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Shale Energy - Impact On Trade, Environment And Policies

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ABSTRACT : The global natural gas industry has been revitalized with the production of natural gas from shale formations,which has ushered a new era in the production of energy and its trade.In the recent past in the US, an increasingly important source of natural gashas been Shale Gas. Shale exploration poses several risks to the environment,especially on the availability of drinking water, problems to irrigation, effecting the aquatic habitat in fresh water; and also include hazards from seismic effects. The environmental risks arising out of exploration and/or production of shale gas has discouraged it's exploitation in several countries and also resulted in legal restrictions. The commercialbenefits to gas users and developers alone cannot be the determining factor and the environmental risks and impacts to local communities must also be considered.

This paper attempts to research on the following issues due to Shale gas exploration:

- ***The environmental hazards, natural calamities and the negative impacts to the local communities in and around the exploration sites;***
- ***Influence on international energy trade;***
- ***Whether the current legislations globally are capableof tackling the issues of shale gas exploration; and***
- ***To conclude whether the economic growth is traded off with the environmental hazards;***

Key Words: Shale, Natural Gas, Exploration, Environment, Trade, Economy, Legislations

1. INTRODUCTION

The global economy is heavily dependent on oil as a primary energy resource.The transportation industry, which is one of the most critical components of the global economy, accounts for a majority of the consumption of Natural Gas including Shale Gas and Oil (the "**Petroleum Products**"). Any disruption in the supply of Petroleum Products would have the potential to cripple the global economy.The major producers of Oil are theOPEC[1]Countries which is presently having Saudi Arabia, Libya, United Arab Emirates, Iran, Iraq, Kuwait, Algeria, Angola, Congo, Ecuador, Equatorial Guinea, Gabon, Nigeria and Venezuela as its members.

Petroleum Products are obtained through various extraction methodologies from beneath the surface of the earth. The OPEC members use conventional means for extracting Oil i.e., through drilling into the ground and using pressure to force the oil to the surface; and when the pressure is low, by forcing fluids to boostthe pressure or use suction motors and pumps to extract the oil.

Shale Gas, on the other hand, is present between layers of shale rock, coal beds and tight sands. The methodology for extracting Shale Gas involves a process called‘fracturing’.This is achieved by drilling deep down to great depths (a mile or more) and pumping bursts of a typical mixture of water, sand (including bauxite or ceramic beads) and additives at very highpressures to ‘hydraulicallyfracture’ the shale rock which then releases the natural gas inside to flow to the surface. This process of extracting the natural gas by causing hydraulic fractures in the shale rock is also referred to as ‘fracking’. It appears that shale gasis in an ideal position to replace coal in power stations as it is cheaper thancoal in the US.

Shale oil is often confused with oil shale,which is mineral rock containing a solid combustible biological compound ‘kerogen’. The term oil shale is misleading as, at the very outset, kerogen is neither a fossil oil nor the sub-strata containing the kerogen is shale. To make extraction of oil possiblefrom oil shale, heating techniques are required to heat the kerogen in the absence of oxygen toas high as 950 degrees Fahrenheit. However,as of now, there has beenlittle or no commercial oil production from Oil Shale.

The blending ofhydraulic fracturing technologies with drilling horizontallyhaveenabled the extraction of large amounts of natural gas from Shale formations which certainly willbe economically beneficial to the state and local communities; creating employment opportunities, increase in income and creating ancillary industries. An important use of natural gas, besides being a source of energy for heating, cooking, and electricity generation, is in the form of an input into various industries, such as,in the production of fertilizers.For this process, Gas being the principal feedstock, it will in turn have an impact on lowering the price of fertilizer thereby benefiting the farmers and also on agricultural production, leading to lower costs and prices.

Shale gas resources are believed to be widespread across the globe, however, most countries, including India, have not, as yet, quantified its exploration and extraction on a commercial basis, except for some countries such asUS. The potential resource of 5 most importantresourcesin the USwere estimated at 3,760 trillion cubic feet(“**Tcf**”)with the viability for recovery of about 475 Tcf. In Canada, two resources have been assessedhaving capacity of about 1,380 Tcf, with about 240 Tcfestimated to be recoverable[2]. North America has been the focus for shale gas until recently, however, the potential of shale gas as a secondary source is increasing in other countries after the success story of the USA.

Throughout the USA, during the period of World War I,there were reserves of Petroleum Products discovered in the shale deposits. However, they were largely inaccessible owing to high costs besides a lack of reliable technology for its extraction; and further the abundant availability of conventional gas and oil also contributed to a lack of demand. Over a period of time, the demand for Petroleum Products coupled with new technology for their extraction through horizontal drilling and fracking,set in motion, the commercial exploitation of those reserves. Horizontal drilling process augments recovery of gas andoil reserves and makes

drilling more economical; and alsofacilitates greater access to the reservoir, thereby increasing the production.

