ENVIRONMENT IMPACT ASSESSMENT REGULATIONS IN SHALE GAS INDUSTRY:
Way Out

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[Abstract: *The great success story of US shale gas development stimulates the shale gas exploitation opportunities in India. The Government of India has aimed to increase the contribution of natural gas up to 15% in India's overall energy mix by 2030 to move towards developing India as a gas-based economy. Being one of the highest consumers of natural gas in the world, India needs to enhance its capacity through shale gas exploitation ensuring minimal impact on the environment externalities. Efficient & sustainable environment policies have been framed to a reasonable degree through Foreign Ministers Framework Dialogue outcome ["FMFD"] and Hydrocarbon Exploration and Licensing Policy reforms. ["HELP"] . These efforts have undoubtedly widened the scope for sustainable & profitable exploitation of unconventional resources in Indian Sedimentary basins, however a lot is still required to be done. The technologies which we use currently for shale gas exploration and production involve massive hydraulic fracturing operations coupled with intense side-tracked horizontal drilling. The research paper aims to explore the nuances of extraction, production, and transportation in the shale gas sector with respect to GHG pollution & other externalities on a local & regional scale, ultimately resulting in Ocean acidification, global warming & climate change. The paper further digs into the process of conducting Environmental Impact Assessment ["EIAs"] in the shale gas value chain in the Indian Context, focussing on associated environment externalities related to air, water/aquifer, intense drilling, noise, and resulting health hazards with the purpose of furtherconsolidation & improvements in EIA practices & policy frameworks for Indian Shale Gas Reservoirs.]*

Keywords*: EIA, GHGs, Shale Gas, Environment externalities, Hydrofracturing, Sustainable Development, Ocean acidization.*

I

Introduction

India has climbed to the fourth position in the world' as an importer of Natural Gas (LNG) since 2011. The increasing imports are attributed to the country's declining domestic production trend and a significant increase in domestic consumption

during the past 10 years.[1] EIA also expects it to further enhance by one-third in the next 3 years as regasification facilities are developed in the near future. The growth in imports and consumption is mainly driven in the industrial sector i.e. fertilizer, petrochemicals, City Gas Distribution, and automotive sectors. India's production of natural gas, majorly produced from offshore prospects (about 70%), has faced a steady decline, from 4.4 billion cubic feet per day (Bcf/d) in 2012 to 2.9 bcf/day in 2019 and further down trending every year. Lack of major gas discoveries puts limited potential for future growth unless unconventional Shale Gas development takes off of in a major way.

Shale gas is a unique unconventional energy source driven primarily by technological Innovations in horizontal drilling and hydro fracturing areas. The entire operational processes essentially require substantial environmental impact evaluations and their timely remedial actions. The evaluations & desired remedial actions vary based on the geology, geomorphology and demographic considerations.Shale gas refers to natural gas trapped within shale rock layers located at depths exceeding 1500 meters. Shale gas can be categorized as either biochemical gas, thermal genetic gas, or a combination of both. It is often found in naturally occurring fractures and has low absorbability in pores. Shale gas has thus gained massive popularity in Countries like US, Canada, China etc. US has been the Champion torch bearer in the shale gas exploitation innovations. All this is due to the domestic availability, lower carbon emissions, and the benefits of energy independence, shale gas is seen as an alternative to other forms of imported gas.[2] Currently, India only produces 6% of its electricity through natural gas.[3] Natural gas is considered as a greener energy source when we compare it with conventional energy sources like coal and oil, and the production of natural gas is significantly cheaper than the production of electricity through other sources.

Ministry of Petroleum & Natural Gas in the year 2013 granted permission for Shale gas and oil exploration and exploitation originally only to public companies on-land

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[1]US ENERGY INFORMATION ADMINISTRATION,*Growth in India's LNG imports will depend on completion of connecting pipelines,available at:*https://www.eia.gov/todayinenergy/detail.php?id=43655 (last visited May 28, 2023).

