Research paper on hydraulic fracturing for shale gas extraction

Technology, Development

Hydraulic fracturing is one of the popular methods of producing natural gas being applied in US in extraction of Shale Gas. The method has been hailed as a success in producing clean gas and as a source of energy that is responsibly produced. However, the method has its limitations in that it involves negative externalities. In this respect, this analysis seeks to explain the process, its pros and cons as well as its costs.

HYDRAULIC FRACTURING PROCESS AND COSTS

Hydraulic fracturing for shale gas extraction has been in US since 194o with an average of 90 percent of US gas and oil production being through hydraulic fracturing. The process involves obtaining government licenses, drilling sites' construction, setting the drilling rigs and finally combining horizontal drilling with hydraulic fracturing through which pressured water is injected to crack rocks releasing the gas trapped in the rocks. Specifically, the firms involved identify sites and in consultation with land owner, identifies the appropriate well site. The organization then does an environmental impact analysis on plants, animals, and archaeological sites and then submits its construction plans and designs for regulatory approval. After approval and construction of the well, the company works with the owner to re-mediate the drilling site and restore the land to its original contours with minimal impacts. In this process, hydro seeding process is used to grow grass in the well locations with inspection by regulating agencies to ensure compliance. (Chevron " How we work")

The direct costs involved in the process include costs of leasing land, licensing, seismic data collection, well site construction, well drilling, hydraulic fracturing, pipeline building and other production costs. On the

other hand, external costs which refer to the costs that accrue to people who are not directly involved in an activity present a significant cost element for the process. (Frank & Bernanke 265) The process has a number of impacts on land, air, water and the communities within which hydraulic fracturing takes place. The external costs associated with the impact include use of high volume of water and water contamination reducing fresh supply of drinking water to the society, waste water disposal in disposal wells causing earthquake tremors, emissions of dangerous gas into the air causing diseases to the community habitats and damage to the scenic places and nature around the wells sites.

EXTERNALITIES AND THEIR RECEPIENTS

Externalities usually occur when individuals and firms do not bear the full costs or reap full the benefits of their actions reflecting a lack of well defined property rights. The external costs involved present negative externalities while benefits spill over presents positive externalities. (Barron & Lynch 265) In this respect the positive and negative externalities associated with shale gas extraction include:

Positive externalities

Research & Development

Research and development is a positive spillover from Shale gas extraction presenting an imperfect case of property rights in the stocks of knowledge as operators share the stock without compensating the original firms. This mainly results from the government’s requirement for operators to make public some of the chemicals they use in hydraulic processing in order for

the public and healthcare institutions to understand the dangers involved. The Research and development spillover provides a higher social rate of return than the private rate of return. The beneficiaries are the firms which get the knowledge stock from the originating firm. (Chevron “ Natural Gas”)

Infrastructure development

Construction of pipelines and roads as necessary infrastructure in Shale gas extraction creates positive spillovers to the community. The set infrastructure sets pace for development in the communities the process takes place. The spillover benefits the communities in terms of access to the infrastructure they haven’t directly paid for. (Williams “ Discovering Shale”)

Negative externalities

Emissions

Shale Gas extraction involves emission which contains air toxics, volatile organic compounds and methane. The emissions negatively affect the habitants of the surroundings who indirectly bears the cost as they risk contracting diseases and having to tolerate foul smell. (Williams “ Discovering Shale”)

Waste water

Externalities related to water use in hydraulic fracturing are highly based on the large volume of water that is used in the process. The process requires a significant amount of water to set the gas extraction wells while water contamination has also been reported due to methane and poor management of waste water as well as due to chemical spills. Example is the

New York City’s watershed which provides drinking water to more than eight million people being adversely affected by contamination denying people access to clean drinking water. (Chevron “ Natural Gas”)

Land and natural environment destruction

The drilling and construction of extraction wells involve altering the landscape and displacing wildlife. The drilling done in the forests also affects the scenic areas negatively destroying the vegetation hence negatively affecting tourism in the regions of operations. The communities pay for the process through loss of scenic sites and tourism. (Chevron “ Natural Gas”)

Earthquakes and tremors associated with waste disposal wells

Although there are two options for wastewater disposal: through disposal wells and recycling. Well disposal has been the popular disposal method with many firms and which has been reported to result to earth tremors in the operation areas and the surroundings. (Williams “ Discovering Shale”)

Infrastructure destruction

During shale gas extraction, truck traffic presents a cost to the society due to the many trucks required in the process of setting up well sites. The trucks are required to ferry millions of gallons of water as well as sand and waste water to and from the site which results in infrastructure destruction presenting a cost to the surrounding community. (Williams “ Discovering Shale”)

Research and Development crowding out

As natural gas extraction increasingly becomes a focus in the US, the process and the related research and development in crowding out research and development in other activities as researchers devote much of their effort and resources on the natural gas. This present an indirect cost to other developments in lack of adequate research. (Chevron “ Natural Gas”)

PROS AND CONS OF SHALE GAS DEVELOPMENT

Shale Gas development process has a number of pros including being a source of the cleanest-burning fossil fuel as well as an efficient source of energy for US. The development will strengthen the US economy and improve the country’s energy security as well as provide responsibly produced gas as compared to other types of energy sources. In addition, the development creates a significant number of jobs and contributes significantly to US GDP while providing a low priced gas and energy options for US consumers. Finally, the development produces low level emissions of greenhouse gas as compared to coal and oil which are heavy hydrocarbon fuels. (Chevron “ Natural Gas”)

On the other hand, Shale Gas development has its cons in that the extraction results in environmental degradation, requires a high level of technology to carry out and the process is expensive in establishing the possible gas sites. In addition, as a new method which has not been fully internalized by the industry, it requires a lot of research and development to establish efficient processing means.

