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„U.S Shale Gas Revolution and its economic impacts in particular on U.S Natural Gas Prices“

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I. Management Summary

Energy prices are described as the general parameters of the world economy. The fluctuations in the prices of energy cause corruptions in the economical balances of the nations who mostly rely on external sources. In our day, the future of the fossil based energy sources is a subject of discussion. Thus, there is a trend to new and ecologically less harmful renewable energy sources. But due to the long-time taking substructure and measurement processes of the renewable energy sources, some nations and companies that operate in energy market are walking on eggs. By this means, a new and exciting attempt showed up in energy market. Due to the increase in energy demand, efficiently subtracting and advanced methods of drilling of rock gas that has been known for a long time, have come up to the fore. Recently, unexpectedly increasing shale gas production changed first America's and then the rest of the world's point of view about energy. This sources contribute a lot economically and they are foreseen to have a much more effect on social and economic fields in the future, despite having been protested in many nations and millions of people, because they are harmful for the quality of ground water, underground water and local air quality, assessing this subject in detail due to its economic benefits have become an obligation. Especially the disasters in global scale, global warming in 20th century, the chemical composition of atmosphere and these compositional changes grabbed the attention of people about its effects on ecology and humanity.

The purpose of this thesis is to give general information about (extracting methods, reserves etc.) the climate change, environmental and economic effects of this shale gas revolution that occurred in USA and other major countries. Recently, there has been a silent revolution in energy market. This revolution has been occurred in USA, is being stated as "shale gas revolution" and shale gas energy is being described as game changer in global energy market. Following general questions caused this thesis come up and the purpose of this research is to answer the following research question

- What has originally caused the demand of shale gas production in the USA, and to what circumstances is there the creation of demand and production of shale gas in the US; and how does it impact the economy?

Additional Question: How is the development of Shale Gas in the US, compared to the worldwide development of Shale Gas?

II. Acknowledgement

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1. Introduction

Problem Description

I would like to start with the importance of energy which is a part of our existence from the beginning. It can be summarized why the natural gas is so popular, like this: Being abundant, effective and a cleaner energy source when compared to the other fuels. Besides, innovations in the technology, as well as developed vertical digging methods, provided us to reach unconventional energy sources. The reason of being unconventional is the method of extraction and different extraction basin. United States has been living the abundance and wealth period of shale gas that does not counted as classic natural gas. Since 1800's, USA noticed that the natural gas, that was stocked in the pores of the rocks, 2000 metres under the soil, and USA has been closely interested in this potential. In 2000's, serious developments happened in the necessary technology to extract shale gas. As USA start extracting shale gas, this sources of energy have grabbed the attentions in global scale. Because USA is one of the biggest importers of natural gas in the world and with this source, decreased its importation amount seriously and decreased the cost of natural gas in county from 8 dollars to 2-4 dollars level. According to the projections of EIA (US Energy Information Administration) the USA will be a natural gas exporter in 2015. This global scale projection caused new projections, new theories and new expectations. Except coal, fossil oil has not been equally spread around the world by means of reserves. These sources are being found on a specific area like Middle East. Having this sources, have serious economic benefits to the countries. Examining the shale gas reserves, it can be seen that it has been spread on a wider scale around the world.
Although, it's not possible yet to extract shale gas efficiently, it is started being extracted in USA and has already been foreseen that particularly China, Mexico, Argentine, Libya, Pakistan, Algeria and Poland and many countries have serious shale gas reserves. In Turkey, especially in Southeast and West Thrace regions, reserves have been found. TPAO with the agreements with international companies like Shell, Exxon Mobile started searching extracting shale gas efficiently (Demirtas, 2013).

The USA has been living the abundance and wealth period of shale gas that does not counted as classic natural gas. Discovered hydraulic fracking and hydraulic fracturing, with their technologies, in shale gas and raw oil products, are spearing far and wide in nations like Canada, Argentine and Australia that have gas beds and petrol sources. Thus, the abundance

of the global hydrocarbon supply has a dramatic effect on the decrease of the raw fuel oil prices. Besides, world natural gas prices that are indexed to the global raw fuel oil barrel receipts are also have a downward tendency. For extracting the disguised and pressurised shale gas, horizontal and vertical innovative hydraulic natural gas production methods are being used. As twentieth century is being described as the gold century of raw fuel oil, twenty first century is being described as the gold century of natural gas. On the other hand, east states of USA with Marcellus shale gas reserves and sources, starting from the New York state's south border, go along all the way up to the Pennsylvania, Ohio, Maryland and West Virginia.

Aim of the thesis

This main purpose of this thesis is to determine how the shale gas production which is rapidly increased after 2007, had affected the US economy. It aims to how strongly this production had influenced the US market in particular in energy sector and the other sector which are affected from shale gas boom. Since United States is a birthplace of shale gas revolution, other major countries in which rich reserves have are also a part of this thesis to see how they have developed their economies to sink their energy dependency.

Research Question

What has originally caused the demand of shale gas production in the USA, and to what circumstances is there the creation of demand and production of shale gas in the US; and how does it impact the economy?

Additional Question: How is the development of Shale Gas in the US, compared to the worldwide development of Shale Gas?

Additional Question 2: Has the US Shale Gas production a statistically significant effect on US natural Gas Prices?

Structure of the Thesis

The Chapter 2 & 3 of the thesis, general information is being given about the world's energy vision. According to this, the sources used in the world's energy consumption and the share of these sources in these consumptions have been described. Historical development of hydraulic fracturing and its differences from conventional extractions are in the first part described. On the other side, it is also mentioned why the shale gas production has become so important and why is it called revolution? Following, unconventional energy sources that are being used in the world's energy consumption will be described and shale gas among these sources will be described in detail. Chapter 2 & 3 is written to create a view to understand the other part of this thesis.

Chapter 4 & 5 shows economic effects of the regions in which the natural gas and especially shale gas is extracted. First, short-term predictions are shown and then the studies that are related to how it will take place in the future are shown and they are supported with the academic studies. Especially America supported the local administrations, residential people, construction companies, accommodation, restaurant, renting services in the region and storages in terms of economic effects that started from gas research and extraction stage in the region, and provided an added value. Tax incomes that were formed within this process, provided new cash flows for the local administrations, and funds were transferred to different places with these incomes. These numbers which are supported by the tables, and the funds which were transferred to the charity, educational and health institutions by the local administrations, are shown. It is mentioned that the world's energy policy was directed not only their extraction places, and that its effect exceeded not only America but also the borders of the countries.

Chapter 6 points out other countries and regions which are the reserves of shale gas are mentioned in particular Europe, Canada, China, Argentina, South Africa, Australia and economic effects of it are stated. The regions and countries which possess shale gas resources apart from America are examined. The energy structure in the countries and regions where they are located, whether they have sufficient infrastructure in order to extract unconventional resources, the reserve amounts, the supply and demand regarding the natural gas are stated. Apart from these, the attention given to the shale gas detection and production works has been indicated separately for each region in partnership and investments realized in addition to this.

As each country has its own legal regulations, source research and extraction activities differentiate from each other for all countries. As the procedures of Europe are stricter when compared to America, drilling activities are interrupted in a few regions until the researches on the health aspect are finished. In this sense, economic effects of shale gas development are mentioned in the second part and advantages and disadvantages are mentioned both locally and globally.

Chapter 7 executes an empirical study between US shale gas production and US natural gas prices. In this chapter the statistical connection between US shale gas production and US natural gas prices is analysed, which is indirectly performed by first observing if US shale gas production is significant part of US total natural gas production. As a second step, the statistical connection between US natural gas production and US natural gas prices is examined. It is found that there is a statistical connection between US shale gas production and US natural gas prices.

2. Background: Why Is It a Revolution?

In the reports that were published in 2012, the common thing was that the meeting ratio of the natural gas reserves which were extracted conventionally was about 60 years. However, this number may be revised upwardly theoretically. In order to understand why these numbers are so high, it will be enough to see only the energy consumption of the world.

While coal, one of the sources that take place in the energy consumption, forms one of three of the total demand, there was a demand for natural gas in the ratio of 27% and for petrol in the ratio of 22% (BBC, 2013). It is a real fact that the environmental policies which have a purpose of reducing the carbon emissions in the world, contributed to natural gas more than the coal. Decision taken by Obama Government for the purpose of reducing the greenhouse gas emission as 'fight against coal', the fact that Germany will not build coal stations which is the biggest coal producer of Europe, are the elements which increase the importance of the natural gas in addition to the renewable energy groups.

It is predicted that one of five of the energy demand increase that was predicted by IEA by the year 2030, will occur in coal but one of three of the total demand will be in natural gas. The share of petrol in this increasing demand is about 10%. Let's add the current economic situation of the world and energy entrance which becomes cheaper due to the increasing sources to this image and it will be possible to understand how attractive that is.

As known, shale gas production has become a great factor in the reduction of natural gas prices from 2008 to its half of nominal value. When comparing the natural gas sales prices of Europe with the ones in Russia and Iran from these periods to nowadays, it is more possible to understand why shale gas is demanded more and more. Of course United States didn't take this eco-political advantage into their hands immediately. As per the researches for years, it accelerated the shale gas and shale oil production by starting from 2010-2011. EIA (2013), Shale gas production which is 9 billion m3 in the year 2000 and which is equivalent to 1.6% of the total production, reached 230 billion m3 in 2012 which is equivalent to 34% of the total production. These numbers show that the United States, which is one of the most important importers in the world, moves forward to meet its own requirements and may become an energy dealer. Additionally in the report, it was mentioned that USA will succeed to produce more petrol than it imported in 2013 since 1997. It will not be wrong to interpret this information that USA will reduce its economic dependency to Middle East.

These reasons explain why shale gas attracts more and more. Of course, having these kinds of energy sources and shale gas, does not mean that the country may use them. As stated in the

study, although Argentina and China have a high level of sources, when the production of these countries is compared with the United States, it does not make any sense. There are legal and structural reasons as well as the technical reasons for this situation.

Technically, 60% of the drilling towers which make production actively in the world, is in USA. 95% of these towers are suitable for drilling and thus the shale-based production. Intensive drilling is a great factor in shale gas and petrol production. 45 thousand of total 49 thousand wells (petrol and gas) that were opened last year in the world, were in the United States.

Today in China and the other countries which have shale gas reserves, there are far less wells than USA when compared. It is a gospel truth that when the legal and structural problems are removed, the production will increase. Such that, today China is the only country which developed the shale gas production except for USA. It is predicted that China will meet 40% of its natural gas production from shale gas by the year 2040. (EIA, 2016)

The method that is used in the production of shale gas (and petrol), namely little earthquakes that may be caused by horizontal drilling for 1-1.5 km after the vertical drilling for 2.5-3 km, and chemical materials that are injected into the cracks and which are possible to mix with the underground waters, are the potential dangers of this production method. In the countries which does not have land property and usage laws that are not as flexible as USA, these concerns become an obstacle in this situation.

2.1 Why shale gas has become so important?

With the developed extraction methods, shale gas production caused a new natural gas demand in USA and it is predicted that this situation will continue until at least 2035.