[2]Y. Zhang, *Shale Gas Development in China: Implications for Indoor and Outdoor Air Quality and Greenhouse Gas Emissions,*Environment International, *141,* 105727(2020). *available at:* https://doi.org/10.1016/j.envint.2020.105727(last visited May 28, 2023).

[3]ENERDATA, *India Energy Information, available at:* https://www.enerdata.net/estore/energy-market/india/#:~:text=Coal%20is%20the%20country's%20top,%2C%20and%20wind)%204%25 (last visited May 22, 2023).

nomination blocks. [4] In India the sedimentary basins for shale gas reservoirs have been explored for potential development and extraction in Cambay Basin, Krishna Godavari Basin, Gondwana Basin, Assam & Assam-Arakan Basin etc. The HELP Policy framework adopted in 2016 in India for promoting ease of doing business in O&G sector provided additional impetus in developing the shale gas industry in the country. The government of India further notified reforms in 2018 regarding policy framework for exploration and development of unconventional hydrocarbons in the current Production Sharing Contracts ["PSC] [5] . The shale gas industry in India is still at a nascent stage and is in dire need to careful evaluation of its environmental impact assessments in the right earnest on field-to-field basis.

As per the shale gas policy of 2013, nomination blocks are awarded to National Oil Companies ["NOCs"] in order to explore and exploit the hydrocarbon reserves of the country under the Oilfields (Regulation and Development) Act of 1948 and the Petroleum and Natural Gas Rules of 1959. [6] There is a high demand for natural gas in India for its ambition of transforming into a gas-based economy following the footsteps of US and to some extent China. The surge in demand can only be fulfilled with the help of unconventional gas exploitation. India is not at the stage of relying on renewable energy transition completely and there is still a long time to go for that to happen. Therefore, the dependence of the country's energy mix on unconventional hydrocarbons cannot be overlooked, and this calls for careful EIA in the shale gas sector coupled with massive unconventional technology infrastructure deployment through JV's with expert Unconventional organisations/Consultants.

Unconventional specific EIA evaluations would help to look into the potential environmental risks surrounding the new projects. EIA conducts assessments to investigate a range of problems, conflicts, and constraints related to natural resources. These assessments serve a dual purpose: to evaluate the feasibility of a project and to predict its potential impact on people, their land, livelihoods, and most importantly the environment externalities. Through examination, the EIA aims to identify any risks or adverse effects that could arise from the implementation of a

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[4]DIRECTORATE GENERAL OF HYDROCARBON, *Shale Oil and Gas*, *available at:* https://dghindia.gov.in/index.php/page?pageId=37 (last visited May 18, 2023).

[5]MINISTRY OF PETROLEUM & NATURAL GAS, *Policy Framework Notified to Permit Exploration and Exploitation of Unconventional Hydrocarbons, available at:* https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1556200 (last visited May 26, 2023).

[6]MINISTRY OF PETROLEUM & NATURAL GAS, *Policy framework for exploration and exploitation of unconventional hydrocarbons under existing production sharing contracts, Coal Bed Methane contracts and nomination fields*, *available at*:http://petroleum.nic.in/sites/default/files/policy_framework_E.pdf (last visited May 26, 2023).

project. This includes assessing the potential harm to local communities, the impact on land fertility and ecosystems, and the potential disruption to people's livelihoods, health etc. Shale gas E&P technology deployments poses numerous environmental challenges causing diverse & severe pollution levels and an overall remedial model & implementation policy frame must be in place through regulatory bodies (DGH& PNGRB) before venturing into the business.

II

Shale Gas Business Life Cycle: From Extraction to Distribution

Shale as a kind of sedimentary rock is usually characterized by its fine-grained nature. It is found in the compaction of clay, silt, mud, and organic matter over a long time period. The deposition of shale gas exists in various spaces such as seas, river deltas, lakes, and lagoons. This sedimentary rock formations are extremely copious and can be found Earth's surface as well as deep underground. Shale gas usually contains a high percentage of methane, ranging from 70% to 90%.[7] Shale gas is most frequently used for various purposes, such as electricity generation and domestic heating along with cooking.