Hydraulic fracturing is extensively used not only in the alternative Petroleum Products reservoirs which include shale rock formations having tight gas and oil resources and coalbeds; but also in regular wells. In the US, the blend of modern methodologies for exploitation of shale has become quite advanced and widespread contributing to a significant enhancement in the productionof Petroleum Products. It has been estimated that,during 2015 in the US, hydraulic fracturing[3] accounted for over a 50% of oil stocks and close to 70% of gas stocks.

The reduced costs of extraction of shale gas has affected the global market in a big way. The perception that the availability of natural Petroleum Productswould fall drastically is not true anymore as the breakthroughs in hydraulic fracturing technology have added more years of supply than what oil experts had forecasted a few years ago. This unconventional methodology of extraction is being used in the US, Canada, and Brazil amongst other countries. While in the past, Saudi Arabia, being the de-facto leader, and the other OPEC countries could determine the prices by cutting or increasing the oil production, in the present, the circumstances have changed drastically with rising production of US Petroleum Products; in fact, the price of Petroleum Products fell during the production cuts by Saudi Arabia in August 2014! This has resulted in positioning the Petroleum Products producers of US as the swing producers[4].

2. ENVIRONMENTAL HAZARDS:

1.1 Overview of Fracking:

The process of fracking is not without its environmental risks; as the poisonous mix of chemicals may seep into the groundwater potentially rendering it unsafe for consumption. Fracking uses substantialcombinations of substances which serve various purposes in keeping the pathways open to enable the Petroleum Products and other gasses and fluids (including effluent discharges) to be extracted. Fracking inputssubstantialquantities of highly pressurised water and chemicals into the gas bearing shale,which mixes with the biologicalcomposites, heavy metals and other ingredients, salts and radionuclides which are present deep in the ground. It takes about a minimum of 3- 5 million gallons of amended water (which contains chloride and magnesium) to fracture a horizontal well. The effluent fluids recovered from such wells istermed as “flowback” or “produced” water,which has enhanced percentage of chloride, TDS, heavy metals and elements; including enhanced amounts of radionuclides,bromide and biologicalsubstancesbesides the fracking chemicals, which vary based on the time taken for their return. The concentrations of the pollutants in flowback water due to fracking have a tendency to enhance through the extended period of contact with foundation materials[5].

Water, a limited environmentalresource, provides sustenance to plants, animals and human life and therefore a clean source of drinking water is an essential basic need of all living beings. For the sustenance of human existence, it is imperative that safe and uncontaminated water is available. Despite the fact remaining that the earth is 2/3rdwater, the availability of potable fresh drinking water is relatively small and not so evenly dispersed across the surface of the earth. A vast majority of the earth’s available water resources is comprised of salt

water, some part of it is in ice caps and glaciers and potable water forms a meagre percentage of the same.

Water is a scarce resource and is essential to human existence. The sources of water consist of surface, underground and also through natural purification processes wherein the sea water naturally evaporates to provide fresh water through rains. Since water directly sustains all aquatic, plant, animal and human life, clean potable water is vital for the sustainment of life on earth. The quality of water is totally dependent upon its surface availability levels and the type of contamination it has been exposed to. Pollution of a majority of surface water is from agriculture, industrial effluents, sewage and domestic sources. The sustenance for plants is through the surface water.

To quote Dr. Conrad Daniel Volz, the extraction of Petroleum Products close to the populated areas creates a conditionfor adults and children which is "*immediately dangerous to life and health*" termed as IDLH.'[6]

The sources of ground water include those regions underneath and adjacent to rivers, lakes and stream beds. A vast majority of civic water systems implemented for agriculture, industry and hoe use is through ground water. An 'Aquifer' is a water source in rock or sub-stratawhich has enough permeability to allow water to flow through it[7]. An aquifer may be depleted of its water resources and is dependent upon recharge, failing which it may not recover for a long time[8].

The plant life is almost totally dependent on large amounts of precipitation and surface water; and tends to be scarce in geographical areas which lack sufficient rainfall and surface water. The level of pollutants and contaminants in water impacts the wellbeing of plants, animals including human beings and can be directly observed[9].

Therefore, improperly managed water resources would negatively impact plant, animal and human health. As the global population keeps increasing, the need for clean drinking water is also escalating. Human activity such as industry, agriculture, domestic sewage, etc., tends to directly contribute towards contamination of water.

The EPA[10]describes resources for potable water to be any water resource, either ground or surface resource that could produce enough amount of water for public or private water supplies[11]. The definition encompasses all the water resources;however, fresh clean drinking water resources are getting scarcer owing to climatic conditions such as droughts and also due to contamination from industry, agriculture and in the present context, fracking.

By far, agriculture is the largest source,approximately seventy percent, of global demand for water whereas, industry accounts for approximately twenty percent followed by domestic usage. As global population surges, the demand for water is also increasing exponentially. There have been increasing trends of water shortages globally and the ground water levels are also depleting steadily in the African continent and Middle East countries.

