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Ungrounded Concern of Societies Regarding Possible Negative Outcomes of Shale Gas Extraction*

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Abstract

The essential purpose of this article is to investigate the negative situations which may occur during Shale gas extraction which is considered as a new option for alternative energy sources. The study focuses on how ungrounded the societies' considerations and concerns are with regard to Shale gas extraction. The objective of the research is to investigate the possible negative outcomes of drilling during the process of extracting this type of energy and integrating it into the sector and as such, to reveal how unground the concerns of some actors in the sector are. It is an undeniable fact that shale gas which has been popular particularly in recent years will be a significant force multiplier in today's energy world. This energy type which had not been put on the agenda before due to its requirement for high costs and advanced technology has started to be one of the top topics of sector's agenda with advanced technology thanks to reduced costs and increased need for energy. First of all, methods and techniques of shale gas extraction will be addressed in following stages of this study and subsequently possible problems will be set forth under different headings and it will be explained how negligible and insignificant these problems are.

Keywords: earthquake, greenhouse gas emission, horizontal and vertical drilling, hydraulic fracturing, water resources.

1. Introduction

In this century, success criterion has almost become synonymous with energy domination. What is energy domination? Conceptually it implies supply of energy that is needed by societies and the ability to achieve sustainability, competition and cost-effectiveness in energy supply and reflect it in production. Just like nations which become dependent on other nations as they are not self-sufficient in production, societies and event countries which cannot establish their own energy domination become dependent on other nations and countries and go into their orbit. Societies need energy to be able to maintain balance in production and sustain it for country's future. They try to diversify alternatives to meet their needs and they try to produce it cost-effectively. So it is a general principle to obtain general public opinion and consent to do this. Recently world's countries watch the silent revolution of United States of America with regard to Shale gas with admiration and try and desire to do the same in their own countries. However, they have some concerns as to "making matters worse while trying to be helpful" which is a Turkish proverb. So methods that are used on the world to extract this type of energy will be addressed in the second

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part of this study and its effects which are considered to be negative will be addressed in the third part and in the fourth section, it will be discussed how ungrounded such considerations are.

2. Methods of Shale Gas Extraction

It has been discussed in detail in the dissertation study that shale gas is natural gas that is found trapped within small pores of sedimentary rock that is made of clay, quartz and calcite minerals. Sedimentary rocks which are named as shale have limited and low permeability in terms of gas and liquid materials that pass through them under normal conditions. The method that has been developed to extract such gas from rocks and use it economically is named as "hydraulic fracturing". By using such method, regions with gas potential are located through long-continued investigations and underground natural gas is extracted by use of drilling technique. Extraction operation is carried out by pumping some chemical products and sand into drilling into borehole, opening cracks in form of shale, releasing hydrocarbons that are trapped therein and enabling flow of natural gas from shale into the borehole.

As technology has advanced, drilling techniques that have been used have also developed. Two prominent technological developments have enabled us to benefit from shale gas economically. One of these is the above-mentioned hydraulic fracturing and the other one is the most significant technique that induces such hydraulic fracturing, which is horizontal drilling technique. Hydraulic fracturing method reduces the high costs which had prevented extraction of such unconventional sources and maximizes natural gas and petrol production from these rocks which are called shale. After the rock type that is named as shale is reached through boreholes that are opened vertically, horizontal drilling technique begins to be used and operation continues horizontally. High amount of a mixture that comprises water, sand and chemicals is pumped in a compressed way into it and as such, the gas that is trapped in pores is released and comes out of the boreholes. This concept was developed for the first time for Barnett Shale unit in Ft. Worth basin that is located in mid-north of Texas, USA. The first borehole was opened in the field in 1981 for conventional purposes and by use of conventional methods. Approximately 100 boreholes were opened from 1981 to 1990 in order to make production from conventional reservoirs. Hydro-fracturing method started to be used after 1997. As a result of it, exploration and production activities accelerated very rapidly in this basin and the number of boreholes used for production reached 6203 at the end of September, 2006. Amount of production multiplied upon excavation of horizontal boreholes as of 2002 and this field has become the largest one in Texas and second largest one in USA. According to the United States Geological Survey (USGS) reports for 2013, the field's producible potential has been reported to be 26.2 tcf (Kemal, 2014).