Extraction and Production of Shale Gas

The formation of shale gas is usually done through unconventional reservoirs, meaning the reservoirs having low permeability. In conventional reservoirs, gas is typically found in interconnected pore spaces, similar to that of a kitchen sponge, which allows for relatively easier flow towards a well. The extraction process of shale gas involves hydraulic fracturing, which is used to create fractures in the shale, increasing its permeability and enabling the gas to be collected.[8] The first and foremost step revolving around the extraction of shale gas is the selection of a suitable drilling site and then preparing it for operations. This involves clearing the area, constructing access roads, and setting up the necessary infrastructure.

After the site is prepared, the step is of drilling of wells, in order to carry on the extraction process. At first, vertical drilling is carried out to reach the target shale formation, mainly at depths exceeding 1500 meters. This process involves the use of various specialised equipment like drilling rigs and drill pipes. After the process of vertical drilling is done and the desired depth is reached, there comes horizontal

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[7]BRITISH GEOLOGICAL SURVEY, *Shale gas*, *available at:*https://www.bgs.ac.uk/geology-projects/shale-gas/ (last visited May 21, 2023).

[8]BRITISH GEOLOGICAL SURVEY, *How is shale gas extracted? available at:*https://www.bgs.ac.uk/geology-projects/shale-gas/shale-gas-extraction/ (last visited May 25, 2023).

drilling. Horizontal drilling helps in maximizing contact with the shale rock.[9] This process is followed by Hydraulic fracturing, also known as fracking, which is a crucial step in the shale gas extraction. It basically involves the injecting of a high-pressure mixture containing water, sand, and chemical additives directly into the well. This in turn creates fractures within the shale rock.[10]

Then the highly pressurized fluid cultivates fractures throughout the shale rock, in turn extending the network of cracks. During this process, sand or ceramic particles, are mixed with the fluid and then pumped into the fractures in order to keep them open. These created fractures provide pathways for the trapped gas to flow toward the wellbore. The gas, along with some of the injected fluids, is then brought to the surface through the well and recovered.[11] The extracted gas then experiences treatment, which facilitates the removal of impurities and is then processed to meet pipeline specifications. This includes removing water, separating natural gas liquids, and compressing the gas for transportation.

Transportation and Distribution of Shale Gas

After the extraction of shale gas is complete, the process of transportation of shale gas begins, where the produced shale gas reaches its end consumers. After the extraction of shale gas is complete, it undergoes some initial processing in order to remove impurities and further ensure that the quality of the gas meets the required standards. This step facilitates the preparation of the gas for transportation. Additionally, in order to make the gas easier to be able to move through pipelines, it is compressed with the help of powerful compressors.[12] This increases the pressure, thus allowing it to flow smoothly and efficiently through the transportation system.

The main mode of transportation of shale gas is through pipelines. The gas travels through these pipelines at very high pressures, propelled by pumps along the way. Throughout the transportation process, the flow of gas has to be closely monitored

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[9]DEPARTMENT OF ENERGY, *How is Shale Gas Produced? available at:*https://www.energy.gov/sites/prod/files/2013/04/f0/how_is_shale_gas_produced.pdf (last visited May 21, 2023).

[10]UNITED STATES ENVIRONMENTAL PROTECTION AGENCY, *The Process of Unconventional Natural Gas Production, available at:* https://www.epa.gov/uog/process-unconventional-natural-gas-production (last visited May 22, 2023).

[11]NATIONAL GEOGRAPHIC, *how hydraulic fracturing works?, available at:*https://education.nationalgeographic.org/resource/how-hydraulic-fracturing-works/(last visited May 25, 2023).