1.2 Land Use:

In a research conducted in Poland, anassortment of scenarios for shale gas exploitation were modelled[12].It was observed that the extent of terrain required for extractionof Petroleum

Products was varying which was dependant on multiple factors such as, the density, size and wells per pad, and the nature of the sub-strata being developed. Since the process of fracking for extraction of Petroleum Products involved predominantly horizontal drilling, wells were commonly drilled in clusters. This process decreased the requirements of direct land-use, as multiple well pads could be maintained by the common infrastructure. It is pertinent to mention here that the presence of urban settlements or ecologically protected areas would affect the availability of land.

The shale gas exploration and extraction activities would certainly increase at a very fast pace as the infrastructure is developed. The characteristics of the sub-strata are the essential criteria in ensuring the effectiveness of growth of the shale resources. However, other considerationsare also important in the processing area such as, accessible water resources for one, proximity of transportation networks and distribution channels for gas. Further, the overall construction area comprises of theterrain necessary for supporting infrastructure,for instanceservices and logistics, includingmanaging areas[13].

The exploitation of Petroleum Products impacts the surrounding localitiesin contrastwith many othersurface intrusions and is quite similar to anexpanding grid; thus far, the impact has been unequal, but widespread, on the environment[14]. Thereason for the altering landscapes[15]appears to be the development of roads and pipelines as most exploration is being done near existing infrastructure and the use of roads has been high.

1.3 Contamination of the groundwater:

The process of fracking water cycle involves five stages, each of which involves water as follows:

a. Water for preparing the hydraulic fracturing fluids;
b. Water, sand and additives for the fracturing fluids;
c. Insertion into the well and in the targeted shale rock;
d. Clearing the Flowback Water or reprocessing the same; and
e. Removal or reprocessing of wastewater.

The EPA compiled a list of 1606 chemicals[16] used in fracking process for evaluating the probable hazards in the water cycle[17]. The chemicals identified are not unique to the fracking process and are prevalently used in other industrial processes also while some of the chemicals are also naturally available in groundwater sources.

The EPA had compiled a catalog of chemicals from various federal and state government sources[18]. The EPA'sFinal Report[19]mentions thatout of the above-mentionedchemicals, 599 have been found in flowback waterincludingnaturally occurring radionuclides and organicsbesides metals, industrial chemicals, and pesticides. These chemicals were recorded from anaggregate of 21 sources[20].

The permeability of shale being naturally low, it must be fractured in order to ensure higher yield. However,since the fracking process involves the use of millions of gallons of water, good water management practices can enable reuse of flow back or produced wastewater. There has been a mounting regulatory pressure and from the public for stringent measures to enforcegood industrypractices for water management[21].

The EPA's stipulationn of criteria for water quality[22]is the recommended guideline for the states implementingthe standards[23]for quality water and provides a methodology for regulatingsecretions or discharges of contaminants.

The results of an analysis, which was conducted by CHEC, of the extent of statutory infringements by well type in Pennsylvania[24]have shown that the wells at Marcellus had between one and a half to four times more infringements per offending wellin comparison with conventional wells. However,since this evaluation was in relation to the total wells drilled, andas drilling has been going on well over a period of 100 years, it is tricky to determine for conventional Petroleum Products wells.

The total Dissolved Salts (TDS) levels in flowback water in the Marcellus Shale[25]was equivalent to greater than 20% salt content. Thislarge array of TDS in flowback water may be owing to normalcircumstances including, but not limited to, the predisposition of increase in TDS of flowback as it flows from the well[26].

1.4 Air Pollution:

Air pollution resulting fromthe fracking process includesdischarge of methane gas and the existence of VOCs[27] evaporating from the produced water stored in open pits; including 'flaring', which is the controlled burning of natural gas. The incidence of increased ground level ozone is also attributable to the VOCs such asBTEX[28]. Ozone at ground level can form due to certain complex chemical reactions in the presence of sunlight with VOCs and other naturally occurring gases. Ozone has been identified to aggravate COPD[29]due to hypersensitivityof airways and also asthma. There is a legitimate concern that in the activity of fracking in fieldswith thousands of wells maybe affected byenhancedozone levels[30].

Another cause for Air pollution is due to the usage of diesel engines in oil production and the numbers of diesel trucks (the "**Vehicles**")which are utilised for the said operations;from gas compressor stations; and from transportation as multiple Vehiclesare utilised for delivering the huge volumes of water required in the fracking process. Vehiclesare also required to deliver proppant and other materials, meant to maintain an induced hydraulic fracture open, which is delivered over a period of a few weeks. If the other deliveriessuch as of fracking compounds, drilling materials etc., as well as the trips to remove the produced gas, oil, or contaminants are included, it makes up for a major case for air pollution. Diesel exhaust and the many substances contained in it, have the potential to lead to cancer. It has been established that the long-term exposure to diesel exhaust particles is an extremely hazardous risk for contracting canceras had been evaluated by Office of Environmental Health Hazard Assessment ("**OEHHA**")[31].OEHHA conducted an analysis of people such as drivers and workers,who worked in the proximity of equipment running on diesel. The result of the studies indicated that the subjectsmost likely to develop lung cancer were those who were most exposed to diesel emissions.

