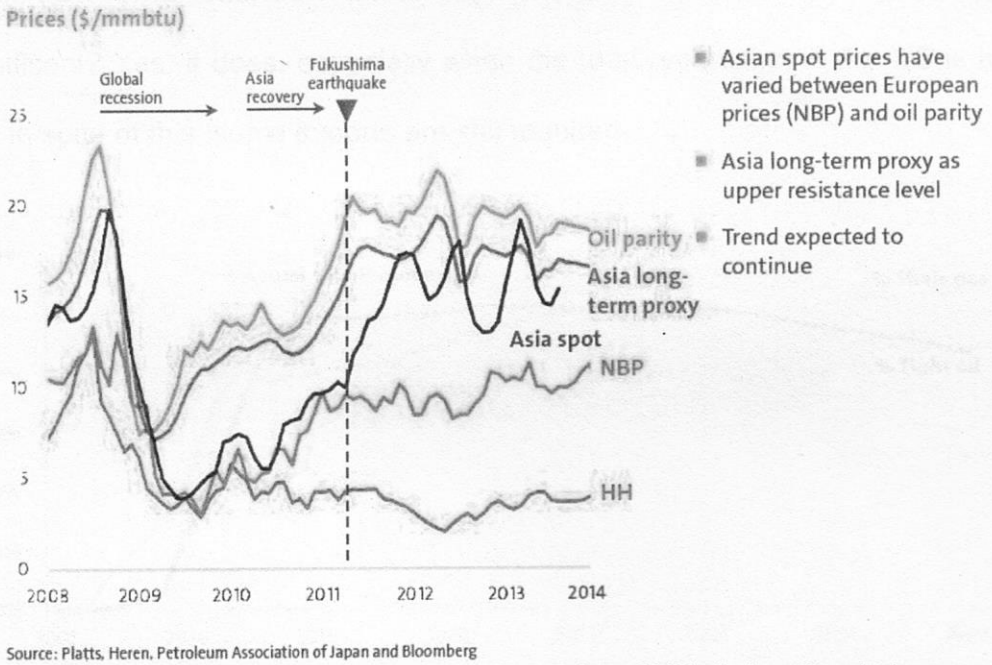


Chart 9: Comparison of Natural Gas Prices With Asian Gas Prices
Source: BP Statistical Review of World Energy 2014 (BP, 2014)

The foregoing does suggest a positive impact on natural gas prices within the US, and since gas prices in the US are low, due to adequate supply, the need for additional imports to the US get mitigated.

Production Levels of Shale Oil & Gas

The next condition which merits examination is the present production levels achieved, in respect of Shale Oil and Shale Gas. This condition is simpler to analyse than the preceding one. All that remains to be done is to study the production levels of Shale/Tight Oil & Gas; in turn, study the significance of this production on the US energy demand, and the global demand–supply dynamics. That reduces the problem, to a simple study of how much Shale & tight oil/gas has since been produced, and is being produced. The chart below, obtained from EIA, is indicative of the percentage of oil & gas that has been produced from Shale/tight formations, as a percentage of total US production. Does it appear significant? Yes, it does, especially when the total production in the US is huge, and in spite of this, some imports are still required.