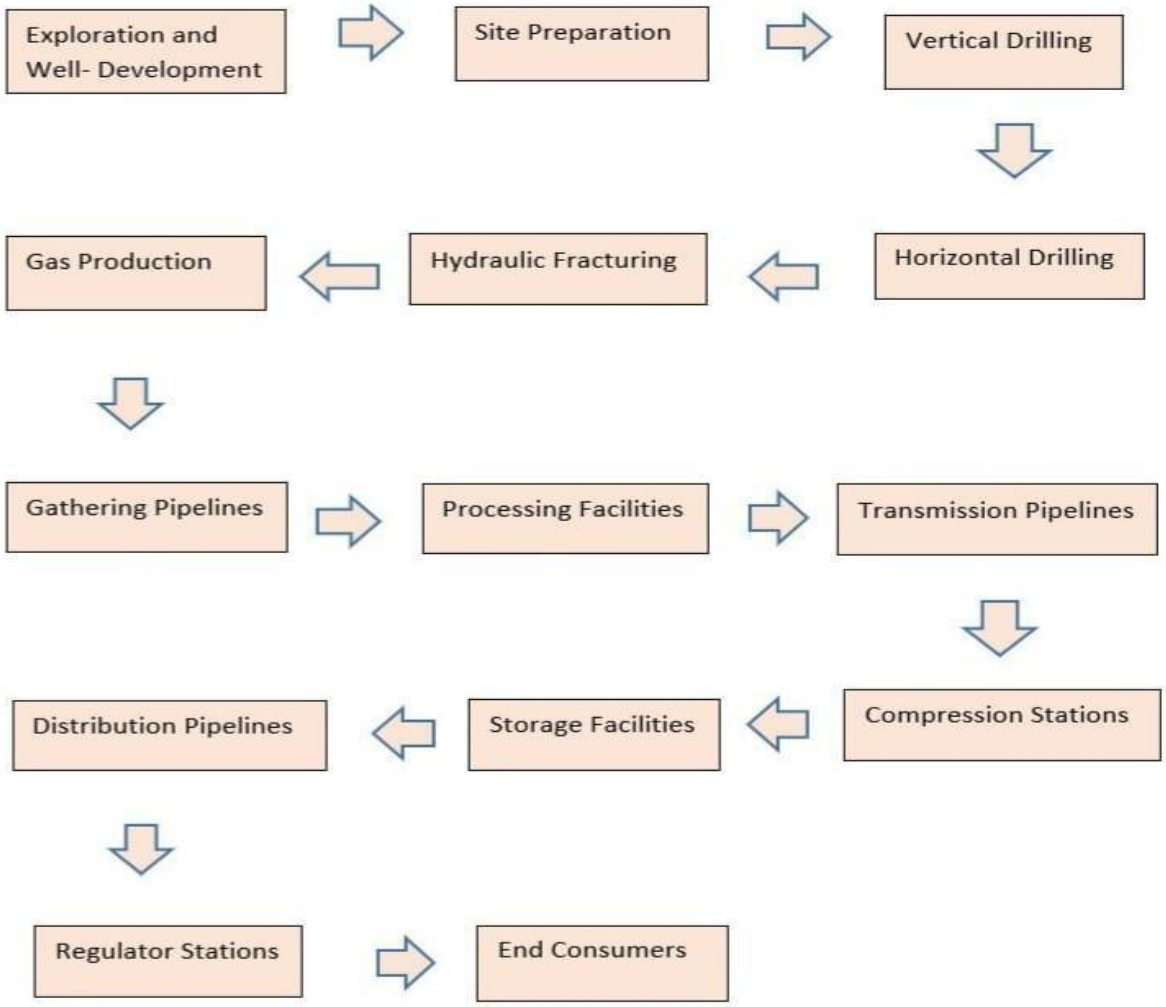
[12]CHEMICAL ENGINEERING RESEARCH AND DESIGN, *Numerical simulation of gas-liquid flow in inclined shale gas pipelines, available at:*https://www.sciencedirect.com/science/article/abs/pii/S0263876223000096(last visited May 25, 2023).

and measured. This helps to ensure that the right amount of gas is transported and helps to identify any potential issues or leaks within the pipeline.Throughout the pipeline network, various storage facilities are critically located.[13] This helps to balance the supply and demand of gas. Excess gas is stored during periods of low demand and when there distributed at the time of higher demand.