1.5 Suggestions:

a. Stringent practice of safer treatment methods for the flowback water, such as, forward osmosis, which can turn muddy, contaminated water, into cleanerwater which can then be reused in the fracking process;

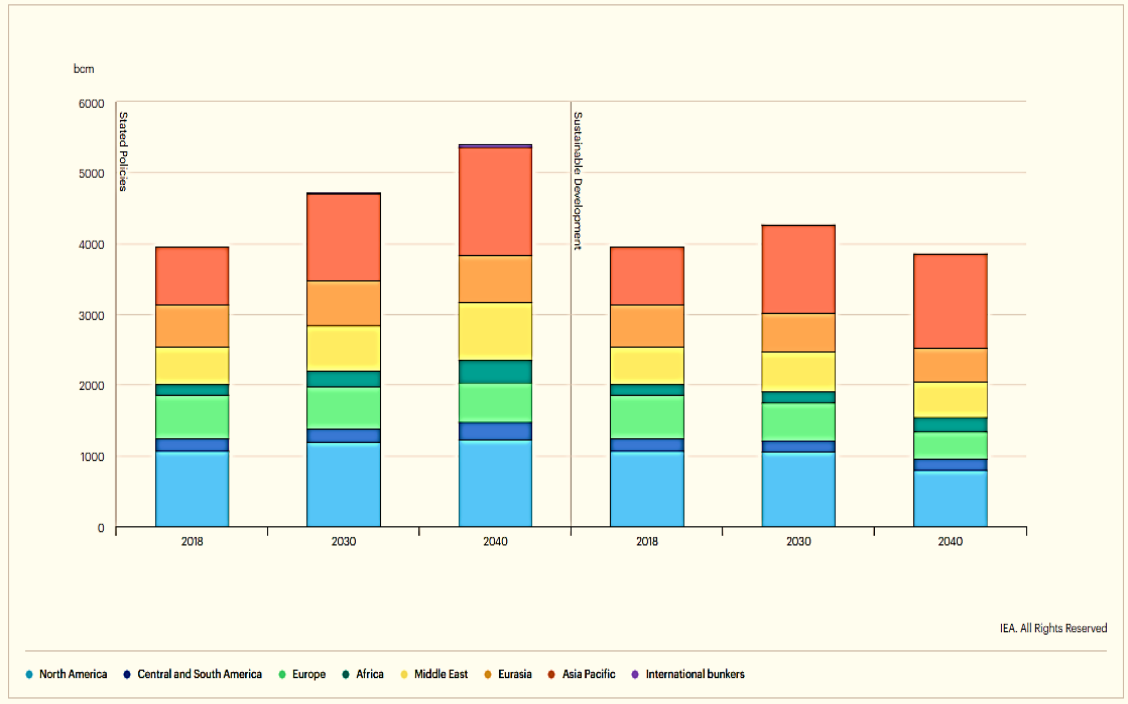
b. The usage of CNG vehicles instead of Diesel vehicles for transportation in the fracking processes could be a start to reduce the air pollution;

c. Including best industry practices and knowledge sharing amongst the Shale companies;

Impact on International Energy Trade: (IET)

1.6 Global Energy Trade:

The IEA[32]in its report had stated that the global energy demand increased by approximately 50% due to increase in natural gas consumption.[33]



Gas demand by region and scenario, 2018-2040[34]

The report further states that the use of natural gas shall increase in next ten years before reaching a peaktowards end of 2020s after which, it starts to taper down[35].The outlook therefore, for natural gas trade appears to be quite positive in the coming decades. The report further mentions that there could be an enhanced consumption of natural gas in the Power sector till 2030.It is pertinent to mention here that coal, as an energy source, is apparently losing favour due to the increasing availability of Petroleum Products and its role in Power production[36].

IEA predicts that the growth in energy trade, particularly that of natural gas, is in an upward trend especially in the LNG and pipeline trade.

1.7 Share of Shale Petroleum Products

The global energy needs have evolved drastically over the last few decades from hydro power and coal to natural gas. The consumption of energy is ever growing as modernisation and

expansion of industries are heavily dependent on electricity. The IEA's Outlook for Natural Gas states that the global energy needs will change dramatically until 2040.[37]