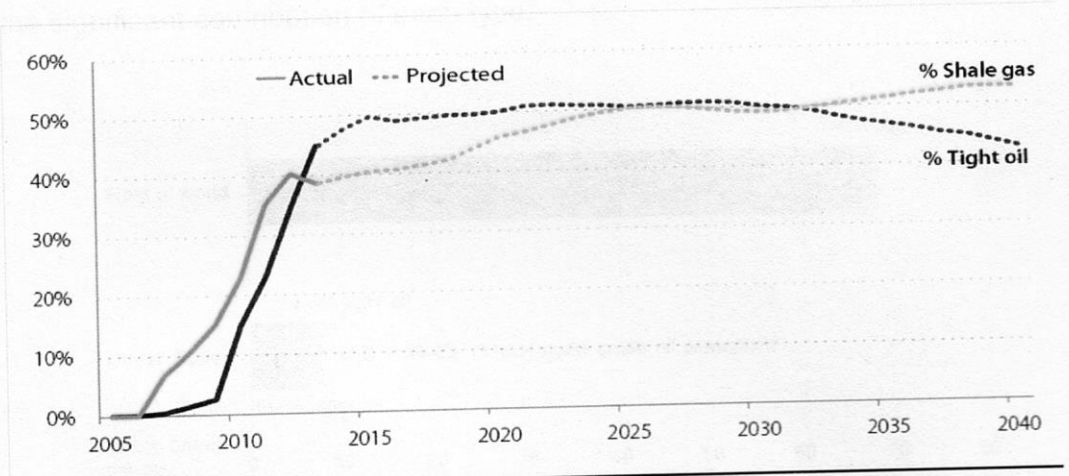


Chart 10: Shale Oil & Shale Gas as % of Total Oil & Gas Production
Source: EIA, *Annual Energy Outlook 2014*, (EIA, 2014a)

Data based production achieved in the past, and estimates of production of oil, from all sources in the US is shown in Chart 11, sourced from the International Energy Agency's Oil Medium Term Market Report, released in June 2014 (IEA, 2014a). LTO refers to 'Light Tight Oil, used synonymously with Shale Oil and Tight Oil. By 2019, total production may exceed 13 Million Barrels /day.

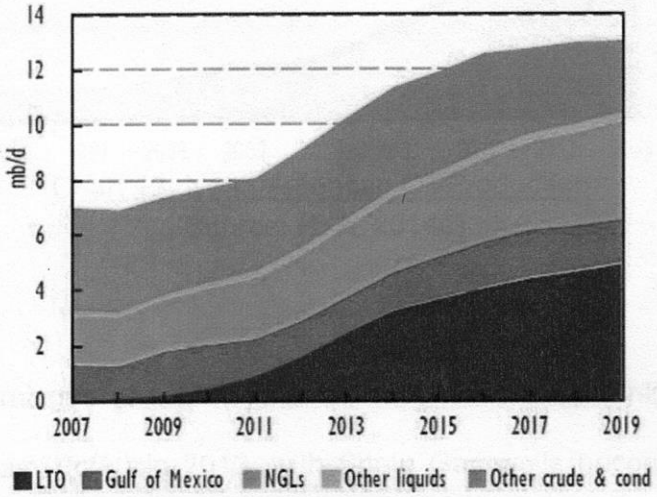


Chart 11: US Total Oil Production by Type

Source: IEA Oil Medium Term Market Report (IEA, 2014a)

In terms of specific quantum of world conventional oil output & US production of both conventional as well as tight oil, the chart below is indicative of the significant contribution of each type.

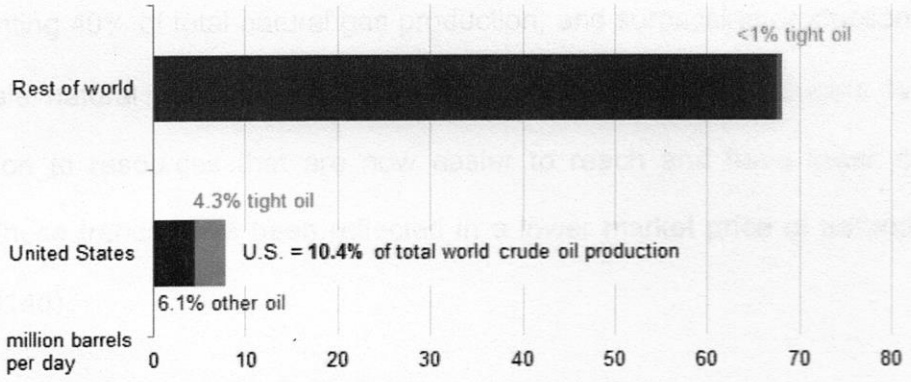


Chart 12: Global Oil Production by Type in 2013

Source: (EIA, 2014d)