The gas is further diversified into smaller pipelines that supply the shale gas to different regions and end-users. These distribution pipelines are developed from the main transportation system and deliver the gas to homes, businesses, and industries. In certain cases, the shale gas may be converted into liquefied natural gas ["LNG"] for long-distance transportation. This involves cooling the gas to a very low temperature, which turns it into a liquid form. The produced LNG can then be loaded on special ships and transported to different parts of the world.

[13]US ENERGY INFORMATION ADMINISTRATION,*Natural gas pipelines*, *available at*:https://www.eia.gov/energyexplained/natural-gas/natural-gas-pipelines.php(last visited May 23, 2023).

The process of shale gas from exploration to transportation is a long process, and can be understood in short from the figure given below:



III

EIA of Shale Gas Industry

Shale is a sedimentary rock with a fine-grained texture, which forms when the mineral particles of silt or clay size compact and layer upon each other. Its unique structure allows it to easily break into thin, parallel layers. Black shale, in particular, contains organic material that can generate oil and natural gas, which is trapped within the rock's porosity. Shale formations across the United States have become significant resources for natural gas and oil production, with plays discovered in approximately 30 states. The Barnett Shale in Texas has been a prominent producer of natural gas for over a decade. The geological and engineering insights gained from the Barnett Shale have served as a foundational technology template for the

development of other shale plays not only in the United States but also around the world. One notable example is the Marcellus shale play, located in the Appalachian Basin, which spans across Ohio, Pennsylvania, and West Virginia. Currently, the Marcellus shale play is recognized as the largest source of natural gas derived from shale formations. The EIA studies made in 2011 indicated 48 major Shale gas reservoirs in 32 Countries including India in Camby, Assam-Arakan, Bengal, Rajasthan, K-G & Cauvery & Gondwana basins.[14] India is way behind the US and China in developing the shale gas industry, owing to a lack of required expertise & technological infrastructure along with a lack of full-scale assessment of numerous associated environmental risks with its exploitation and full-scale desired impact analysis. The major environmental externalities to be fully understood ,assessed & included in the policy framework of India are brought out below.

Water Pollution

Shale rocks withhydrocarbons are trapped around 1500 meters underneath low permeable rocks, and thus, a mixture of water, sand, and chemicals, known as shale fluid, is used to break into and fracture the low porosity-permeability shale rocks in order to extract the shale gas and oil volumes trapped within. The process called hydrofracturing is highly technology intensive and consumes around 5 to 9 million liters of water in every hydro fracturing job. The injected chemical-based fluids contain 98% fresh water mixed with chemicals under pressure. This water requirement is fulfilled usually surface water, shallow ground water, and deep groundwater etc.[15] However, companies have the option to utilize several wastewater sources. This includes flowback water, which is a mixture of injected water and water derived from gas formations that is brought back to the surface and recovered during gas extraction. Additionally, industries can recycle wastewater from different purposes, like municipal water usage. This plays the role of villain in the lives of farmers and normal people, as major portion of the water is utilised in shale gas extraction, leaving them with lack for water resources for carrying out basic activities like agriculture and domestic work. As per scientists, in order to extract shale gas for a period of 20 years, about 113 million tonnes of water could be

[14]WEST BENGAL POLLUTION CONTROL BOARD, *Binay K Dutta, Shale Gas- Environmental Impact and Safeguard*, *available at:*https://bengalchamber.com/shalegas/bk-dutta.pdf (last visited May 27, 2023).
[15]Campbell Karen and Matt Horne, *Shale Gas Extraction: How It Impacts Water*,*available at:*http://www.jstor.org/stable/resrep00262.4 (last visited May 27, 2023).