According to EIA, unproved shale gas reserves of USA are more than 480 trillion cubic feet and it is predicted that the total reserves with the known ones reach 540 trillion cubic feet. We may give an example to understand these numbers easily. Shale gas production of 5 trillion cubic feet met 23% of the gas production of USA in 2010, a production of 13 trillion cubic feet (2035) will meet half of total gas production of USA. (EIA, 2012, p.3)

Generally, with the increasing production in the country, the prices went down and the tendency on depending to importation in energy decreased and energy safety of USA raised. In addition to these benefices, thousands of people were employed thanks to the energy platform in the developed internal market. When the wells were dug, when the pipelines were constructed and additionally the production sites were formed and conducted, thousands of people were employed. This increase in the production capacity, raised the taxation incomes

of the local and federal governments, and added a great contribution for the landowners who had copyrights.

Shale gas does not only contribute in economic situation. It also has a beneficial effect on environmental issues. Almost one of four of total electricity of the country is met from shale gas production. With this natural gas, millions of people and institution meet their heating and business needs. Additionally, it has a contribution over the energy amount which is needed by the industry of USA.

According to the numbers of EIA (2013), it has some effects such as having a 175 billion dollar income and employing 2 million people. Additionally according to the data of the agency, a 250 billion dollar income is predicted as an institutional income.

In the report, EIA (2016) gave exactly the following title to the shale gas: "Shale resources remain the dominant source of U.S. natural gas production growth" (directed cited, EIA, 2016, p. 53). One of the most important factors in the increase of definite natural gas is the shale gas and the developments in shale gas extraction. As per the technological developments, shale gas production which becomes easier than it was in the past with the developed extraction methods moves the United States to a very different direction. In the near future, it is predicted that the shale gas will make the United States as an exporter and will change the location of the milestones not only in economic situation but also in political point of view. The figure below shows how rapid the US decreased its natural gas import after producing shale gas.

Figure 1: US Natural Gas Import Volumes (million cubic feet)

Source: Bilgili, 2016, p. 966

3. World Energy View, Unconventional Energy Sources and Shale Gas

3.1. Energy Reserves

By examining today's energy usage percentages, the table is like: the biggest percentage of usage is fossil fuels (coal, natural gas, fuel oil). As indicated in the previous chapter, 87% of the global energy consumption of the world consists of fossil fuels. After that, renewable sources, as we can say other sources, to come. Because renewable energy water, sun, wind and geothermal sources are increasingly be used. By looking at the past 50 years, it can be seen that these sources have been used economically. But still the fossil fuels have been the most common ones. Thus, it can be seen that it is critically important they have these fossil fuels as countries. It can also be seen that these sources haven't been equally distributed geographically. As one of the most important fossil fuels, coal, can be found through a wide geography, fuel oil and natural gas can only be found in certain regions. But regions are mainly, Middle East, Russia, Iran, Algeria and Venezuela. OPEC countries Russia and Middle East countries can seriously affect and be affected by the changes in energy market. Therefore, these obtain serious revenue by fuel oil and natural gas. The countries which don't have these sources like Turkey, Japan, and Germany are foreign-dependent. Even the USA, although having high percentages of fuel and natural gas sources, imports considerable part of its energy to be able to supply the high demand. These imports have an important effect on countries economic indicators by means of current deficit and foreign trade deficit. By this means, the countries which doesn't have too much petrol or natural gas sources or which cant supply the demand effectively are foreign dependent to importer countries, because the development of their industries are dependent to obtaining these import energy sources. Thus, this is a very critical geopolitics subject. But, apart from these conventional fossil fuels, also there are unconventional energy sources and recently, these have been very popular by means of alternative source searches and technologic development and increased to economically beneficial percentages. Also as these sources are geographically more distributed globally, keep the interest alive. Thus, in this episode, it will be indicated to these sources which are recently come up and will create serious effects on global energy market and the prices in the countries like USA, Canada, and Poland in the future.

Current emission amounts of America are on the levels of the year 1990, which is a very positive table at all. This situation was achieved after America applied especially shale gas and coal (Birol, 2014).

Accordingly, shale gas is an important factor in terms of climate changes. One of the sources that will contribute to decrease the global greenhouse gas emissions is shale gas. Because if this energy source is applied with the coal. It will contribute to decrease the greenhouse gases effectively.

It is expected that the promising decisions will be taken in Climate Change Panel between the Governments that will be held in Paris in 2015 in terms of climate changes. One of the basic foundations of these expectations is that the United States decreased its emissions significantly thanks to shale gas and that the coal-based industry in China caused significant environment problems in the country. As a result of this environmental issue in China, important steps are taken in terms of energy productivity and renewable energy. These steps become obligatory. Thus, these developments in United States and the changes in China are a glimmer of hope in the meeting in Paris in 2015.

Table 1: World Petrol, Natural Gas and Coal Reserves, Production and Consumption Amounts

		North America	Middle&South America	Europe and Asia	Middle East	Africa	Asia Pacific	World Total
Petrol	Reserves (billion tons)	35.3	51.2	20.9	109.7	17.1	5.7	239.8
	Production (million tons)	868.8	391.0	834.3	1,339.5	392.2	396.7	4,220.6
	Consumption (million tons)	1,024.4	326.5	858.9	393	179.4	1,428.9	4,211.1
Natural Gas	Reserves (trillion m^3	12.1	7.7	58.0	79.8	14.2	15.3	187.1

	Production (billion m^3	948.4	175.0	1,002.4	601	202.6	531.2	3,460.6
	Cons (billion m^3	949.4	170.1	1,009.6	465.2	120.1	678.6	3,393
Coal	Reserves (billion tons)	245.0	14.6	310.5	1.2	32.9	288.3	891.5
	Production (billion mtpes)	551.4	65	441.6	0.7	152.2	2,722.2	3,933
	Consumption (billion mtpes)	488.9	31.6	476.5	9.7	98.6	2,776.6	3,882.8

Source: BP, 2015

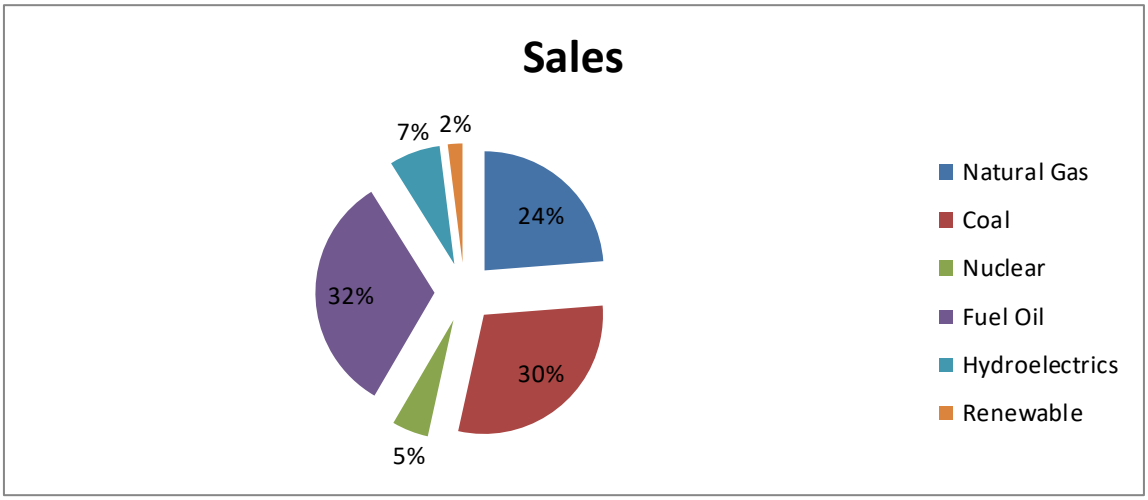
3.1.2 Energy Production

Energy is an inevitable source for the daily needs of humanity. Especially with the revolution of industry by starting the use of fossil oil in developed countries started using energy and thus developed and expanded their armies, economies, technologies and populations. In the twenty first century, considering the daily needs of humanity, importance of the energy in human life can be understood far better.

Energy generally plays a key role in the expansion development and geopolitics of the countries. By this means owning the resources of energy, obtaining them cheap, and marketing these in the world energy market is very important. Looking at the June 2013 report of BP Statistical World Review of Energy, it can be seen that, total consumption of world's energy is equal to 12.5 billion of fuel oil. According to this, looking world's energy consumption on the basis of the resources, fossil fuel takes the lead as a very high, 86.9%. By looking them each separately, fuel oil 33.1% natural gas 23.9%, and coal 29.9% used in the world's energy consumption. Percentage of renewable energy which the world cherish the hope by means of nature friendly and climate change is 8.6%. As is known, major renewable

energy sources are hydraulics, wind, sun, geothermal and biomass. By means of sources, consumption of renewable energy in hydraulics is 6.7% and other renewable energy sources are 1.9%.

Figure 2: Worlds Major Energy Consumption on Sources basis



Source: BP Statistical World Review of Energy, July 2013

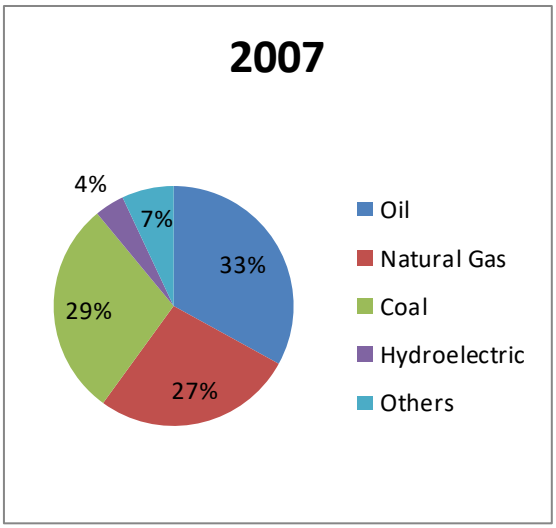
Due to population growth and industrialization, energy consumption increases every year. Thus, world major consumption of energy in 2011 increased 2.5% by the previous year and reached 12.4 billion tpy's. Net growth in energy consumption, took place in growing economies and China has been caused the 71% growth of global consumption of energy alone. (BP Statistical Review of World Energy, p.3) In the 2015 edition of the same report, these have been stated about China: Chinese consumption growth was the slowest since 1998, yet China still recorded the world's largest increase in primary energy consumption for the fourteenth consecutive year. (BP Statistical Review of World 2015, p.1)

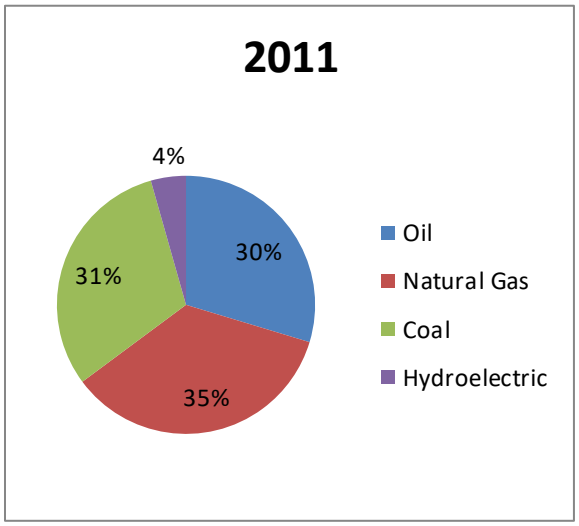
As 86.9% of worlds energy demands come from fossil fuels, by means of greenhouse gases released into atmosphere that is a critical problem. The mean reason of global warming is sera gas. Globally, there have been serious discussion panels, conferences, and congresses are held to discuss how to decrease the percentages of these energy sources.