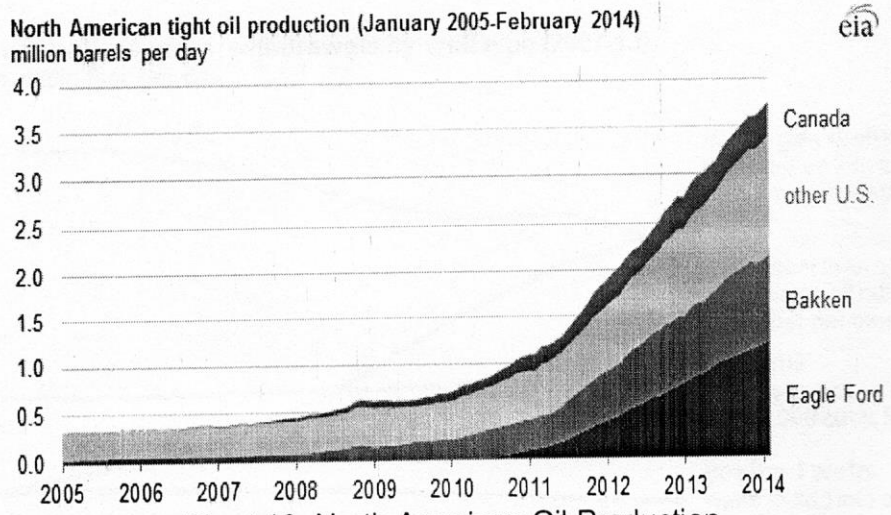


Chart 13: North American Oil Production
Source: (EIA, 2014d)

U.S. natural gas gross withdrawals reached a record high of 82 billion cubic feet per day (Bcf/d) in 2013, with Shale Gas wells becoming the largest source of total natural gas production. Natural gas gross withdrawals are a measure of full well stream production including all natural gas plant liquids and non hydrocarbon gases after oil, lease condensate, and water have been removed. According to the periodical '*Natural Gas Annual*', gross withdrawals from Shale Gas wells increased from 5 Bcf/d in 2007 to 33 Bcf/d in 2013, representing 40% of total natural gas production, and surpassing production from non-Shale natural gas wells. New technology has enabled producers to shift production to resources that are now easier to reach and have lower drilling costs. These trends have been reflected in a lower market price of natural gas. (EIA, 2014d)