The most significant component of horizontal drilling and hydraulic fracturing techniques is water. Approximately 20,000 litres of water is used to enable horizontal and hydraulic fracturing of a borehole (EIA, 2019). In addition, when it is considered that a borehole can be pierced for more than once, the amount of water used can reach high numbers; so much so that, it is known that China has been experiencing some problems regarding shale gas extraction due to excessive need for amount of water used for hydraulic fracturing operation (Hook, 2012). Some stages and criteria are also required for shale gas extraction besides vital importance for close proximity to a water source. Stages of shale gas extraction are listed and outlined below:

* Geological and seismic researches process
* Platform construction
* Vertical drilling operations
* Horizontal drilling operations
* Perforation
* Fracturing (Hydraulic Fracturing)
* Waste management
* Production process

*** Geological and seismic researches:** Geological and seismic researches are conducted to draw three dimensional maps of underground geological formations. With regard to the sites where studies will be conducted; appropriate rock structures are located first, appropriate thicknesses and depth of rock structure are identified and information is gathered as to which boreholes will be opened in which locations and how many boreholes will be opened.

* **Platform construction:** In order to open boreholes in pre-determined locations, site preparations are completed, assemblies are placed in certain distances on the ground and the platform must be constructed for the equipment.

Vertical drilling: It implies the vertical drilling that is conducted until the rock layer is reached while the earth crust is pierced towards the underground. However, concrete is laid between steel pipes and interwoven pipes for safety purposes to prevent internal collapse of drilling.

Horizontal drilling: It implies the drilling that is conducted horizontally up to one to two km in order to expand the surface area by rotating 90 degrees when the inner rock layer is reached vertically.

Perforation: It implies the operation of creating small holes on concrete coatings in the places that are emptied inside the horizontal drilling.

Fracturing: A mixture made of chemical substance, water and sand particles is pumped with high compression into the emptiness that is created after vertical and horizontal drilling. The purpose is to create capillary fractures to enable leakage gases that are trapped in rock structure.

Waste management: It implies the operation of storing the liquid mixture, which is used for drilling, when it resurfaces and re-purification to clean such liquid. This liquid mixture is very important. As tons of water is used for fracturing, water must be purified from the chemical substances it has and then released back into nature to prevent contamination of underground sources.

Production: It implies the demounting of all equipment, establishment of shale gas collection equipment and carrying out works as required for its transfer after drilling and fracturing operations are completed under ideal conditions.

The most common method that is used for shale gas exploration and extraction operations is "horizontal fracking". In addition, vertical hydraulic fracking and rotary hydraulic fracking are used.

2.1. Vertical Drilling (Piercing-Opening a Hole)

Vertical hydraulic fracking is a drilling technology used by opening vertical pits on the surface. This method has been used for a long time and the term "vertical fracking" was used for conventional fracking methods before horizontal fracking. Vertical hydraulic fracking is a technique that does not use wide peripheral components although it contains some short horizontal components (Ahıshalı, 2013). At this stage, after the appropriate shale layers are located after investigations, preparations are made to bring it to a very large space, a site medium and this space equals 25 football fields approximately. Then the act of drilling begins after drilling platform is established with required assemblies. Drilling operation lasts from 3 to 6 weeks depending on the structure of underground resources. Water that comprises mud and particles and that comes out while drilling is poured into a very large pool. Concrete sheet block is created with 3 interwoven steel pipes to prevent contamination of underground water and blend of underground water with natural gas in following stages as earth's layers are perforated during the operation of drilling. Concrete block body is used generally to coat the hole (borehole) on the inside. This operation has to be made essentially to protect the shale gas, which will come out after drilling, from underground waters (aquifers). The above-mentioned operations including laying the concrete, concrete sheet block and cementation have to be made based on certain principles. This is compliant with the current industrial standard stipulated by petrol and natural gas laws and the specifications used by American Petroleum Institute. These specifications set out the length, thickness, tensile strength and composition of coating for a specific situation and describes the most common method used for selecting petroleum and gas preservation.