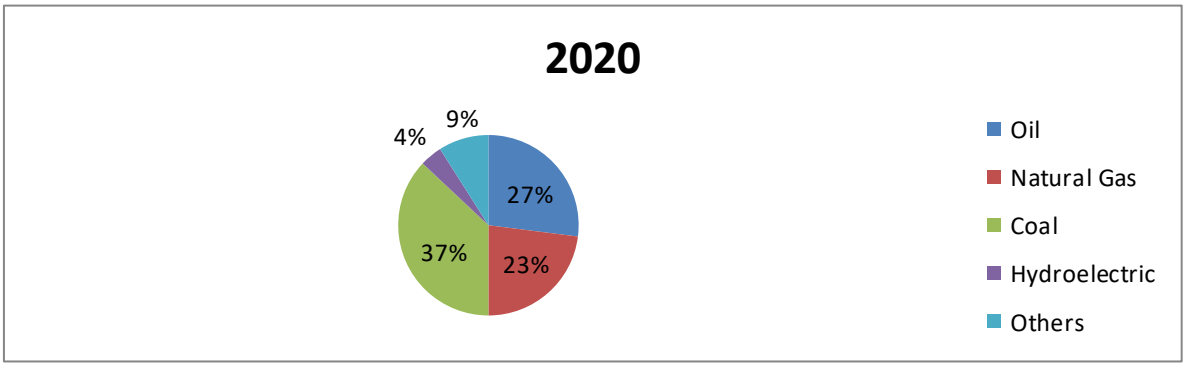
In fact, by looking at the 2011 numbers, proved oil reserves are 234.3 billion tons and yearly consumption is 4 billion tons, with this consumption speed, it has been assumed that petrol reserves will drain away in 54 years(Ahıshalı, 2013, p.14). In natural gas, proven reserves total is 208.4 trillion m3's and yearly production is 3.3 trillion m3's, with these percentages of consumption natural gas has 64 years to live. Also the 861 billion of coal in total calculated

known world sources have 112 years to live (BP Statistical Review of World Energy, 2012, p.31).

Figure 3: World Energy sources usage between 2007 - 2020 years.







Source: Turkey Cogeneration and Clean Energy Technologies Association, 2013 Turkey

By looking the percentage of usages by means of world's energy sources, natural gas increased to 32% in 2011 as it was 27% in 2007. By looking at the projection of 2020, natural gas usage assumed to draw back to 23%. By examining petrol, as it has a 33% of usage in 2007, has been regressed to 27% in 2011. By 2020 no increase in petrol usage increase is assumed and it is predicted to continue by 27%. By looking another fossil source, coal, in 2007, 29% of global demand of energy has been supplied by coal. By 2011 though, coal usage has been regressed to 28%. But, by looking at 2020 projections, it has been predicted to increase by 37%.

3.2. Unconventional Energy Sources – Contra Conventional

3.2.1 Definition: Conventional contra Unconventional Energy Sources

The main difference between conventional and unconventional sources is the type of their extraction. In another words, type of extraction of unconventional sources does not resemble to another one. Extraction of sources by using different methods separates them into two groups. Conventional oil and gas have significant structures generally into geological formations and there are no need of special or developed method or technology to extract them. In these formations, there is hydrocarbon. In oil or gas extraction that are extracted conventionally, wells are opened in the regions where the source is found and it is ensured that the source rises up. Then they are extracted with various pumping methods.

Since industrial revolution, because the energy need of the world has increased day by day, we extract these sources since the day we know their existence. After it was found out that these conventional sources were decreasing, and thus, after appearance of new technologies, this conventional method is being left day by day. Developments in technology give chance for economical extraction of oil and gas which come from unconventional sources. Unconventional sources are made in order to allow oil and gas to flow upwards by creating cracks in the underground rocks. It is called hydraulic fracturing.

3.2.2 Change towards Unconventional Energy Sources

With the developments in technology, drilling methods that are used currently are also developed. Two important developments in technology give chance to benefit from shale gas economically. First of these is hydraulic fracturing and second one is horizontal drilling method. Hydraulic fracturing method reduces high cost which hinders the extraction of these unconventional sources, and makes natural gas and oil production possible that are called shale. Hydraulic fracturing is a method in which water sand and hydraulic fracturing liquids are injected underground with high pressure in order to form fractions and cracks into the rocks. Thus, it is ensured that the natural gas and oil in the rocks leak from the cracks by forming cracks on the rock formations that are found underground. Millions of barrels of water, sand and special chemical mixtures are injected into the well under high pressure by drilling a well on the rock. The applied pressure breaks the rock and opens cracks which enable the extraction of natural gas and oil from the well and a more free circulation.

Horizontal drilling method starts with the horizontal processing after reaching to the rock type called shale with the wells that are drilled vertically. High amounts of water, sand and chemical mixture are injected into it with pressure and the gas which is stuck into the rock formations is extracted from the wells after it is released.

3.2.3 Shale Gas Exploration Techniques and Costs in Comparison to other Unconventional Energy Sources

Methane gas, known as a natural gas, is the main component of coal, oil and natural gas. Sources such as coal, oil and natural gas, are known as the conventional energy sources. Shale gas, which is within the classification of unconventional energy sources, takes its name from the rock type in which it is found. Shale gas is the gas which is found in the pores of the sedimentary rock which is formed by clay, quartz and calcite minerals. In addition to shale gas, tight sandstone and coal bed methane are also within the unconventional energy sources.

Sedimentary rocks called as shale gas, have limited and low permeability in terms of gas and liquid material permeation inside them. There are three different methods that are developed for extracting this gas from the rocks and for using economically. First of these is 'hydraulic fracturing'. With this method, after long term studies, the regions that have gas potential are determined and underground natural gas is extracted with the drilling method.

This concept was firstly developed for Barnett Shale unit in Ft. Worth Basin which is located in the middle-northern part of Texas State of USA. First well in the field was opened in 1981 with conventional purposes and methods. Approximately 100 wells were opened between 1981 and 1990 in order to make production in conventional reservoirs. After 1997, hydraulic fracturing (hydro-frac) was used with 'unconventional' methods. As a result of this, research and production activities in this basin increased rapidly and the number of wells for production reached to 6203 at the end of September, 2006. With starting to dig the horizontal wells since 2002, the production rates have doubled and this basin became the second biggest basin in USA. According to the reports of United States Institution of Geological Research (USGS) in 2004, productivity potential of the field was reported as 26.2 tcf. (Yalcin, 2012)

The most important component of this process is water. In order to subject a well to a horizontal hydraulic fraction, approximately 8 to 15 million litres of water is used (NETL, 2013). In addition to this, considering that a well may be drilled several times, the amount of water reaches very high numbers. Namely, due to the high amount of water used in hydraulic fraction process, it is known that China has problems in shale gas extraction works (Hook,

2012). The most common method used in shale gas research and extraction is 'horizontal fracking' method. In addition to this, there are also vertical fracking and rotary fracking methods.

3.2.4 Hydraulic Fracturing

Vertical hydraulic fracturing is a drilling technology performed by opening vertical pits on the surface. This method has been used for years, and 'vertical fracking' term is used for conventional fracking methods before the horizontal fracking. Although vertical hydraulic fracking contains some short-structured components, it is a method in which the wide peripheral components are not used (Ahıshalı, 2013, p.13). This partnership contributed to the development of technologies to obtain natural gas with the activities of multi-stage fraction and slippery water fraction, as well as horizontal wells which have a vital importance (King, 2010). Practical applications of horizontal drilling for oil extraction were started in 1983.

Table 2: Developments of Hydraulic Fracturing

	Hydraulic Fracturing Technological Milestones
Early 1900s	Natural gas extracted from shale wells. Vertical wells fractured with foam.
1983	First gas well drilled in Barnett Shale in Texas
1980-1990s	Cross-linked fracturing fluids developed and used in vertical wells
1991	First horizontal well drilled in Barnett Shale
1991	Orientation of induced fractures identified
1996	Slickwater fracturing fluids introduced
1996	Microseismic post-fracturing mapping developed
1998	Slickwater refracturing of originally gel-fractured wells
2002	Multi-stage slickwater fracturing of horizontal wells
2003	First hydraulic fracturing of Marcellus Shale
2005	Increased emphasis on improving the recovery factor
2007	Use of multi-well pads and cluster drilling

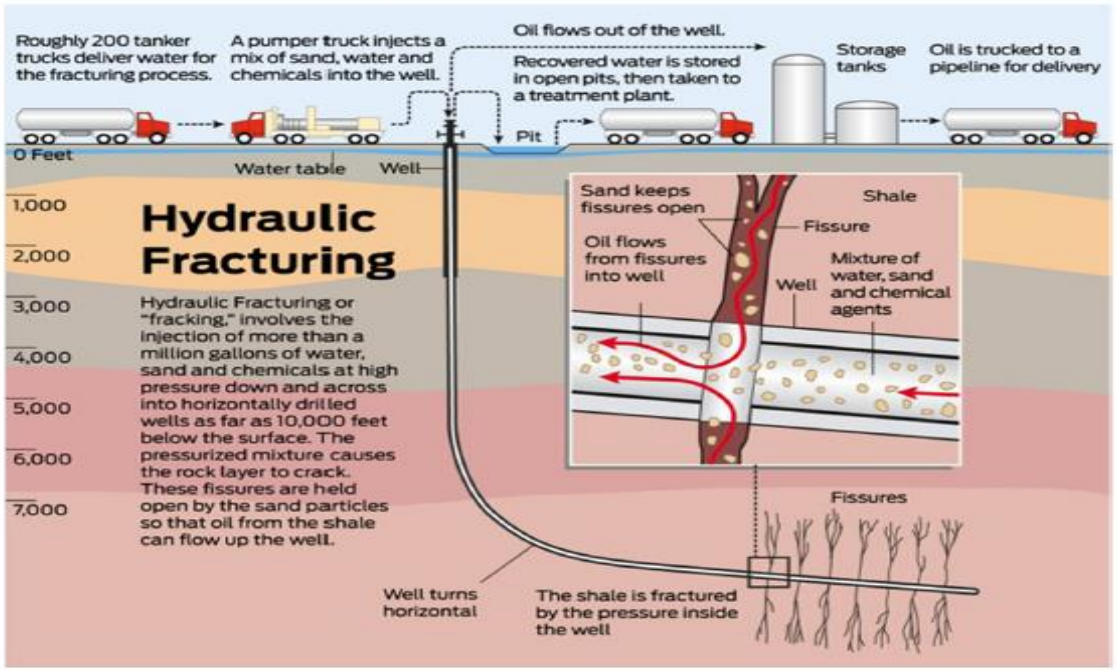
Source: Cojoianu, 2013, p.13

3.2.5 Horizontal Fracturing

Horizontal hydraulic fracturing enables the opened wells to move forward horizontal direction instead of moving downwards, so it may reach a wider area without opening several pits on the surface. A horizontal well, contrary to the vertical one, may reach to three kilometres

throughout a rock deposit. Horizontal structure of horizontal drilling enables the hydraulic fraction with high volumes. Hydraulic fraction with high volumes is a method which was developed in 1990's and which contains different chemical mixture when compared to the drilling methods that were used before (vertical fracturing). Hydraulic fraction with high volumes requires less gelling agent and uses more chemical materials which have the capacity of decreasing the friction when compared to the other methods (hydraulic fraction liquids). In this method, 70 to 300 times more liquid is used when compared to the previous methods (M. A. Ahıshalı, 2013, p.13). Within this content, the difference between vertical and horizontal hydraulic fraction is the usage of material during the extraction of shale gas. Briefly, drilling first starts vertically in horizontal fracking method, but it continues by turning to sides. In addition to this, horizontal fracking uses more water, sand and chemical materials and enables to extract more natural gas by ensuring the hydraulic fraction with high volumes.