required.[16] The issue of fresh water depletion due to shale gas industry needs is one of the major bottle neck in Indian Context . Industry once takes off could face major water shortage on the neighbouring population and their agriculture needs of water. [17]

Multiple Hydrofracturing jobs are doneto inject the desired quantity of chemically induced water into the targeted reservoir Shale formation in order to hydrofracture to the desired level for extracting thenatural gas.[18] In addition to the amount of water contamination risk posed by hydraulic fracturing, flowback/return wateralso causes major risks owing to higher concentrations of salts, radioactive material, and other contaminants, including arsenic, benzene, and mercury, that are generally contained in shale gas.

The wastewater is often pumped into holding ponds which generally poses certain risks if not properly recycled and subsequently treated with remedial chemical processes/neutralizing agents. The return formation/hydrfrac waste fluids ponds have the potential to leak, allowing the wastewater to seep into the surrounding groundwater aquifers & and agri soil. [19] Such leakages could have adverse effects on the local ecosystem, including wildlife and diverse fauna/flora.

The intense multi well side tracked & horizontal drilling & testing operations done in smaller acreages can have a severe impact on the water quality as well as GHG emissions. However, the need for regular storage, transportation, and ultimate disposal of substantial quantities of flowback water poses acute surface contamination risks. Temporary storage tanks, storage pits, transport trucks, and pipelines are highly prone to leakages and spills, which could have potential environmental hazards.[20]

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[16]ENVIROTECH ONLINE, *Shale gas extraction 'causing water pollution',available at:*https://www.envirotech-online.com/news/water-wastewater/9/breaking-news/shale-gas-extraction-causing-water-pollution/15515 (last visited May 27, 2023).

[17]SCIENTIFIC AMERICAN, *Gayathri Vaidyanathan, Fracking Can Contaminate Drinking Water,available at:*https://www.scientificamerican.com/article/fracking-can-contaminate-drinking-water/. (last visited May 27, 2023).

[18]NATIONAL LIBRARY OF MEDICINE, *Health Impact Assessment of Shale Gas Extraction: Workshop Summary, available at:*https://www.ncbi.nlm.nih.gov/books/NBK201899/. (last visited May 27, 2023).

[19]FOOTPRINT CALCULATOR, *Hydraulic Fracturing and its Impact on Water Resources, Water, available at:*https://www.watercalculator.org/footprint/fracking-water/. (last visited May 27, 2023).

[20]*Supra* note16.

During the transportation and distribution phase of natural gas, water pollution due to pipeline failure (CO2 & fluid corrosion) or sewage pipeline's leaks do happen and result into potential fire accidents etc.[21].

Air Pollution

Multiple Shale gas development & extraction processes and subsequent transportation poses risks on the quality of air we breathe. Natural gas extraction accounts for 25% of total methane emission into the environment. Methane along with other gases contributes significantly in GHG emissions resulting into global warming, climate change and loss of biodiversity etc. Air pollution can happen during various steps in the life cycle of shale gas such as drilling, well completion, and transportation processes associated with shale gas.[22] Methane can escape from equipment leaks, intentional releases, or even venting. Along with methane, the production and processing of shale gas also expose other air pollutants and GHGs into the environment such as volatile organic compounds, nitrogen oxides, and other particulate matter. These pollutants have adverse effects on air quality, human health, and the environment, contributing to smog formation and aggravating respiratory ailments.[23]

While hydraulic fracturing is one component of the overall shale gas development process, it occurs for a relatively brief duration. It is important to note that air pollution happens in almost all the steps in the life cycle of shale gas exploitation to distribution and the impact it does to the environment is irretrievable.

Further, it is important to note that natural gas-fired engines can be notable sources of formaldehyde, which is considered as a major secondary pollutant. Shale gas production can also lead to the release of aromatics like benzene and toluene.