2.2. Horizontal Drilling (Horizontal Hydraulic Fracturing-Fracking)

This stage is the cracking stage following continued horizontal drilling for one to two meters after piercing and advancing down to rock layers. Approximately 20 thousand cubic meter water, 1800 cubic meter sand and 100 tons of additives are used before going through with this stage. Additives which are prepared externally are as follows. The reason why mixture substances will be used and percentage rates of substances in the mixture will be indicated below. Usually water constitutes 97.5–98 % of general total volume in the mixture. Such water contains cracking liquid, minerals and bitter water that return from boreholes. 30 % to 70 % of such water is original

cracking liquid. Additionally, natural formation waters get mixed into such water and come out. 10 % to 40 % of water pumped after hydraulic cracking operation in shale gas production return. Quality of returning water changes depending on the place of borehole and depth; however, they are subjected to purification at different levels and are used after clean water is added. Returning water contains high amount of sodium, calcium and magnesium. Therefore, it must be purified before it is used or accumulated as waste. Endeavours are made to develop new technologies in order to minimize need for water in hydraulic cracking due to high cost of water purification. Such endeavours focus on finding new alternatives to water such as liquid propane, carbon dioxide, nitrogen gas and cracking by using sound waves without any liquid. Such methods concentrate on developing special equipment to open borehole. Returning water and formation water that comes out as a result of production is used in a purification system established in the borehole region, in purification system of local administrations in the region or in a private purification facility.

2.3. Rotary Drilling (Rotary Hydraulic Fracturing)

Rotary hydraulic fracturing is a drilling technology that uses a sharp and rotating drill in order to open holes on the earth's crust. Such technology uses liquid that is known as "mud" and such liquid generally contains minerals like barite, chalk (or hematite) and clay. Such mud liquid is petroleum-based and formed generally by use of petroleum products such as diesel or synthetic oil. Moreover; water and clay mixtures can be used to create mud (Glass, 2011). Actually it is the operation of realizing usual vertical drilling with a different technique.

3. Effects/Risks Of Shale Gas

Human beings have used their environment, and therefore natural resources, to meet their own needs since the very beginning and as such, have contaminated the environment and have been affected by the environment. When human-nature relations and environmental problems are considered from this perspective, it can be understood that the single and the biggest root of all ecological problems that occur is irresponsible use of nature to meet unlimited human needs. As a matter of fact; significant and irreparable damages are made to the nature in each stage of meeting such needs including supplying required raw materials, producing and consuming commodities and services and them transferring them to nature as waste. That's why the effects and risks of shale gas that is considered as alternative energy source will be discussed in this part of the study.

3.1. Earthquake Effect/Risk

One of the problems that occur in shale gas extraction activities is that several environmentalist organizations protest shale gas extraction operations claiming that shale gas causes environmental pollution. For that matter; France, Bulgaria and Czech Republic banned shale gas works claiming that it causes environmental problems and earthquakes. England, Spain and South Africa have stopped works (However, England abolished the decision and resumed shale gas extraction activities).

3.2. Its Effects on/Risks to Agricultural Fields

Borehole is opened almost at every kilometre for shale gas production works and this occupies large space on earth as it requires construction of connecting roads or new roads for logistic purposes. This is particularly important for places that are engaged with agricultural activities. It was considered by local folk as a significant source of income at first as it was an opportunity for them to lease or sell their lands to petrol companies but in years they started to think that such lands would not be as fruitful as they were before (due to low agricultural yield or pollution), they responded negatively.

3.3. Its Effects on/Risks to Air

Global warming is a long-term rise in the average temperature of the Earth. Such rise is so big that it affects ecological balance. The greatest effect of global warming is on the climate system. Climate change that is a result of global warming occurs when effects of global warming result in changes in concentrations of some gases that are naturally present in atmosphere and named as greenhouse gases and when, consequently, earth's temperature rises excessively and some ecological imbalances occur (Karakaya, Özçağ, 2004).