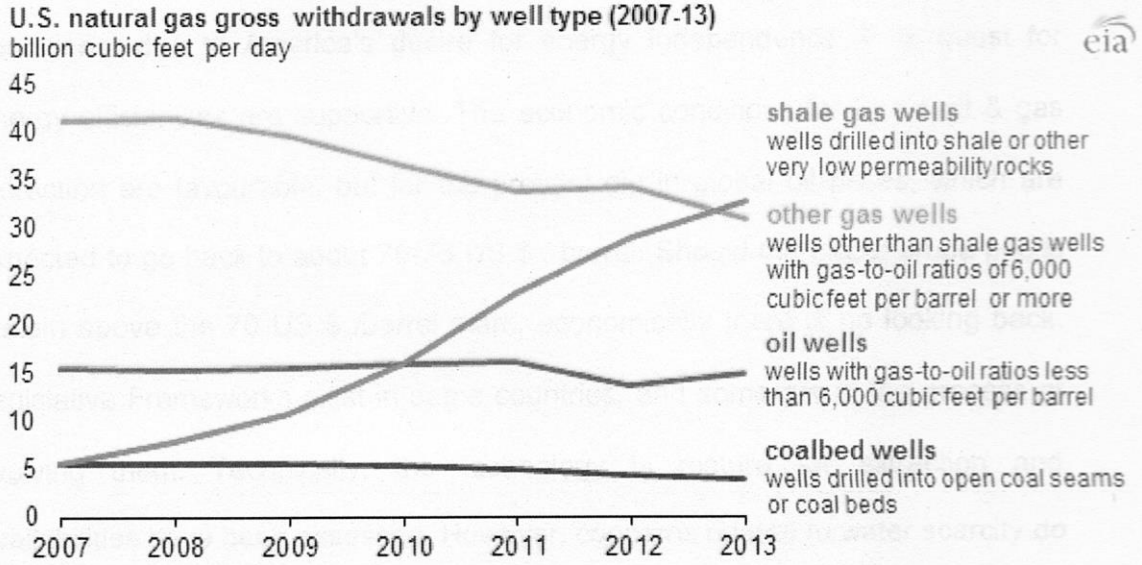


Chart 14: Natural Gas Gross Withdrawals Source: (EIA, 2014d)

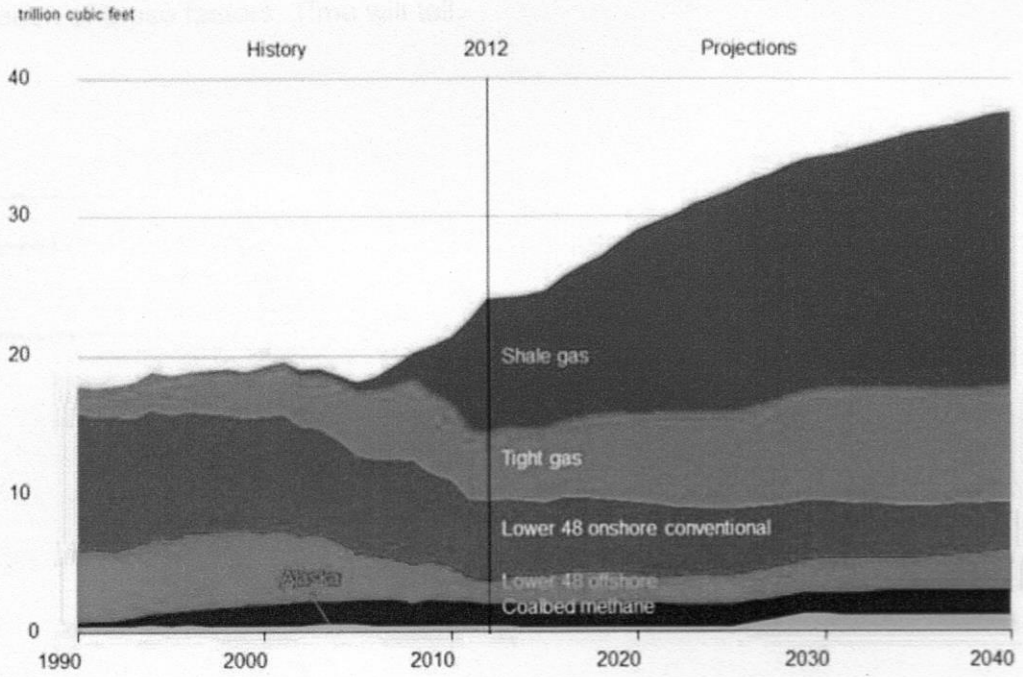


Chart 15: US Natural Gas Production Projections by Source in 'Reference Case' of the EIA Long Term Energy Outlook Source: (EIA, 2014a)

Conclusion

Shale Oil & Gas can actually become game changers. The geopolitical conditions, due to America's desire for energy independence & its quest for energy efficiencies are supportive. The economic conditions for Shale oil & gas extraction are favourable, but for the present dip in global oil prices, which are expected to go back to about 70-75 US $ / barrel. Should the global crude prices remain above the 70 US $ /barrel mark, economically there is no looking back. Legislative Frameworks exist in some countries, and some are in the process of evolving them. Technically, the technology is mature for extraction and availabilities have been assessed. However, concerns related to water scarcity do preclude Shale Oil/Gas extraction from some regions around the world. Similarly, some environmental concerns remain & need to be addresses. Whether Shale Oil & Gas actually do become a game changer will depend, finally, on a juxtaposition of each of these factors. Time will tell.