Figure 4: Typical horizontally drilled well



Source: Propublica, 2012

3.2.6 Shale Gas Exploration – Environmental Questions

Scientists previse that the shale gas is a fossil fuel and a source of carbon dioxide. In addition, several environmental organizations react to the shale gas extraction activities by claiming that the shale gas causes environmental pollution. After it was determined that the shale gas drilling caused environmental issues and earthquakes, France, Bulgaria and Czech Republic

banned the shale gas activities. England and Spain stopped the activities. However, England continued its shale gas activities again by cancelling this stoppage decision later. Environmentalists, who claim that the mixtures in the fraction liquid which is used for shale gas extraction is involved in the underground water, demand that these shale gas extraction activities should come to an end.

The fraction liquid consists of 98% water and 2% sand and chemicals (King, 2012, p.7). Fine-grained sand or clay enters into the fractions. When the pressure is removed at the end of hydraulic fraction process, this material keeps the thin fractions opened and ensures that the shale gas accumulates and flows through the well. Some chemicals inside this liquid help to perform this fraction process successfully. In this process, approximately 10.000 m3 to 25.000 m3 water is needed for a well (Broomfield, 2012, p.7).

Pollution of underground water in shale gas production is claimed nowadays. In the report issued by USA Massachusetts Institute of Technology (MIT) in 2011, the problems which were determined in 20.000 wells in which hydraulic fraction was applied for the last 10 years were examined. In this research, only 43 serious water pollution cases were determined. In 21 cases of these 43 cases, it was seen that the underground water was contaminated by the gas and hydraulic fraction liquid, there was pollution on the surface around the site in 15 cases, there were draft survey and air pollution problems in 4 cases and there were waste collection problems in the last 3 cases.

According to the report issued by MIT in 2011, 47% of the environmental pollution occurred in the shale gas extraction activities, was caused by the mixture of water which is used during shale gas extraction and underground water (considering that the water needs of the people are provided by the underground waters, it is a devastating and dangerous rate), 33% was caused by the contamination on the surface, 10% was caused by excessive draft survey and 9% was caused by the other reasons.

MIT evaluated in this report that problematical wells ratio was very low within 20000 wells and this was a positive result. However in the same report, it was stated that the risk of shale gas extraction activities was high in terms of environment and it should be taken into consideration that the faults which may occur even in a few wells, my create very serious environmental problems. (MIT, 2011, p.39)

Because in the researches which were performed in the aquifers inside the shale gas formations such as Northern-East Pennsylvania and Marcellus and Utica in New York, methane mixture related to the shale gas extraction was systematically found in the drinking water (Osborn, 2011). In 4.5% of 316.000 wells that were examined, leakage was determined.

It was determined that the main source of the mixture which contaminated the underground water, was liquid and solid materials which spread accidentally. (Nygaard, 2010, p.6).

There are various critics about the hydraulic fraction method which is most common used during the shale gas extraction activities. These critics are mostly about the usage of high amount of pressure which is the basis of hydraulic fraction method. The possibility of mixing the chemicals inside the pressurized water inside the underground water worries the environmentalists and local people.

Another and possibly the most important concern on the hydraulic fraction technology is about the drinking waters. As stated when mentioning about the operation of hydraulic fraction process, a mixture which contains tons of chemicals, several of which are special, and millions of liters of water for each fraction are used in order to extract the natural gas from the rocks which locate thousands of meters under the surface. The water used in this process is contaminated later and this water should be cleaned or removed in order not to damage the environment. Most people concern about which chemicals are used in these fracturing processes and the possibility of contamination of the underground drinking waters by these chemicals.

Global Warming

Global warming means gradual increase of the temperature in most of the world. This temperature increase reaches the dimensions which may affect several ecological balances. The greatest effect of global temperature warming is on the climate system. Climate change which arises by basing on the global warming, means the concentration changes of some gases which are naturally found in the atmosphere and which are called as greenhouse gases, and the excessive heating of the terra based on this and the appearance of some ecological instabilities. According to the 5. Evaluation Report of IPCC as 1. Working Group, global warming is absolute and most of the changes that were observed in the climate since 1950's, were as never before from ten years until a time period of a thousand years. In this period, atmosphere and oceans were heated, snow and ice amounts decreased, average sea level raised and accumulation of greenhouse gases increased. Atmospheric accumulation (concentration) of Carbon dioxide (CO_2), methane (CH_4) and diazotmonoxide (N_2O) gases reached a very high level as never seen before in the last at least 800.000 years. CO_2 accumulations increased at the rate of 40% when compared to the preindustrial period, due to the emissions caused by fossil fuel usage principally and change in net field usage. The oceans absorbed and acidulated 30% of the human-based carbon which was released in the

atmosphere. In International Climate Change Panel organized from time to time, studies aimed at the reduction of greenhouse gas release, generally failed. The Europe took serious measures in this issue and lowered much of its emissions. They achieved this success thanks to the encouragements they provided for the renewable energy and changes in energy policies. But in recent years these encouragements provided for the renewable energy in Europe, have been discussed in terms of the charge they brought for the budget. The countries which didn't agree on the subject concerning the reduction of greenhouse gas emissions and climate change agreements contrary to Europe were especially China and United States of America. Because these countries use the fossil fuels seriously in energy-based sectors. However, in recent years, after the shale gas revolution occurred in the United States, this country reduced its greenhouse gas emissions seriously thanks to the shale gas which releases less greenhouse gas than the fossil fuels. Abundance of natural gas and gas wealth in the United States, cause some important changes in the country. For example, the United States broke the record of reducing the greenhouse gas emissions for the last 5 years, which decreased 450 million tons. It was the first time that we witnessed such a decrease in the world in terms of global greenhouse gas emission (Taner, 2012, p.3).

Current emission amounts of United States are at the levels of 1990's which is an extremely positive table. This situation was reached after the United States replaced the coal by the shale gas (Birol, WEO 2014).

Thus, the shale gas is an important factor in terms of climate change. One of the sources that may help reducing the global greenhouse gas emissions, is the shale gas. Because when this source of energy is replaced by the coal, it will help reducing the greenhouse gas emissions seriously.

3.2.7 Different Kinds of Unconventional Energy Sources

3.2.7.1 Coal bet Methane

Coal based methane is a gas which is naturally comprised in the coal veins and which contains none or little hydrocarbon. As a result of some physical or chemical processes of vegetable oils also comprise methane. Especially, with temperature and pressure effects, vegetable wastes starts carbonisation and by this process also comprise carbon dioxide, water and nitrogen with methane. In methane formation, two mechanisms called biogenic and termogenic are active. In the first process of carbonisation, with certain temperature and

pressure vegetable wastes decompose microbiologically and create biogenic methane. In this process of carbonisation; fossil biogenic methane accumulations, as methane has no reservoir or mass are very few. With the increasing depth and temperature, not only the degree of carbonisation is increased but it also causes formation of termogenic methane. As the increasing depth increases carbonisation, it also increases the amount of the methane. (Yalçın & Durucan, 1984, p. 320) This pressure depends on the degree of the coal, depth of the vein and the form of the coal. Methane, as long as the balanced pressure inside the coal maintained, it doesn't come off.

Coal based methane, in certain regions, can be an alternative to natural gases for liquid natural gas production, and can be a cheap source. Due to the improvements in gas liquidation technologies and the downsizing of the small scaled cooling equipment and the eased application of the process, in recent years, usage of the application started to increase (Sööt, 2006, p. 408).

In USA and Canada, unconventional pressurised gas and shale gas and in Australia, Coal Based Methane, although they are in the beginning of the gas revolution, started the effect the market. That turned USA, from a huge gas importer to, as the price of the natural gas increased, an important gas exporter. With the development of CBM production Australia planning to take de lead of LNG market by 2020. Japan, after the Fukushima disaster, closed down all its nuclear plants and is on its way to be the biggest client of the Australia. In South East Asia, China and India, to meet their energy demand and to decrease their bills tending forward unconventional gas. In 2015, China predicted to increase its CBM production dramatically. Indonesia and Argentina are predicted to increase production amount of CBM by years of 2020- 2025. Yet, the production of unconventional gas is under 1% in Europe, it is predicted to increase 27% by 2035 and 47% in European Union. In Europe, Poland is expected to be in this field and England, France, and Norway closely following this unconventional gas revolution in USA. After Fukushima, the EU, by criticizing the nuclear energy again, is predicted the make a choice between unconventional gas and dependence to Russian gas (World Energy Outlook, 2012, p.1-5).

3.2.7.2 Oil Sand

Oil sand is a mixture consisted of heavy and dense sand, clay and other minerals, and has to be processed before being used by the refineries to produce useful oil. Sand Oil can be found in many regions of the world, mostly in Venezuela, USA and Russia but, Alberta Athabasca

bed in Canada is the most advanced one and it utilises the most advanced production processes. Canada has the world's third biggest petrol reserves and 97% of these reserves come out of the oil sand. Mathematically, 173 billion barrel Canadian petrol can be considered as economic and 168 billion barrel of this reserve consists of oil sand. (CAPP, 2013)

3.2.7.3 Shale Oil

Shale oil is also the raw petrol like the shale gas, confined to the source rock. Reason that it is not as popular as shale gas is, it is technically and economically too hard to produce from impermeable layers as the gas production. The lower density and volatility of gases make them superior (Demirtas, 2013). In the table below, ten countries which have deductible shale oil are indicated. As seen in the table, unlike the most conventional petrol reserves, shale oil is geographically more widely distributed around the globe.