POLICIES IMPLICATIONS AND THEIR RELATIVE MERITS

The objective of managing externalities is not to fully eliminate them, but rather to take into account the spillovers in resources allocation. In this respect, addressing externalities can be through two types of measures; economic based instruments which internalize the externalities in the operators' decision making hence providing incentives to address the spillovers and the regulatory based measures which seek to set standards and set limits to spillovers. However, in implementing the policy, establishing the party that pays for the negative externality is paramount. It is also necessary to establish the level of the actions and the means of transferring the cost to the operators in order to encourage expected reduction in the negative externalities. (Arason, Ferral & Sassene 12)

In addition, addressing externalities is usually a daunting task owing to the difficulty in understanding the nature of externalities involved, environmental impact uncertainties and differing opinions regarding the beneficiaries and the operators pays as well as the remedy policies unrealistic objectives. In this consideration, below is an explanation of the possible application of taxation, subsidies, standards as well as trade permits in addressing negative externalities associated with Shale gas extraction. (Barron & Lynch 268)

Taxes

Imposing a Pogouvian Tax would be a way of internalizing the externality issue in decision making hence having an economic incentive for the operators to achieve the objective of promoting efficient use of water in the

process. A Pigouvian tax can be used tagging water depending on its use establishing quality level that is efficient in the society's perspective. In case of a Pigouvian tax, the operations and their consumers share the burden. However, the extent to which each contributes to the tax depends on the elasticity of demand for the product or service. In this respect, natural gas has an inelastic demand since an increase in price would not result into a lesser proportionate reduction in demand hence a significant tax burden would fall on the consumers through increased prices. Use of Taxation has the merit in that the cost is shared between the two parties hence would not discourage gas extraction. (Baumal " On taxation")

Subsidies

Instead of pricing the renewable energy generation in correspondence with the magnitude of its externalities, the same cost differential can be maintained by subsidizing the low emitting operations rather than taxing for high emissions. Picking the operators who achieve low gas emissions, the government can subsidize their activities to promote efficiency. The subsidy would motivate producers to reduce production to the level where the forgone profit equals the subsidy amount hence reducing the negative externalities. (Arason, Ferral & Sassene 12)

Standards

Establishing of standards to be followed by firms in order to address negative externalities is one of the most effective remedies which does not impose monetary burden on recipients rather enforces adherence by those directly involved with the action. This can be achieved by imposing quotas which

define the level of output that is allowed for each producer and the market in general. (Arason, Ferral & Sassene 14)

Trade permits

Trading permits can be used as a way of addressing negative externalities by imposing an emission permit which would allow permit trading between the hydraulic fracturing operators. This would provide an economic incentive based system motivating operators to reduce use of harmful chemicals and reduce emission in their operations. Operators would get permits for a certain level of chemical use and those who efficiently utilize chemicals and use less than the apportioned amount would have excess to sell to the others who need to use more. This would enhance efficient use of chemicals hence reduction of pollution. (Frank & Bernanke 275)

POLICY RECOMMENDATION

Market self regulation in addressing Hydraulic fracturing externalities fails due to the assumption of perfect information for optimal solution as it is unlikely to fully measure environmental implication of the process. It is also difficult to identify involved parties and it would also involve high negotiation costs. The process is also hampered by the difficulty in dividing property rights resulting to the problem of the free rider. (Baron & Lynch 265) Therefore, it calls for intervention with the appropriate policies to effectively address the problem.

However, Shale Gas extraction has been characterized by lack of government regulation either through oversight or standards. Therefore, setting appropriate standards could be recommended for controlling

negative externalities through setting up of Quotas in production. The graph below demonstrates the effect of such a quota on the welfare.

Source: Barron & Lynch 264.

If the initial output of shale gas was Q at a price P, the market would be at an equilibrium point D. Thus the initial consumer surplus would be PDB while producer surplus would be PDA. With establishment of a quota that limits output to Q1, the gas price would rise to price P1 and the new equilibrium would be at point C. This would have an implication of reducing the consumer surplus to P1CB marked in green while increasing the producer surplus to be P1CEA marked in red. However, the policy would also have an effect of reducing total surplus by CDE marked in yellow which would be the dead weight loss. (Baro &Lynch 265)

Thus, the policy would be the most appropriate to apply since it would increase producer surplus hence motivating them to continue with production at a level that has the pollution in control. This would be more appropriate that imposing a tax which would have a reduced producer surplus. On the other hand, using a subsidy would have attracted more producers in the long-run hence the quota system being the most appropriate policy to address externalities. (Frank & Bernanke 274)

CONCLUSION

The analysis demonstrates Hydraulic fracturing as one of the growing methods of Shale gas extraction in the US. The process has gained momentum in its provision of reliable and clean source of energy. However, the production process is riddled with the problem of external costs with

spillovers to people who are not directly related to the process with the key externalities being air, soil and water pollution. However, the process can be regulated to reduce the effects through various Pigouvian policies including tax, subsidies and standards as well as trading permits. In this respect, standards control through application of output quota has been recommended for its efficiency in remedying the case compared to the other policies.

Works cited

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