However, recently, there is significant increase in discussions regarding reduction of such subvention that are given to renewable energy generally in Europe including Italy, Spain and Germany. In this sense, such subventions may decrease in 2016. Some changes have started to occur in richness of natural gas and gas in USA. For example; greenhouse gas emissions have broken the record of reduction down to the lowest level of the last five years by decrease of

450 million tons. Such reduction is a first on the world in terms of global greenhouse gas emissions (Taner, 2012). America's current amount of emission is around 1990, which is an extremely positive level. It has been achieved especially after substitution of shale gas and charcoal (Birol, 2014).

3.4. Its Effects on/Risks to Water

There are several negative comments as to hydraulic fracturing method that is a common method used for shale gas extraction activities. Such commends generally focus on use of large amount of compressed water which is the basis of hydraulic fracturing method. The possibility that the chemicals contained in compressed water may contaminate the underground water causes local folk and especially environmentalists to get concerned. Another and probably the most significant concern which surfaces regarding hydraulic fracturing technology is related to potable water. As it was described while explaining how the hydraulic fracturing method works, a mixture that contains tons of special chemicals and millions of litres of water is used to extract natural gas from rocks that are located thousands of meters under the earth. Water used for this operation is contaminated later and therefore it has to be cleaned or destroyed so that it cannot damage the environment. Most people are concerned about the types of chemicals used for fracking and the possible contamination of underground water by such chemicals. In addition to this, there are several wrong opinions as to what liquids are used for hydraulic fracturing and how such liquids are collected and destroyed after they pumped into underground for shale gas extraction (Ahıshalı, 2013).

Waste water that occurs as a result of shale gas production is divided into two categories. Water that is collected from boreholes within approximately 30 days following hydraulic fracturing is named as "returning water". The other one is the water that accumulates on the surface together with gas after start of gas production. Another subject of criticism is use of large amount of water during drilling works. People are concerned that they may have difficulty in accessing water which they need in many areas of life and that water ecosystem may be affected negatively during such works. As a result of hydraulic fracturing, significant amount of waste water comes out in addition to large amount of water consumption and as such waste water may contain unsolved chemicals, it has to be processed before it is used again (Yıldız, 2013).

The fact that waste water that comes out as a result of hydraulic fracking operation is purified generally in public purification plants and that such plants are not adequately equipped for Radioactive substance purifications has led to discussions in USA (Caruso, 2011).

While it is indicated that 0.75 % of the fluid resurfaces according to experiences of USA, returning water contains the chemicals used for implementation, heavy metals, salt and radioactive substances that are naturally contained in geological formations. It must be taken into consideration that while the amount of water used changes depending on the depth and length of horizontal boreholes, 2500 m^3 is needed for a vertical borehole and such amount rises to 10 thousand – 25 thousand m^3 for a horizontal borehole. In such case, the pressure of water that is needed for high-volume hydraulic fracturing on fresh water resources should be kept in mind and it should be taken into consideration that water that is trapped in underground formations surfaces as a result of drilling operations and as a matter of fact, large part of waste water comprises such "produced water". All of these factors contribute to enhanced significance of water management in hydraulic fracturing practices (Osborn et al., 2011).

4. The Reasons Why Such Concerns Are Ungrounded

4.1. Concerns About Earthquake

It is right to think that hydraulic fracturing may trigger small seismic activities and even small-scale earthquakes. However, these are generally small quakes which are felt in places where such fracturing operations take place, which do not harm people or the environment and which just cause traces of tracks on roads or small damages to buildings in some areas. Such activities lead to earthquake especially when fractured basins are faulted and easily triggered. For example, couple of small earthquakes were detected in places that are close to the injection point as a result of fracturing operation that was carried out in 2011 in Preese Hall-1 which is the first shale borehole of England. Such earthquake's magnitude was 2.3 and scale was 1,5 Richter. Cracks occurred on some roads while it did not cause any destruction on the surface.

4.2. Concerns about Agricultural Fields

Considering that a borehole life of a shale gas field is 15 to 20 years, agricultural fields and life qualities of settlements which are within the domain will be relatively affected. Therefore, such

concerns will be eliminated if exploration and drilling activities for this energy type are carried out in places away from agricultural fields and respective legal terms are enforced.