Table 3: World Shale Oil Reserve

Rank	Country	Shale Oil (Billion Barrels)
1	Russia	75
2	USA	58
3	Chine	32
4	Argentine	27
5	Libya	26
6	Australia	18
7	Venezuela	13
8	Mexico	19
9	Pakistan	9
10	Canada	9
Total		**286**

Source: EIA, 2013

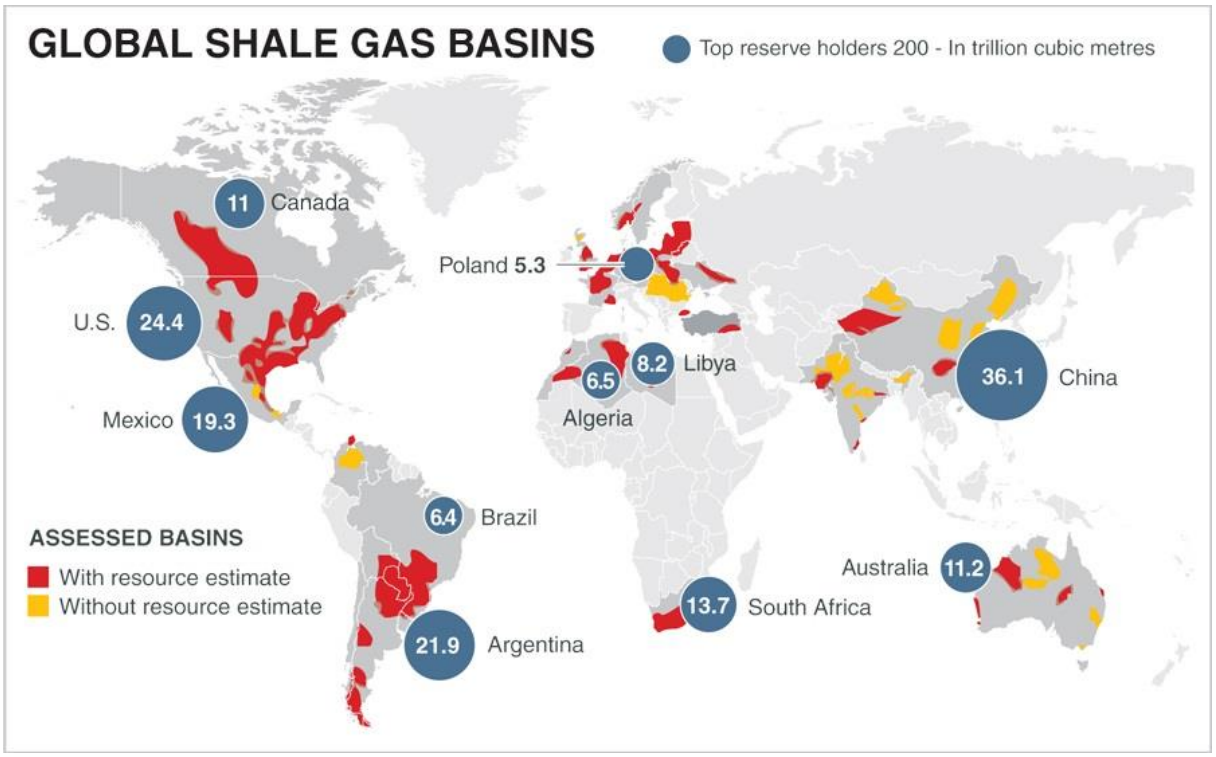
Technically most shale oil is, with 75 billion barrel reserve, in Russia. Respectively, with 58 billion barrel reserve, USA and with 32 billion barrel of reserves China pursue Russia. 10

countries which have the most technically deductible shale oil have 280 billion barrel of reserve in total. Looking at the total reserves, this amount increases to 345 billion barrels. In Middle East region, two countries have the most shale oil. One is with 26 billion barrels of reserve, Libya, and the other one, with 9 billion barrels, Pakistan. (EIA, 2013) Considering this potential, it's predicted that the world will keep meeting its energy demand mostly in Middle East countries. Looking at worlds total reserves these amounts correspond to 345 billion barrels. With its shale oil reserves, Middle East keeps drawing attention. Considering the energy supply security though, the political instabilities in Middle East countries, make it hard to this energy to reach the other countries safely. Thus, positive political and social attitudes inside these countries are very critic for creating a healthy supply and demand relationship.

3.2.7.4 Shale Gas

Shale gas is a natural gas confined inside the formations called rock. With a technic called Hydraulic Cracking, creating cracks inside the rocks and make it come off. For this cracks, water pressure is utilised. The inseparable relationship of the water and Shale gas starts here.
The source of the shale gas is same with all hydrocarbons like coal, gas and petrol. This gas formed in source rock; accumulated under the oceans and lakes, by the transformation of rich sedimentary. In historical process, this sedimentary keep burying deeper and by collecting temperature and pressure, transform the hydrocarbons which they have, into organic materials. Most hydrocarbons formed in this way, are discarded and make their way to the surface. In some cases though, these hydrocarbons going through the surface are interrupted by an impermeable rock barrier and accumulate under a rock and eventually these hydrocarbons formed into gas and oil reserves (Total, 2012).
In the image below, regions predicted to have shale gas and shale oil are given. Red marked regions indicate the regions that have gone through reserve prediction, and the yellow marked regions indicate that haven't gone through reserve prediction.

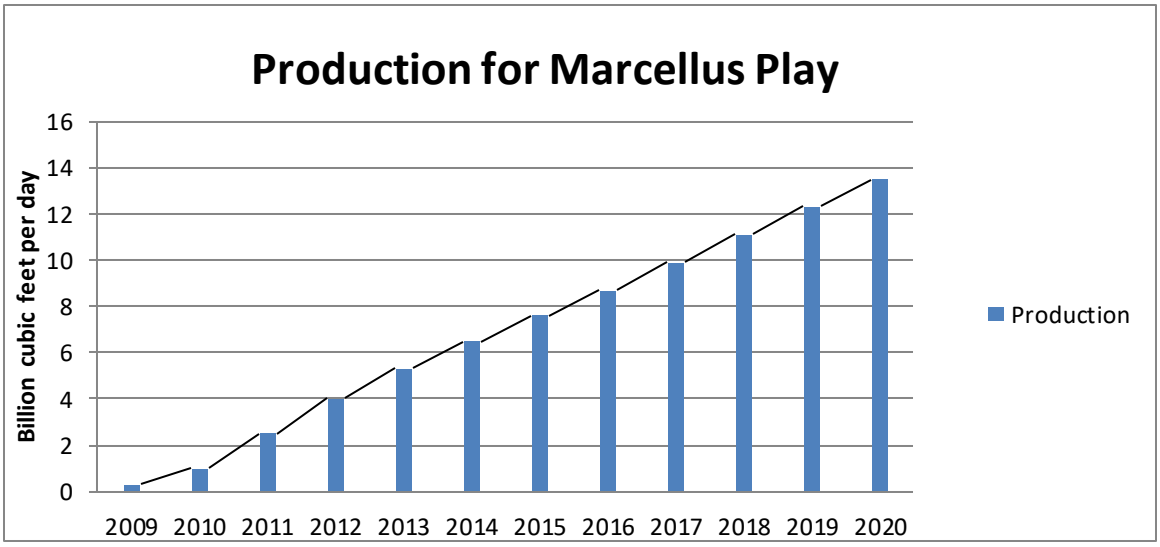
Figure 5: Global Shale Gas Basins



Source: EIA based on Advanced Resources International Inc. data, BP

In our day, serious shale gas extraction works are being done in USA. The total natural gas production in 2010 is 610 billion m3 and 25% of this production is consists of shale gas. (EIA) With this amount, USA have a critic importance by means of world energy market because, USA shale gas production keeps increasing and in time, will be a self-supporting country and will then be an energy exporter.

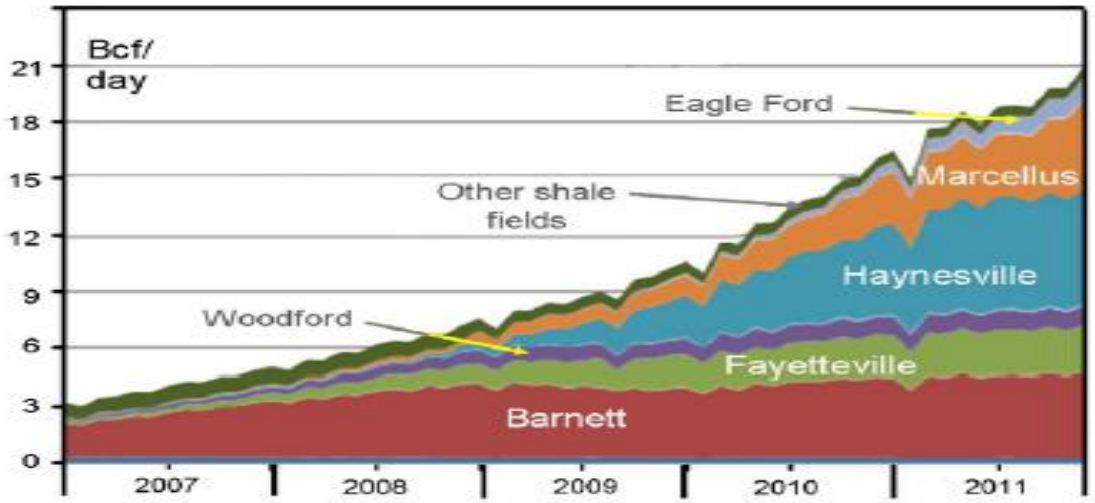
Figure 6: Forecast Production for Marcellus Shale Gas Play



Source: Considine et al., 2010

Shale gas development in USA diminished the popularity of the conventional gas, and even took its place. It is also being indicated in sections above that in the next twenty years, USA will have an important role in energy export.

Figure 7: USA shale gas fields and production levels



Source: EIA, 2011 cited in Weijemars, 2013

As the shale gas development in USA is being completed increased its value in the market. Shale gas production in the 2012 was half as the gas amount obtained from unconventional ways throughout the country.

4. Literature Review

The purpose of this part is to carry out a comprehensive literature review for the economic impacts of the shale gas revolution. - At the outset, the articles, examining the relationship of the production with the economic growth are indicated. The literature regarding the (positive/negative) impact on the economies of the countries with natural resource slack takes place. After that, specifically the effect of shale gas is mentioned.

Scopus and Repec provide a favorable opportunity for reviewing academic literature to research the evolution and economic returns of the shale gas. Thanks to the numerous articles and citations found in it, it provides opportunity to follow the studies carried out till so far in the literature. It provides a great advantage to the researchers for their studies through its resource opportunities which are not only with economic dimension, but also contains socio-cultural and technological developments of the subject handled.

The economic impacts of the shale gas extraction in the USA remains a bit unclear because none of the studies carried out up to date has realized a decisive research on GDP and unemployment in general terms. It would not be wrong to say that there is a lot of uncertainty. Therefore, it will be based on the results of the tests made in the direction of the sources published until today. The results obtained from the important indicators such as the Input-Output model and the IMPLAN Model, the models used to research the economic impact of anything, have been tried to be indicated.

4.1 Literature Review about Economic Impacts of Shale Gas Revolution

Up until now, researches have been conducted on the fact that the dependency of a country on energy affects the growth rate of the country in question.

Stevens (2003) conducted the most extensive one. Sala'-i Martin (1997), for example, pointed out the negative relationship between the production and the growth, and stated that the result continues with an economic model. The negative correlation existing between the resource dependency and growth depends on the economic and political foundations. Generally defended opinion asserts that since the country with resource slack is aware that it can generate an income by selling the resources implements an expansionary policy and usually creates instability in its economy (Auty, 2001).