Noise Pollution

The work zone environment near the drill sites can experience a significant increases in noise levels, majorly attributed to the operation of heavy-duty pumps and other

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[21]JOURNAL OF PHYSICS: CONFERENCE SERIES,*Yanjun Chen, Failure analysis of the sewage pipeline on a shale gas platform, available at:*https://iopscience.iop.org/article/10.1088/1742-6596/2499/1/012015/pdf (last visited May 27, 2023).

[22]NATIONAL LIBRARY OF MEDICINE,*Health Impact Assessment of Shale Gas Extraction: Workshop Summary, available at:*https://www.ncbi.nlm.nih.gov/books/NBK201897/#:~:text=Aromatics%20(e.g.%2C%20benzene%20and%20toluene,diesel%20fuel%20combustion%20impacts%20climate (last visited May 27, 2023).

[23]*Daniel PSchrag, Is Shale Gas Good for Climate Chang,available at:*http://www.jstor.org/stable/23240280 (last visited May 27, 2023).

fracking equipment.[24]After the well construction is done, the process of drilling begins which can continue for up to 30 days, depending upon the depth of the well. The drilling operation is extremely noisy and often operates 24 hours a day, even during the night when nearby communities are more sensitive to noise disturbances.[25] This has severe impact on people living near the exploration sites and disturb their peaceful lives.

Soil Pollution & Fertility erosion

Shale gas extraction and distribution process have the potential to cause soil pollution through numerous ways. Some of the ways through which soil is polluted is accidental spills or leaks of chemicals, fracking fluids, or wastewater during their transportation, storage, or handling near drilling sites. These incidents can introduce pollutants into the soil, posing a risk to its quality and potentially harming the surrounding ecosystem and biodiversity.

As per a study, around 10% to 40% of shale fluid, containing various chemicals which is injected into the permeability rock during the hydraulic fracturing surges back into the earth's surface.[26] The additional steps associated with shale gas extraction like land clearing, grading, and construction activities increase the risk of soil erosion. These activities disrupt the natural soil structure, remove vegetation cover, and expose the soil to erosion by wind and water. The loss of topsoil and nutrient-rich layer impact the soil health and productivity, affecting future land use and the ecological balance. Further, the corrosion in the pipelines impact the inner layer of soil, making the soil inferior for future use.

Current EIA framework in the Country

In order to mitigate the environmental challenges posed by shale gas exploration and exploitation in the country, the Directorate General of Hydrocarbon ["DGH"] has proposed a set of guidelines to regulate the extent of environmental externalities caused during diverse shale gas exploitation processes. The guidelines are bought

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[24]DIRECTORATE GENERAL OF HYDROCARBON, *Guidelines for Environmental Management during Shale Gas/Oil Exploration and Production,available at:*https://dghindia.gov.in/assets/downloads/59645efa09b1cGuidelines_for_Environmental_Management_during_Shale_Gas_Oil_Exploration_and_Production.pdf (last visited May 27, 2023).

[25]BRÜEL & KJÆR,*Phil Stollery, MANAGING THE NOISE IMPACT FROM SHALE GAS DRILLING, available at:*https://www.bksv.com/media/doc/bn1379.pdf (last visited May 27, 2023).

[26]POLLUTION SOLUTIONS,*Fracking 'could cause greater levels of soil pollution',available at:*https://www.pollutionsolutions-online.com/news/soil-remediation/18/breaking-news/fracking-could-cause-greater-levels-of-soil-pollution/30718 (last visited May 27, 2023).

out to monitor the prospective pollution risks on the surrounding environment and health of people .

The Ministry of Petroleum and Natural Gas ["MoPNG"] is in charge of oil and gas exploration and development in the country.[27] According to the EIA notification in India, both offshore and onshore oil and gas exploration, development, and production activities are classified under item 1(b) of the Schedule. These activities are further categorized as 'Category A' projects, which are considered to have a potentially significant environmental impact and therefore require a thorough assessment.