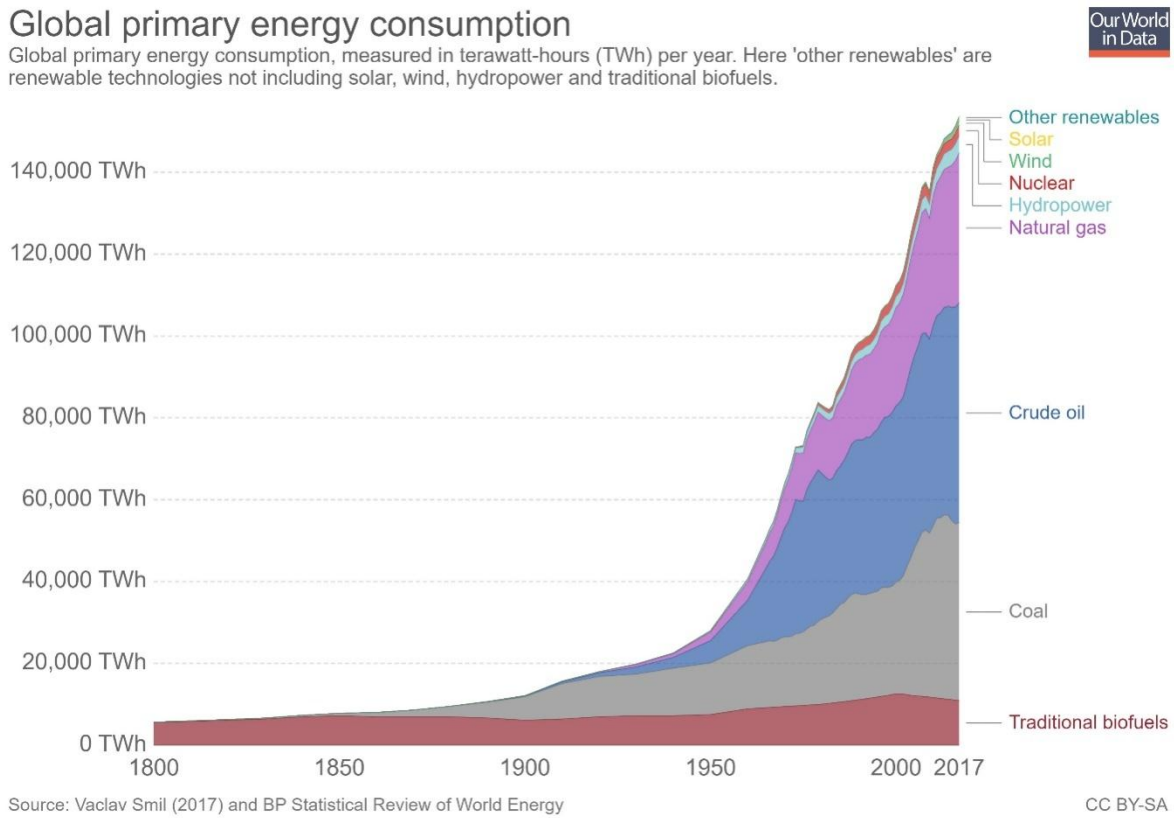
The global demand of natural gas, from 2016 to 2040, has been predicted to increase manifold. The table below details the demand of natural gas by region.

							2016-40	
	2000	2016	2025	2030	2035	2040	Change	CAAGR*
North America	800	961	1 045	1 068	1 109	1 143	182	0.7%
United States	669	779	834	846	867	880	101	0.5%
Central & South America	97	166	183	205	237	271	106	2.1%
Brazil	9	36	38	43	55	64	28	2.4%
Europe	606	590	604	618	633	631	41	0.3%
European Union	487	463	461	467	469	454	- 8	-0.1%
Africa	57	134	177	211	251	306	171	3.5%
South Africa	1	4	5	7	8	10	6	3.8%
Middle East	174	477	568	657	737	795	318	2.2%
Eurasia	471	575	583	593	615	636	61	0.4%
Russia	388	456	452	456	463	470	13	0.1%
Asia Pacific	314	732	998	1 167	1 331	1 472	740	3.0%
China	28	210	397	482	554	610	401	4.6%
India	28	55	97	126	155	183	128	5.2%
Japan	82	123	95	100	106	107	- 16	-0.6%
Southeast Asia	88	170	195	216	244	269	99	1.9%
Bunkers**	0	0	16	26	37	51	51	n.a.
World	2 518	3 635	4 174	4 545	4 950	5 304	1 669	1.6%

* Compound average annual growth rate. ** LNG used as an international marine fuel.

Natural gas demand by region[38]

In the United States alone, Shale gas-fired power in electricity generation has witnessed an



increased share[39]

The IEA's Outlook for Natural Gas[40] further states that even though consumption of oil and coal will reduce,and renewable energy will witness strong growth, natural gas would become most prominent single fuel in the global mix.

1.8 USA and other Shale producing countries:

The United States has made a remarkable progress in the exploitation of its resources of Petroleum Products since the dawn of the millennium. With the advent of cheaper and more efficient means of Shale gas and oil extraction, the US has become the major global producer of Petroleum Products. A January 8, 2018 report of the 'Insider'[41] mentioned that it was likely that the biggest gas exporter would be Australia overtaking Qatar and the US could assumethe said role by the mid-2020's.