Mehlum et. al. (2006) studied out that there is not any positive effect between GDP growth and the natural resource slack. Sach and Wamer (2001) stated that the countries with natural

resources have high price levels and that this situation increases the demand through the return of the growing industry.

In his study, Michaels (2010) examined the areas of oil resources in the United States. In particular, He studied out that the southern region, which is rich in oil resources, is in economic growth. He then emphasized that the people living in resource-rich areas are more educated and have higher incomes.

Marchand (2010) researched the effect of labor force groups in the Western Canada against oil and gas extraction. It was observed that the total employment increased by around 6.5 per cent within a period of 10 years. The income that comes with the growth of the energy sector states that it transmitted the growth which began within itself first and the earnings to the service sector. However, he found an increase in the income of the workers' groups and a decrease in the poverty rate.

Caselli and Michaels (2009) researched how oil production in Brazil influenced the local economic growth, municipal income and expenditure between the years 2000-2005. The result here indicates that contrary to Marchan's results, the oil production has never benefited beyond its own sector. Apart from that, they studied out a strong correlation between the oil production and the local government revenues. Its impact on poverty and households demonstrates that a part of the share consisting of oil production contribute even if just a bit.

Black et. al. (2005) researched the effect of coal extraction on the regions in question in the 70s and 80s. Regarding the stability, they observed that the coal producing regions are faster than those who do not, and that their profits grow faster in the same way. An additional workplace environment was created through mining and a decline in poverty levels was observed.

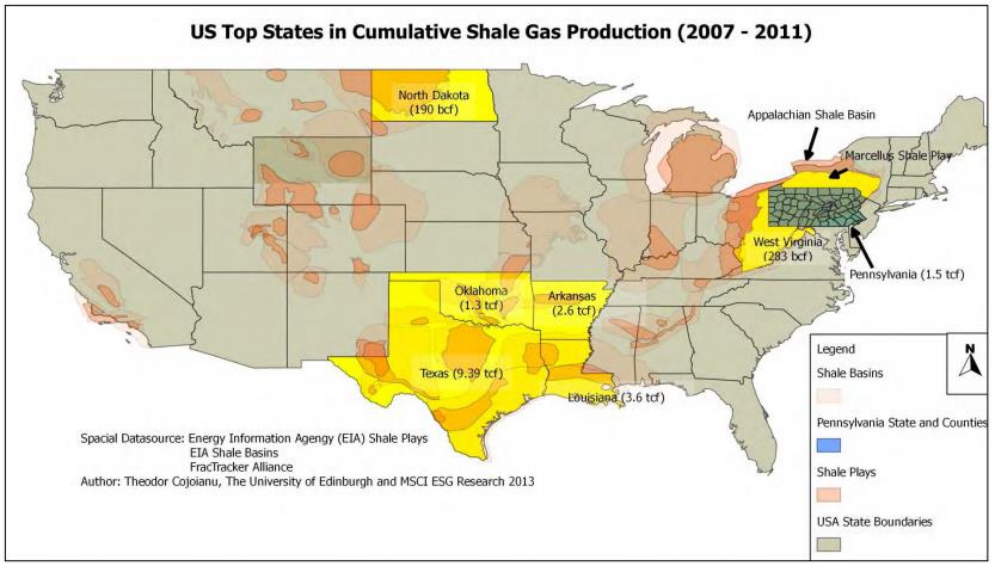
Bilgili et. al. observed the long-term effect of the shale gas production on industrial production in the USA. It was observed that the shale gas production had a positive impact on the industrial production in the USA by conducting a causality test based on the vector error correction model. The causality test demonstrates that the shale gas production causes industrial production in the long term. It was also emphasized that industrial production was positively affected in the long run. In addition, they list the issues to be considered in the following processes. First of all, importance should be attached to the technological developments in order to prevent the negative developments. The technological developments

not only reduce production costs, but also help to solve the environmental problems. (Bilgili et al., 2016, p.1)

The USA is the country, which has the greatest decrease in carbon dioxide release until now by 430 million tons within 5 years. IEA's chief economist Fatih Birol: Switching from the coal to the natural gas and the use of less petroleum in transportation sector has played an important role in reducing CO2 emissions in energy production. (Wang, 2014, p. 11)

It will be much more accurate to move on regardless of its result-focused effect. For this, it will facilitate to understand the subject. Firstly studying the production figures and establishing a connection between the effects, it has created according to the output. According to the report which EIA published, it is stated that the increasing shale gas trend, which started in 2007, has reached nearly 20 trillion cubic feet of production in 2011 and it is demonstrated that the largest share of this production belongs to Texas. Then Oklahoma, Arkansas and Louisiana, the neighbors of Texas follow. The production is also performed in Pennsylvania, which is located in the north-east of the country, northern Dakota, which is in the north of the country. The picture below demonstrates exactly how much production is performed and where it is performed.

Figure 8: Shale Gas Production of US Top States



Source: Cojoianu, 2014, p.16

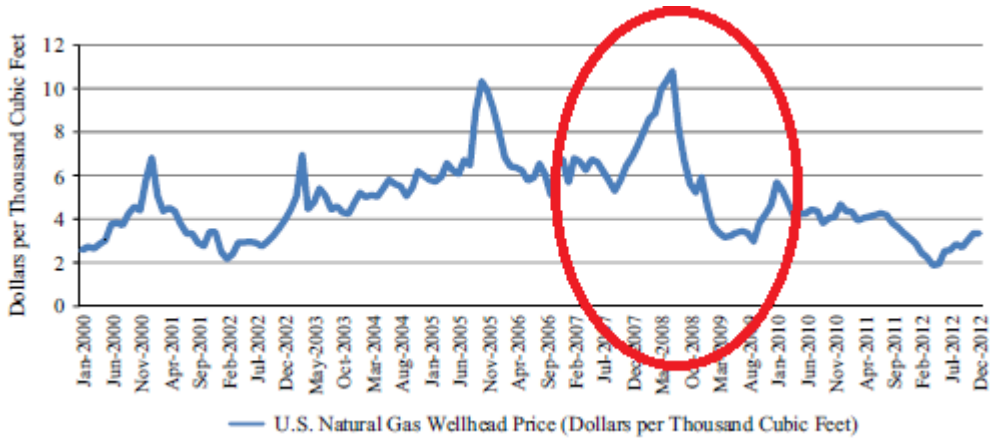
The most important factors should be taken into consideration when assessing the impact of Shale Gas on the economy. These can be collected under four main headings: labor creation

(employment), gas prices, or more generally energy prices, economic growth and dependence on energy.

If we begin with energy dependency, it can be said that America has covered a great distance. In particular, the energy dependency that has been going on for many years has decreased considerably with the shale gas production. As I mentioned earlier in the study, this production can lead the USA into the role of shale gas-based natural gas exporter in the coming periods as well as it lowers the USA's energy dependency. With this change, it will lead changes not only in American energy policy but also in the policies of the countries of which America used to meet energy needs. While it was the major gas importer, it has become a self-sufficient country by increasing its production almost 12 times within a period of 10 years. While the shale gas production was 0.39 trillion cubic feet in 2000, this figure reached up to 4.8 trillion cubic feet in 2010s. This increase has contributed positively to the economy of the USA by revising its natural gas imports downwardly (Wang, 2014, p.1).

Wang observed that the impact of the shale gas production on the natural gas prices in the USA. According to Wang, the shale gas boom not only provided a cheap natural gas type to emerge in America, but it also provided the natural gas of the USA to sever all its ties with crude oil. These reasons have also affected the global gas prices. Besides, American gas pricing is a system based entirely on supply and demand. When the increased production is added to this, the reason for the sagging prices is explained. (Wang, 2014, p.12)

Figure 9: U.S Natural Gas Prices 2000-2012



Source: Wang, 2014, p.11

Wang also mentioned about the impact of the shale gas extraction on the employment and his projections for the future. One of the economic effects of traditional gas activities is 58

employment fields – more than 600.000 person – is being created by virtue of shale gas. It is estimated that this number will be more than 870.000 totally in 2015 and more than 1.6 million in 2035. Root cause of strong economic effects which are generated from shale gas is high "employment multiplier/factor" which is generated by virtue of employment created as direct and indirect in order to support industrial activities. Contribution of USA's shale gas to its GDP was more than 76.9 billion dollars in 2010; this number will be 118.2 billion dollars during 2015 and be 231.1 billion dollars when we reach 2035, tripling 2010. Shale gas industry, for the next 25 years, will create a tax income of more than 900 billion dollars for domestic, federal governments and states. Savings emerged due to more low gas prices and gas procurement of other consumers with more low prices created an additional increase of annually more than 900 dollars as average in disposable income per domicile between years of 2012 and 2015. (Wang, 2012, p. 14)

In the study carried out by Weber (2012), it is stated that the sector consisting of the shale gas production had a positive impact on the employment, salary and wages and up to the incomes of the household. The study conducted by Weber is one of the earliest studies researching the effect of the shale gas on the local population in the literature. In the study conducted for Texas and Colorado, it has been observed that the shale gas extraction provided a considerable number of jobs for the people in the region and adjacent regions. While a growing sector needs a lot of labor force, the employees, who provide financial income together with the labor force earned, also have direct and indirect economic influences. Weber, 2012, p. 1580

Corden and Neary (1982) examined the need for labor force which emerged with the growth of the industry in the model which they developed in order to understand the effect of gas extraction. They have argued that the wages will increase due to the demand for labor force. In this model, the wage to be paid for the internal labor force is directly proportional to the difficulty level of the demanded work. The harder is the work performed, the higher is the wage earned. According to the model, if the growing sector offers jobs to the people who could not find a job in the average market wage earlier, the incomes will increase and therefore the poverty will decrease. On the other side of the model, if the growing sector cannot provide labor force from the local region, they will have to offer a high wage in order to influence the workers from outside the region or the close surroundings, which increase the income and reduce the poverty in the same way. Again due to the lack of labor force in the region in the same vein, it may lead to engage qualified workers from outside the region. Here

again, the wages will show an increase directly proportional with the qualification of the employee. Another point, to which they pay attention, is that the influx of the workers together with the proposal of higher wages may increase the rents in the region. Thus, they also state that if the cost of legislation becomes higher than the income earned through employment, the poverty can increase. Another point that is emphasized is right at the point of the paid rent. The authors mentioning about the benefits created by both private and public rents, have stated that the companies that work in the region mostly work on private land, and therefore pay to the landowners for the costs of use, thus the income of the landowners increase. At the same time, the type of payment that is related to how much gas is extracted from the site where the drilling is done gives the landowners the chance of different payment channels. On the other hand, the tax revenues from the natural gas extraction would have wider impacts by increasing the public services and investments. (Corden & Neary, 1982, p. 838)

Adamson resulted that the productivity increase in shale gas production in Haynesville is important according to Törnqvist index results. He also concluded that the natural gas production of the last three years is coherent with the economic growth in Haynesville. Results also show that the producer‘s answer to the price changes is changing their production applications. Time series analysis resulted that shock scales are diminished in time and this reduced shocks diminish the effect, in the first production processes dramatically. (Adamson, 2011 cited in Chermak et. al. 2012, p.6)

Kum tested the G-7 country‘s 1970-2008 years data and the relation between natural gas consumption, economic growth and capital, by using the causality test which is corrected with bootstrap. According to results eight meanings Granger causality relation are being found. As for Italy, the Granger causality is from natural gas production through the growth, for United Kingdom, the results are totally opposite. For France, Germany and USA, there’s a double way relation between natural gas consumption and growth. (Kum et. al., 2012, p. 2361)

Asche examined the developments in shale gas production of USA in their work. Possible effects of the natural gas production of USA, over the natural gas prices in Europe have been examined. They observed that there is a stable balance in fuel oil and natural gas, in long period in Europe. They obtained results that Europe fuel oil pipelines will remain competitive. (Asche et. al. 2012, p. 1)

Aruga researched whether the shale gas revolution in USA is still a local matter of fact or will have an effect on global gas market. Used Bai-Peron test to determine the shale gas revolution start date and examined the price connections among USA, Europe and Japan gas markets.