According to this classification, both offshore and onshore oil and gas projects must undergo a comprehensive EIA process that involves evaluating the potential environmental impacts, devising appropriate mitigation measures, conducting public consultations, and undergoing rigorous review by regulatory authorities. The main aim here is to ensure that these projects meet the required environmental standards and address any potential adverse effects.The company engaged in the activity of exploitation of shale gas holds the responsibility for all Health, Safety, and Environment ["HSE"] aspects associated with Shale Gas and Oil operations. This includes adhering to the guidelines and rules set forth by the MoPNG, the Ministry of Environment and Forests ["MoEF"], and other relevant statutory authorities. Key areas covered by Exploration and Production ["E&P"] regulations include well fencing, standard procedures in well construction, hydraulic fracturing, waste handling, well blocking along with the management of chemicals and water spills.[28]

Further, the Acts regulating the environmental aspects of the country also apply to shale gas development prospects, like, Forest (Conservation) Act, 1980, Wildlife (Protection) Act, 1972, Environment (Protection) Act, 1986, Hazardous and Other Waste (Management and Trans-boundary Movement) Rules, 2016, Water (Prevention and Control of Pollution) Act, 1974,Air (Prevention and Control of Pollution) Act, 1981 , and Hazardous and Other Waste (Management and Trans-boundary Movement) Rules, 2016.

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[27] *Supra* note 25.

[28] NITI AAYOG, *Anil Kumar Jain and Rajnath Ram, SHALE GAS IN INDIA: CHALLENGES AND PROSPECTS,* (May 27, 2023, 19:10),*available at*:https://www.niti.gov.in/sites/default/files/energy/Shale-gas-in-India-Prospects-and-Challenges-1.pdf (last visited May 27, 2023).

IV

Conclusion and Way Forward

1. Shale natural gas contains within itself numerous severe and irretrievable environmental and health hazards, the extent of which needs to be constantly monitored and regulated in order to curtail Air/Water pollution, GHG emissions, lessen the impact of global warming, Ocean acidification, and climate change.
2. Finding a balance in bringing out a natural gas-based economy and reducing /reversing climate change narratives through robust EIA policies is a complex challenge.
3. Transitioning towards a low-carbon, green, and sustainable energy future requires a comprehensive EIA approach in order to reduce methane emissions from shale gas operations.
4. The guidelines provided by the upstream Regulator (DGH) make almost no differentiation in conducting the EIA activities in conventional and unconventional hydrocarbons. It provides five separate pointers regarding water contamination regulations. However, the principles laid down by DGH are nowhere close to providing proper protection to water bodies in the country, and it fails to provide proper replacement/replenishment & recycling directives to conserve water resources for other usages.
5. Not enough guidelines are provided to protect sub-surface water aquifers in the country.
6. DGH has also incorporated a list of tasks to be done to protect the air quality. However monitoring component is required to be strengthened
7. India has projected a pretty high level of Natural gas demand for the next 10 years, which in turn necessitates the unconventional Shale gas resource development. However, it is crucial to implement guidelines that prioritize sustainable development. In doing so, all stakeholders, ranging from the companies leading shale gas exploration to the local communities affected by its exploitation, must be actively engaged. An inclusive policy needs to be formulated, which ensures that no one is adversely impacted by the Shale gas exploitation process.
8. Environmental threats associated with shale gas extraction process needs to be thoroughly assessed and addressed. Robust monitoring Systems & processes with heavy penalty mechanisms should be in place in order to ensure that the exploitation of shale gas remains in check, with strict

adherence to environmental regulations and safeguards. Comprehensive policies must be implemented to keep a check whether guidelines are followed by the company or not.

9. To check upon the adverse effects of shale gas extraction, emphasis must be placed upon research and development. Investing in innovative technologies and practices will help to minimize the environmental impacts, improve efficiency, and reduce the carbon emissions associated with shale gas operations.
10. Additionally, transparency and accountability should be key to proper policy framework. Regular monitoring, reporting, and independent audits should be conducted to ensure compliance with environmental standards and to evaluate the effectiveness of mitigation measures.