4.3. Concerns about Its Effects on Air

Shale gas is an important factor in terms of climate change. Shale gas is one of the sources that will help us reduce global greenhouse gas emissions because when this energy type substitutes for charcoal, there will be significant reduction in greenhouse gases. China takes important steps in terms of energy efficiency and renewable energy. Such steps have become mandatory. However, although some carbon reduction mechanisms are under pressure, some initiatives such as USA's Climate Change Action Plan, China's plan for reducing charcoal within its local energy supply basket, Europe's strategic energy and climate-related discussions for 2030 and Japan's new energy plan discussions can enable us to limit CO_2 emissions in energy sources. According to the main scenario, it is foreseen that energy-induced CO_2 emissions will increase by 20 percent in 2035 despite the effects of all declared measures which will be taken by governments to increase energy efficiency, support renewable energy sources, limit subventions supplied to fossil fuels and, in some cases, to price carbon emissions. This indicates that our earth may be faced with average temperature increase of 3,6°C in the long run. This level is way above 2°C that was internationally agreed upon objective (Birol, 2013). Natural gas has been an important substitute for charcoal recently and will reduce greenhouse emissions significantly. However, there has to be significant reduction in future CO_2 emissions, natural gas must be regarded as just a transition stage rather than a final solution for a low-carbon future. On the long term, common (and profound) use of natural gas will probably lead to negative results in terms of climate change. Shale gas technology can support a final solution for climate change by both increasing economic capacity of renewable technology and substituting for charcoal abroad (Cohen, 2013).

4.4. Concerns about Its Effects on Water

When shale gas extraction activities that are carried out on the world are examined generally, it can be seen that companies take serious measures in order to prevent contamination of underground water through hydraulic fracturing, place emphasis on keeping potable water clean and carry out works in this regard. Risks which may occur due to shale gas extraction activities will be naturally reduced as technology advances. In this sense, "borehole case" which is one of the measures taken to minimize such risks is an important one. Borehole case is a layered wall that is generally made of cement and steel. This structure supports the borehole and is separated from the geological structure around the borehole. As such, contamination of potable water with hydraulic fracturing liquids can be prevented. The depth of underground water can be measured through legal regulations and it can be determined how much the borehole case must be expanded (Glass, 2011). Criticisms about the liquids used for hydraulic fracturing have increased as shale gas manufacturers abstained from revealing the liquid formula in order to protect their own technologies commercially in early 2000s. This situation was eliminated through pressure of public authorities and regulations and manufacturers became more transparent about the chemical substances that are used. Today, liquid that is used for hydraulic fracturing contain approximately 97 % water, 2 % sand and around 1 % friction modifier, antimicrobial and chemicals that prevent accumulation of waste. Chemicals that are used are polyacrylamide, bromine, methanol, naphthalene, hydrochloric acid, ethylene glycol, butanol and similar substances and it is stated that as such chemicals are diluted, they would be harmless even if they get mixed with potable water. On the other hand, it is a very low probability that hydraulic fracturing liquids be mixed with underground water aquifer through fractures because underground water trays are in 300-meter depth at most and shale formations where hydraulic fracturing is implemented take place at least at 2500 depth underground. Fractures that occur across the horizontal drilling extend 200 meters upwards at most and there are impermeable rock layers which have thickness of 1 to 2 kilometres between underground water sources and the top point of fractures even in hydraulic fracturing operations with the most superficial depth (Demirtaş, 2013). Therefore it is evident that shale gas which is considered as an alternative energy source to fossil fuels is less undeniably less harmful than other types in terms of water factor which is our essential resource and that its significance will increase even more in the following days due to advancing technology in today's world.

5. Conclusion

For countries, the most important thing is to meet their energy needs from an inexpensive cost, to ensure sustainability of energy supply and pave the way for convenient access to such resources. As we need green energy more and more every day in order to prevent increase in earth's temperature and to ensure sustainability, our world still meets its energy needs from fossil fuels. Shale gas that has an ever-increasing trend in energy sector is an important exit point in this regard. However; this type of energy cannot be quite understood by societies yet as it is a new type of energy and it requires state-of-the-art technology. As societies do not have adequate familiarity with this type of energy, they have prejudices and they tend to opt for conventional fuels. In the following days, maybe in years, such prejudices will be broken down and countries will do silent reform just like United States of America and will have taken important step in establishing their own energy domination with shale gas.

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