The results are in direction of that USA gas market had a price connection with international markets before the shale gas revolution, but this relation has disappeared after the shale gas revolution. This result shows that USA is independent after the shale gas revolution and the price connection between USA and the Europe has been weakened after the shale gas revolution. (Aruga, 2013, p.1)

Wakamatsu & Aruga researched whether the increase in shale gas production of USA changed the natural gas market of USA and Japan between the years of 2002:5-2012:5. In the research with the Bai and Peron structural bending test, alongside the natural gas prices and consumption, also the bending point of the outer shocks that are not related with natural gas, have also been detected. According to VAR modelling, USA markets have some before and after bending effects on Japan markets. Accordingly as there was a one way relation before 2005 after 2005 it has been observed that this effect has disappeared. Results are the indicators that the shale gas revolution that has been triggered by shale gas extraction caused changes in USA and Japan natural gas markets. (Wakamatsu & Aruga, 2013, p. 1002)

Bilgili tested the relation, with panel data method by using eight (OECD) country's natural gas consumption per person, per capital income, natural gas prices data and the relation between these parameters within 1979-2006 years. According to the majority of the prediction results, it has turned out that natural gas consumption law of demand has been a negative trended unit elastic or pursued in the way of demand in relatively more elastic than unit elastic and the income elasticity of the natural gas has more knock back with relatively bigger unit

In their study, Munasib & Rickman researched the local economic effects of shale gas production. Employment which increased thanks to the works and business spaces occurred during the research, drilling and extraction activities, was mentioned and an increase in the profits was underlined. Besides, increase in interim financial purchases and promotions in local expenditures are amongst the positive effects spread over this area. (Munasib & Rickman, 2015, p. 1)

In recent years, a great increase was determined in the usage of the 'Fracking' mining method which is used in order to extract natural gas between the underground rocks. In his study, Paylor stated that fracking increase provided more economical benefits in developed economies than the developing countries. Besides he stated that the shale gas caused a decrease in energy costs and in addition to this, the poverty was also decreased. Furthermore, he mentioned that fuel poverty would be also ended and a serious socio-economic benefit would be provided as an assistant to the respiratory tract diseases and suchlike health problems that caused by insufficient heating. (Paylor, 2016, p.12)

It can be seen that the economic impacts of a growth in the natural resource industry can change according to the time, the goods and the measured value when the literature is examined. In general terms, it is to research the economic impact caused by the growth in the natural gas sector in the USA on the literature (employment, balance of income and expenses, economic growth, energy dependency). Undoubtedly, the increase in the shale gas production has accompanied the increase in the employment and income items. As a result, such a production cannot be carried out alone, and such a serious business needs organization, knowledge and a large number of workers.

5. US Shale Gas Development and its economic impacts

5.1 Shale Gas Development in the US

Horizontal drilling usage as well as hydraulic fraction enlarged the capacities of the producers for the production of profitable natural gas and oil from rocks with low permeability, especially shale rocks. Although the first experiences of fraction application methods was seen in 19. Century, these applications have started to increase after 1950's with the encouragements. By starting from the middle of 1970's, new technologies have been developed in order to obtain commercial natural gas from Devonian (Huron) rock which is a shallow rock on Eastern part of United States, with the common researches and works of Ministry of Energy of USA and Gas Research Institution (GRI). Discovery of developed under-well drilling engines and required supportive materials, tools and technologies, brought some applications within the scope of commercial aliveness (DEA, 1993). Horizontal drilling and hydraulic fracking were developed in United States in 1940's, however these applications were quite limited until the end of 19. Century due to technological inefficacy. Large-scaled shale gas production gained a commercial reality with the deep shale gas production on Barnett Rock in Northern-Middle Texas of Mitchell Energy and Development Inc. until 1980's and 1990's. When Mitchell Energy and Development got a significant success, other companies became interested in this sector until 2005. Thus, 0.5 trillion cubic feet of shale gas was produced only on Barnett Rock in a year. The producers gained trust in order to produce profitable shale gas on Barnett Rock with the confirmation of the results that were obtained from Fayetteville Rock in Arkansas. Thus, they followed Haynesville, Marcellus, Woodfrod, Eagle Ford and other rock deposits (EIA, 22 2011). Between 1997 and 2009, more than 13.500 gas wells were completed on Barnett Rock (Newell, 2011). Although National Energy

Modelling System (NEMS) and energy projections of Energy Information Agency of USA (EIA) represented shale gas resource development and production in the middle of 1990's, has become known as 'game changer' in natural gas and shale gas market in the last 5 years. The increase of the activities in the new shale reserves, increased the dry natural gas production in USA from 1 trillion cubic feet in 2006 to 4.8 trillion cubic feet in 2010. This number is equivalent to 23% of total dry natural gas production. Because the shale gas reserves form 21% of natural gas reserves in USA, this number reached to 60.64 trillion cubic feet until the end of 2009 by increasing each year. Now it has the highest level since 1971. Oil production from shale reserves has increased significantly in recent years, this increase can be seen especially on Northern Dakota and Bakken Rock in Montana (EIA, 2010). "Shale gas revolution" first started in United States 13-14 years before with the rapid increase in unconventional gas production and a few years later in unconventional oil production. This revolution will bring economical and geopolitical effects for the countries which produce and consume energy. Thus, it is expected that the countries will review their energy policies and will change some policies with this revolution. The most serious effects of shale gas revolution (positively) will be on United States. For this reason, United States is the country which obtains the most serious income from shale gas and the country which has the technology to extract shale gas for economic reasons, is United States. Therefore, because shale gas technology was developed in United States and the United States used this technology on its local sources, natural gas prices and natural gas importation in the country are affected by this situation. UK Department of Energy & Climate Change published a report which approached to the shale gas development by years. In the report, information about the first wells, in which state they were opened, which activities were carried out was published. Also, developments of hydraulic cracking technologies were indicated. America Energy Ministry and Gas Researching Institute's shale gas obtaining activities were also mentioned. This information was briefed by the table below.

Table 4: Historical Development of Shale Gas

1860 and 1920s	The natural gas obtained from Appalachian and Illinois region cracks were used in near cities.
1930s	American transfer pipes were built to transform gas.
1940s	In 1947 first hydraulic cracking application was made in Grant County, Kansas 1. No Kelpler Well.

1970s	Directional drilling technologies were developed.
1970s and 80s	DOE (U.S Department Of Energy) predicted significant unconventional reserve potential.
1980s and 90s	DOE and GRI (Gas Research Institute), designed disciplined projects for big cracking concepts, reservoir characterization and finishing applications. Technologic developments made Barnett Rock feasible and multi horizontal cracking technology which was key for shale gas reservoir development was utilised
2001-04	Barnett shale gas production surpassed gas production from shallow rock beds (Appalachian and Michigan).
2005-10	Developments in other big rock regions started.
2010- present	Developments on Marcellus Rock were started and American Rock investment achieved satisfaction. American/Canadian companies and experts started researching transoceanic rock beds around the world.

Source: (Department of Energy & Climate Change, 2012)

Table above briefly indicates the past of the shale gas. One should examine also the other studies about shale gas. Shale gas has first found in 1821 in Fredonia New York with shallow and low permeable cracks (Department of Environmental Conservation, 2014). Horizontal drilling has started by 1930's and, the first rock cracking activity made in 1974, in America (Stevens, 2012, p.3). Federal Price controls caused problems by 1970's (Wang & Krupnick, 2013, p.7). Federal government after facing diminishing production invested on many supply alternatives. In 1976 two Morgantown Energy Research Centre (MERC) engineer took the patent of directional drilling on the rock. Among these, there were Eastern Gas Shale Project (1976 to 1992) and Gas Research Institute which was highly financed by Federal government. Federal government also provided tax credit and 1980 Energy legislation. (Stevens, 2012, p.3).

U.S Energy Ministry also cooperated with special gas companies to realize the first successful multi crack horizontal drilling in 1986 and in Wayne Country, West Virginia made the first horizontal drilling. Federal government promoted drilling for shale gas between 1980-2002 years with tax credits for rock drilling. Ministry of Energy also benefited from these technologies. These were the wide scaled hydraulic cracking and horizontal drilling activities

to apply to shale gas formations. In 1991 GRI, subvansed Mitchell Energy's first successful horizontal well study on the Texas Barnett Rock. (Shellenberger et al, 2012, p.57). George P. Mitchell, known as the father of shale gas industry, diminished the expenses on Barnett Rock to 4 dollars. (Forbes, 2013) Mitchell Energy, by using slick-water fracturing was successful first time to fracture economically in 1998 (Bloomberg, 2012). After these developments, since 2005 it can be seen that unconventional natural gas production developing far more efficiently than the other energy types. Known as "Shale Gas Boom" this "shale gas boom" highly diminished the natural gas prices in USA and made several economic effects.

Horizontal drilling usage with hydraulic cracking expanded the capacities of the suppliers draining from the low permeable rocks and shale rocks by means of efficient natural gas and petrol. Although the experiences of the cracking technics reach out to 19th century, in 1950's these applications with incentives started to develop quite fast. Starting from the middle 1970's, with the common studies of USA ministry of energy and Gas Research Institute, from a shallow rock called Devonion from east of the USA, new technologies have been developed to obtain commercial natural gas. This partnership helped developing technics like horizontal wells, multi-staged cracking, oily water cracking which are essential for the natural gas production (King, 2010, p.2). The practical application of horizontal drilling for oil has been started by 1982. Developed drilling motors and the invention of supporting materials, tools and technologies offered some commercial applications (DEC). Horizontal drilling and hydraulic cracking developed in USA by 1940's but these applications were quite limited until late 19th centuries due to insufficient technologies.