The increasing exploitation of US Shale resources had contributed to the oil prices plummeting in 2014. The IEA had, in its Market Report Series: Gas 2017[42], had stated that the global gas market is changing with the increased shale-gas exploitation in the US and the second wave of additional liquefaction capacity from Australia and the US.

The World Energy Outlook 2017[43] report on 'Outlook for Natural Gas' stated that the natural gas market is experiencing a rebalancing due to which, by mid-2020, the US would become the largest gas exporting country in the global gas market. It further reiterates that the US would add approximately 300 bcm of global gas supplies in the next 25 years which would be

closely followed by China with about 200 bcm; Iran and Russia with around 145 bcm each; while Australia and Argentina also contributing to the global gas supplies.

This is where the future of gas and oil appears to be headed as unlike in the past, though the conventional reserves of natural gas and oil in the Middle-East Countries and the OPEC had a predominant effect on the control of global Petroleum Products prices, it certainly is not the case at present. This is further supported by the projection in the 'Outlook for Natural Gas'[44]that the new sources of global gas supplies would be from US, Russia and Qatar.

However, a worrying outcome of all the euphoria over the US Shale extraction has largely been ignored, if not altogether acknowledged. It is the cash flow problems in the exploration and extraction of Petroleum Products by the US companies. According to Kurt Cobb[45], in the Sale Oil industry, investors' money is not being utilised appropriately and for the first half of 2018, out of 33 Petroleum Products companies,only 9 had surplus free cash flow!What is alarming is that this situation has arisen despite that fact the prices had risen over $70 range by the middle of 2018 from a low of around $30 in 2016. Ultimately the outcome appears to be bleak for these companies in the US and it appears to be only a matter of time before they may go bust.

3. Global Legislations:

1.9 USA:

The legislation pertaining to Fracking in the US, more particularly governing the disposal of flowback, is the Clean Water Act ("**CWA**"). The CWA stipulates the specifications for the flowback and bans the release of the non-complying contaminants into the waters of the US. Any discharge of contaminants into waters require a prior permit[46]. Despite having such rigid standards, it has been found thatelevatedconcentrations of contaminantswere present in a number of water resources across the United States. It appears that Unites States is relaxing the relevant regulations with a reasonable approach which is promoting efficiency through lower gas prices.

In 1974, Safe Drinking Water Act (SDWA) was enactedintending to safeguardpotable water. EPA is tasked with setting the standards for the quality of drinking water including to monitor and report the requirements. More particularly with regards to fracking, the SDWA prohibits underground infusion of fracking liquids unless a prior permit is obtained which is the protection afforded to the sources of drinking water[47].

In the classes of wells inthe permit system under UIC, Class II wells are relevant for fracking. Prior to the petition filed by the Legal Environmental Assistance Foundation, Inc. ("**LEAF**")[48], fracking was not considered as an underground injection by the EPA.

It appears that there has been a commendable attempt through the various regulations, to bring in a balanced approach to serve both, for an overall benefit to the economy in the United States of America.

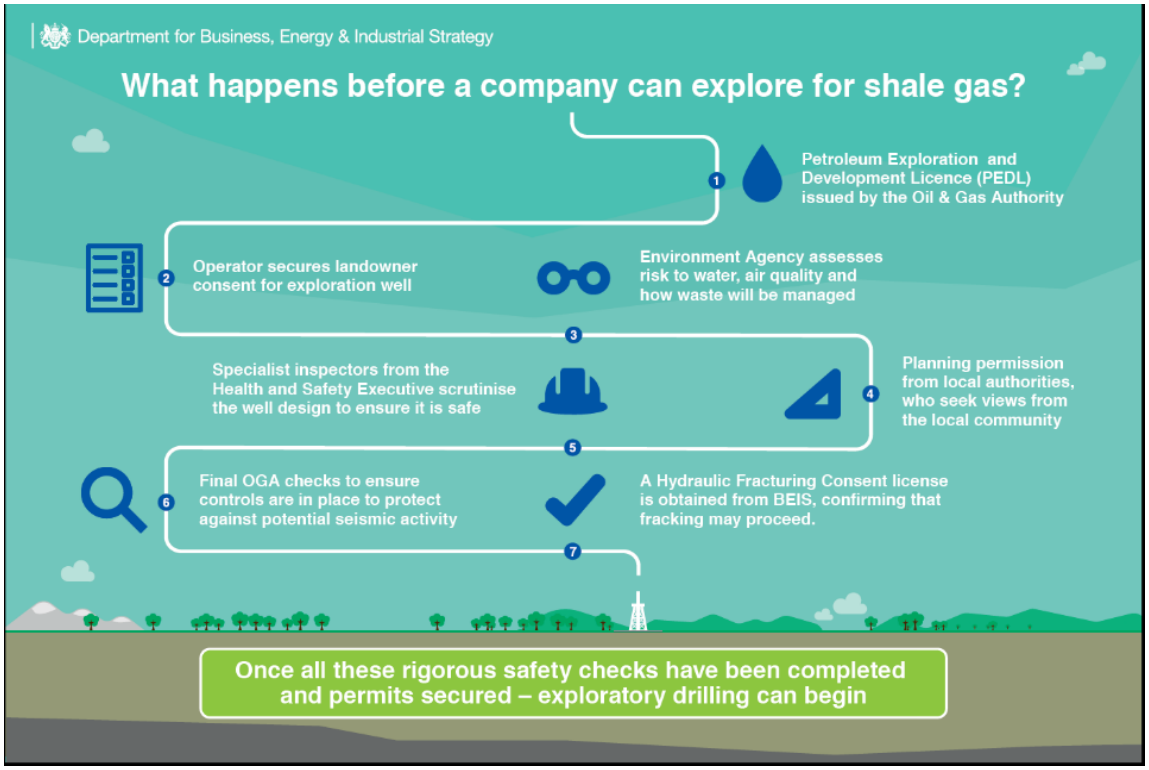
1.10 UK:

UK had a chequered history with regards to fracking. Though UK was exporting gas in the past, the declining production of gas had converted it into a net importer. The UK apparently

hasenough Petroleum Products reserves to last about 470 years, which would be ample to resolve its energy crisis[49].

The Infrastructure Act 2015[50], in Part 6 'Energy' under the head 'Petroleum and geothermal energy in deep-level land', simplifies the procedure for any person to obtain the permit for the purpose of tapping the Petroleum Products and deep geothermal energy in thesub-strata 300 metres and below. It covers various provisions for the imposition of financial penalties in respect of breach of relevant requirements.

The exploitation of UK's resources of Petroleum Productsis controlled and regulated by the Petroleum Products Authority of UK ("**OGA**").Before commencing any activity of fracking in the UK, the operators should obtain clearances formeticulous health and safetyprocesses, permission forprocesses relating to planning and environment[51].



1.11Germany:

Germany has used Fracking technology since the 1960s for the extraction of Petroleum Products from traditionalresources which include sandstone and carbonate stones. At present, about one third of the Petroleum Products produced in Germany are from conventional fracking.

'Unconventional fracking' is the process of using horizontal drilling techniques for exploiting Petroleum Products which are found in coal formations, shale, clay and marl[52]. However, Germany regulates this technology only for the purposes of scientific research and that too only in compliance with strict regulations.

The German Government has taken a strong stance on the issue of environmental damage due to unconventional fracking. The Federal Government Website of Germany https://www.bundesregierung.de reported that Fracking will not be a major activity in Germany andprotection of drinking water reserves and natural landscapes has precedence over economic interests.[53]

In the past, the authorisation for fracking was under the Federal Mining Act. However, owing to strong public opposition and environmental concerns German domestic gas production has declined.[54]

1.12 France:
France purportedly has the second largest shale gas reserves in Europe after Poland, however, the local legislations have prevented its extraction including exploring opportunities which have halted attempts at even assessing the potential of its shale resources. About 75% of France's energy needs are met by nuclear energy and 15% are from renewable sources leaving the rest to be fulfilled by fossil fuels. Therefore, France does not perceive any immediate need to tap its shale resources.

1.13 Poland:
In Europe, Poland reportedly has the biggest reserves and has been one of the pioneers for permitting fracking. The Geological Mining Law of 1994 was replaced with the Geological and Mining Act of 2011 ("**GMA**") which had also regulated hydrocarbons.

In Poland, prospecting for minerals is a two-step process:

First Step: the entity must acquire an exclusive right (mining usufruct) to capture the water under the property subject to the safeguards to the property;

Second Step: the entity registered in Poland, must obtain a concession, or an official approval for a geological work program.

The Minister of the Environment (MoE) is the authority for awarding concessions in Poland[55].The GMA was significantlymodifiedunder the Act of 11 July 2014, thereby simplifying the process wherein just one license is necessary; and also, to encourage investors in carrying out exploration activities[56].

1.14 Algeria:
Algeria had enacted the Hydrocarbon Law in 1986 and allowed Sonatrach[57], the national state-owned oil company of Algeria, to be open to partnerships, however with the stipulation of holding and maintaining a minimum participation rate of 51%. The Hydrocarbon Law had facilitated better access to overseasinvestment through joint ventures, production sharing agreements and risk-service contracts, and reduced royalties and income taxes. The Hydrocarbon Law was amended in 1991 for making the recovery of invested funds by foreign companies operating in the gas sector easier and other favourable conditions but the foreign companies did not respond positively. Thereafter, there were further changes brought about by the amendment in March 2005 to encourage foreign companies to operate and invest in areas which were previously dominated by Sonatrach.

The Hydrocarbon Law did not apportion any participation rate to the state, so it was further amended in 2006 introducing a windfall tax of up to 50% on profits when oil prices exceeded $30/bbl, and mandated Sonatrach's minimum participation of 51%. Further, on February 20, 2013, the Hydrocarbon Law was once again amended to increase Petroleum Products reserves and explore new territories, such as offshore areas in the Mediterranean and onshore areas containing Petroleum Products reserves. Furthermore, this law aims at involving foreign companies to enhance petroleum recovery rates within mature fields[58].

1.15 India:

In India, the regulation of exploration of petroleum was through the Oilfields(Regulation and Development) Act, 1948 and the rules made thereunder are the Petroleum and Natural Gas Rules, 1959. The governing functions are discharged by the Directorate General of Hydrocarbons ("**DGH**"), an autonomous body which regulatesthe safety and environment, leasing and licensing and also reservoir management, conservation anddevelopment of Hydrocarbon resources in India[59]. One amongst the many roles and functions of the DGH is the exploration and development of unconventional Petroleum Products.

The Policy Guidelines[60]granted the right for the exploration and exploitation of Petroleum Productsonly to the National Oil Companies ("**NOC**") which hold Petroleum Exploration License ("**PEL**")/Petroleum Mining Lease ("**PML**"). Private operators like Reliance Industries, even Gujarat state government's Gujarat State Petroleum Corporation Ltd and others have not been granted rights. Only six basins have been permitted to be explored in India which are:

a. Assam-Arakan (in the North-East);
b. Cambay (in Gujarat);
c. Gondwana (in central India);
d. Indo- Gangetic Plain;
e. Kaveri onshore; and
f. Krishna-Godavari onshore (in Andhra Pradesh),

However, owing to the federal system in India, several jurisdictional issues, more particularly relating to land and environment may arise for opening the Shale Gas and Oil exploration to private enterprises and also to address the benefit to the state government. There is a need for a comprehensive regulatory regime for encompassing NOCs and private enterprises for creating a level playing field.

However, in November 2019, ONGC has shelved its shale exploration, spread over Gujarat, Andhra Pradesh and Assam, after having spent more than 5 years as the results hadn't been encouraging[61]. There were several contributory factors for the setback, as ONGC had, concluded drilling in about 26 wells in the three hydrocarbon basins of Assam-Arakan,Cambay and Krishna-Godavari at a cost of over Rs 600crore.

Is economic growth is traded off with the environmental hazards:
The commercial exploitation of Petroleum Products has impacted the global trade in energy leading to an overall fiscal growth of the country. In the US,growth in annual shale gas production in 2012 grew to about 9.7 Tcf from about 1 trillion cubic feet (Tcf) in 2006, andthe net exports of natural gas from US from January till June 2018,averaged 0.87 Bcf/d, which was double the daily average net exports during the year 2017[62].

The presence of shale oil in the exploration and extraction of Petroleum Products, though more expensive than conventional extraction methods, makes it more profitable. In the US the improvements made in the methodologies applied for exploration and extraction over the years have made it cheaper as compared with the rest of the world. The lower gas prices in the US have led to increased investment in industries within the US and is predicted to create over a million jobs by 2025[63].

However, the novel coronavirus ("**COVID-19**") pandemic has created a global uncertainty, not only to the Petroleum Products market but also in every aspect of our lives. In view of this pandemic, the year 2020 would certainly witness a 'first-time' contraction in the global Petroleum Products demand. At this early stage, it is difficult to even make a beginning for an assessment into its impact.

US Shale companies in the recent past have been reeling from the global oil price slump. Since the US shale companies are heavily reliant on loans, they are facing the flack due to slack in demand coupled with global slump in oil prices. In fact, it has been projected that many are fighting for survival and the outlook appears grim. It has been reported that the banks may soon start taking overthe assets of underperforming shale oil companies[64].

The present situation is critical for the survival of the US Shale companies with the COVID-19 pandemic running across US, global slump in demand and thereby a drop in oil prices and declining yields in the wells. On April 1, 2020, it has been reported that Whiting Petroleum filed for bankruptcy[65]. This may indeed be the tip of the iceberg and time alone can tell the fate of the rest of the oil companies.

The impact of Fracking on health is real and cannot be ignored. Several cases of health hazards associated with living close to the Fracking rigs such as, bloody nose, outbreaks on skin, queasiness and giddiness, increases in premature births and birth defects[66]have been reported.

Further, the environmental impact is also considerable as the Fracking process releases toxic chemicals into the ground and makes the groundwater unhealthy even leading to degeneration of the soil sub-strata. There is even air pollution due to the emission of gasses and pollutants which make the Fracking site hazardous for the personnel engaged in these activities. Other related social hazards are noise pollution and increase in heavy traffic.

Considering the environmental and health impacts of Shale Oil, and the exponential growth that this sector had witnessed in the US alone over the last two decades, it is apparent that it is a trade-off with the economic growth.

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b. Class II. Petroleum Products related injection wells;
c. Class III. Solution mining wells;
d. Class IV. Shallow hazardous and radioactive waste injection wells;
e. Class V. Wells that inject non-hazardous fluids into or above underground sources of drinking water;
f. Class VI. Geologic sequestration wells for carbon dioxide.

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