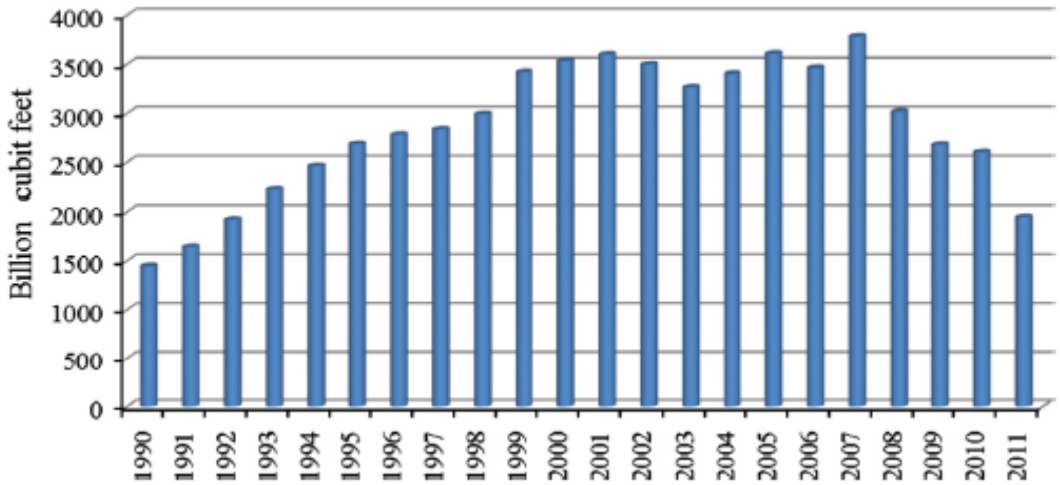
Wide-scaled shale gas production, took commercial reality with Mitchell Energy and Development CO by 1980 1990's on Barnett Rock deep shale gas production in Middle Texas. As Mitchell Energy Development made a visible success, other companies also interested with this sector by 2005. Thus, only from Barnett rock 0.5 trillion/annually cubic feet shale gas was produced. Producers from Arkansas with the approval of Fayetteville shale results encouraged to produce efficient natural gas from Barnett rock. Thus they started following Haynesville, Marcellus, Woodfrod, Eagle Ford and other bed rocks. (EIA, 2011) Between 1997 and 2009 more than 13.500 gas well was completed (Newell, 2011).

Although National Energy Modelling System (NEMS) of US Energy Information Association and energy projections in middle 1990's started representing production of shale gas source developing and production, just in five years, shale gas started be known as „game changer" in natural gas market. As the new bed rock applications became more popular, in USA dry natural gas production increased in 2006 from 1 trillion cubic feet to 4.8 trillion cubic feet in

2010. This amount corresponds to 23% of total natural gas production. As the shale gas reserves generally constituted 21% of total natural gas reserves, by the end of 2009 by increasing every year, reached to 60, 64 trillion cubic feet. Since 1971, it has been the biggest amount. Recently, oil production from bed rocks is also made a heavy increase. These increase especially more visible in North Dakota and Bakken rock in Montana (EIA, 2010).

"Shale gas Revolution" started mainly as an increase in unconventional gas and a few years later as an unconventional oil production in America 10 years ago. This revolution will bring producing and consuming countries economic and geopolitics effects. Thus countries with this revolution should revive their energy politics and are predicted to change some of them. The most dramatic positive effects of shale gas revolution will on USA. Therefore, America has the biggest revenue from shale gas and America will be the country to bring the gas out most effectively and technologically. As the America both developed the shale gas technology and used these technologies on its local sources, both the natural gas process and natural gas export will be affected from that. Its economic effects and possible predicted effects will be mentioned in another chapter.

Figure 10: US Natural Gas Import between 1990 and 2011



Source: Wang, 2014

5.1.1 Starting Point of Shale Gas Development: Pennsylvania, Marcellus and IMPLAN Modell

First of all, governments have more responsibilities than the other factors on the development of shale gas. It is necessary to research this subject which covers the factors that affect the nature and humans, and to investigate any kind of its effects. In this subject, it will be useful

to separate 2 things from each other in terms of social and state economies when preparing the economic development plans. Economic target of a thing for a short while should be evaluated apart from the long term plan of an exhaustible source in two different platforms (Kay, 2011, p.2). Shale gas researches that were performed before 2011, showed positive results and this positive development was reflected to almost each report that were prepared and issued in the industry.

As it is in Pennsylvania where the shale gas drills were started, the sources in New York got the attraction of the sector. One of the other main reasons of attraction is the natural resource existence. As mentioned before, the environments which interested in this subject in New York are sensible for environmental issues instead of the value that will be added on their economies. Effect of the gas development in this region within the shortest time is for the local businesses and landowners. But this does not mean that everybody benefits from this common ground equally. Definitely, this trend which was increased and still maintains its continuity, affected some environments negatively. It is a truth that the trends which provide economic gains within short periods, don't turn into an economic development. Additionally it is necessary to mention that the short-term economic gains shouldn't make the responsible persons' eyes blind, and it should always be remembered that the studies are to be targeted for long-term periods. Academic commissions that should be established on this subject, must be considered more.

If it is wished to examine the effect of drilling a shale gas source, it should be sought in gas production ratio. In order to place a basic prediction in detail, the correlation between the production amount and time should be determined and they should be analysed together. After these processes are performed, obtained results should be harmonized with the model and hypothesis should be established according to this.

When talking about Marcellus, it is necessary to state that it is one of the broadest natural gas fields of the world. Natural gas reserves that were found, equal to approximately 87 million barrels of fuel, which is an amount that may meet the whole world's needs for three years. Considine brought billions of dollars of income and thousands of works even if the developments in Pennsylvania are more recent. When examining the economic effect of this formation, we should separate it into branches. With the development of this sector, several working areas were formed and there was a chance to get a piece of the pie for everybody. As mentioned before, we may compile as the payments that are made to the landowners, resource research, drilling and extraction, processing the source that is extracted, transportation (it is

one of the points that should be considered), trucks that are used and construction materials. Besides, it is necessary to state that the gas companies are paying taxes due to the income they obtained. High energy consumption is an important factor that forms labour force, income and tax incomes. These results are obtained by using the input-output model that is modelled with IMPLAN model. Having rock gas reserves does not mean that you can extract it easily. It is a really serious working branch and it requires a serious substructure study. Although it is an expensive and tiring work, it brings a good income. In the first years when these sources were extracted, gas companies invested 4.5 billion dollars around this region. Added-value of this investment as per the proposed numbers by using IMPLAN model equals to approximately 4 billion dollars. In terms of tax incomes, it created a source of income of 400 million dollars in 2009 for the state that it was applied, and over 40 thousand of employment. (Considine, 2010, p. iv)

Table 5: Summary of Economic Impacts of Shale Gas in United States

Year	Value Added	State&Local Taxes	Job
2008	2,556	265	30,137
2009	3,877	389	44,098
2010	8,039	785	88,588
2011	10,129	987	111,413
2015 Forecast	14,415	1,417	160,205
2020	**18,853**	**1,872**	**211,909**

Source: Considine et al., 2010

With the investment, highly profitable situation was evaluated positively by the gas companies. And in the processes from now on, they decided to invest more. Approximately 20 billion dollars were invested in 2010 and 2011. These high investments provided a tax income of approximately 2 billion dollars for state and government and the labour force increased linearly each year. As seen on the table, 88 thousand of employment in 2010 increased 25% in 2011. Nowadays, these numbers exceed 150 thousand and it is foreseen that they will exceed 200 thousand by the year 2020. With this increase in drilling works, a significant decrease in gas prices was observed.

It was mentioned that the basin was big in this region. And likewise, if we consider that the technological activities will develop, we may predict that the sources to be extracted will increase year by year and the cash flows that are created in parallel, (tax, income) will also

increase. It is obvious that these investments created great advantages for the local people. Since natural gas extraction is an activity which requires several workforce branches. When we get deeper in our research, namely if we consider the additional work fields from the main work fields such as searching, drilling, transportation and substructure, we may compile such as: The team which will perform research activities in the region, must buy equipment. As they are not daily or hourly works, they contribute to another field such as accommodation. They benefit from the restaurants in the region as per their daily food needs. Truck companies in the region are the sector which benefits most. With the establishment of the pipelines, construction sector is required etc… If it is necessary to mention about the economic advantages that this trend provides, formation of various income sources such as the rental fees that the investment companies pay to the landowners, copyrights and a part of production income, is the other income source of this process. Input-output model which is used for measuring all of these values are also used by the economists for almost every sector to be invested. They use the input-output model from construction sites to shipyard production, from factories to technological investments, and they predict what the benefits are that come from this investment. For example, before investing in a sector, the first question to be asked is how much employment it will bring and how much people will affect from this. If the result is satisfactory, next stage is applied. As it is in Pennsylvania example, state authorities calculated how much investment to be made and the added value that will arise from this investment by using IMPLAN model. After this, workforce to be created and the tax incomes to be obtained are taken into consideration. After the first level is completed, prediction processes are started for the latter stages. As shown in the table above, predictions are made in the level of workforce and incomes that will be created in the future, along with the recent values. All of these predictions are a part of this model which is used.

Shale gas extraction is more difficult when compared to the fuel and natural gas extractions with normal ways. It requires a continuous drilling and the interruptions affect the future output negatively. It is another factor which contributes to the input-output model, to perform researches about the geographic features of the field on which the works are to be performed.

5.1.2 Regional Assessments

In Marcellus, more than 700 wells were opened in 2009 as horizontal and vertical wells. There is a significant increase in the number of fields where the gas extraction activity was performed in the northern part of Pennsylvania in 2009 when compared to the previous year.

When talking about the investments made in the region, expenses made in 2008 and 2009 are shown in the following table. There is a 1.3 billion dollars increase among the general expenses within a year's time.

Table 6: Sector Spendings of US Energy Firms Between 2008 and 2009

	2008	**2009**
Lease & Bonus	1,837,734	1,728,765
Exploration	121,940	243,831
Upstream: Drilling & Completion	857,751	1,700,435
Midstream: Pipeline & Processing	329,437	695,801
Royalities	22,183	54,683
Other	55,531	111,787
Total Spending	**$ 3,224,577**	**$ 4,535,304**

Source: Considine et al.,2010

There is a growing in discovery studies which is approximately twice. It is an evidence of seriousness and certainty of the productivity of this subject. Expenses of drilling, digging and pipeline works are also twice. We mentioned the sectors that are affected by these works before. All of these ones have an effect on the other sectors. It is good to mention that all of these expenses were not made in Pennsylvania State. It is necessary to state that some parts of the tools and equipment that are used in development activities came from outside of the state. Considine stated that almost all of the expenses were made in Pennsylvania according to the researches and international fuel and gas companies established an important substructure centre in Pennsylvania (Considine, 2010, p.5).

'Shale mineral' landowners in Pennsylvania take 10% of the value of the gas which is extracted from their lands, and this percentage is provided for them by the State. Among the evaluations about China in the last part of the study, one of the steps that should be proceeded by China government is about personal encouragement and right of use in this direction. This arrangement is a very good example for this.

In addition, Agarwal et al. performed a regional analysis in a study by reaching the credit card companies, as a result of this analysis, he found some clues that shows the household reduced the credit card debts in the region and he stated that more reserve rate would be reached thanks to the decreasing debts and he believed that they would perform more business in the future thanks to the increasing profit. (Agarwal, 2007 cited in Paredes, 2015, p. 113) Of

course it is good to remind that the credit card debt is one of a short-term debt. Because the result shows the short-term effect. Yet, it is difficult to mention if it may provide a positive result for his mortgaged house.

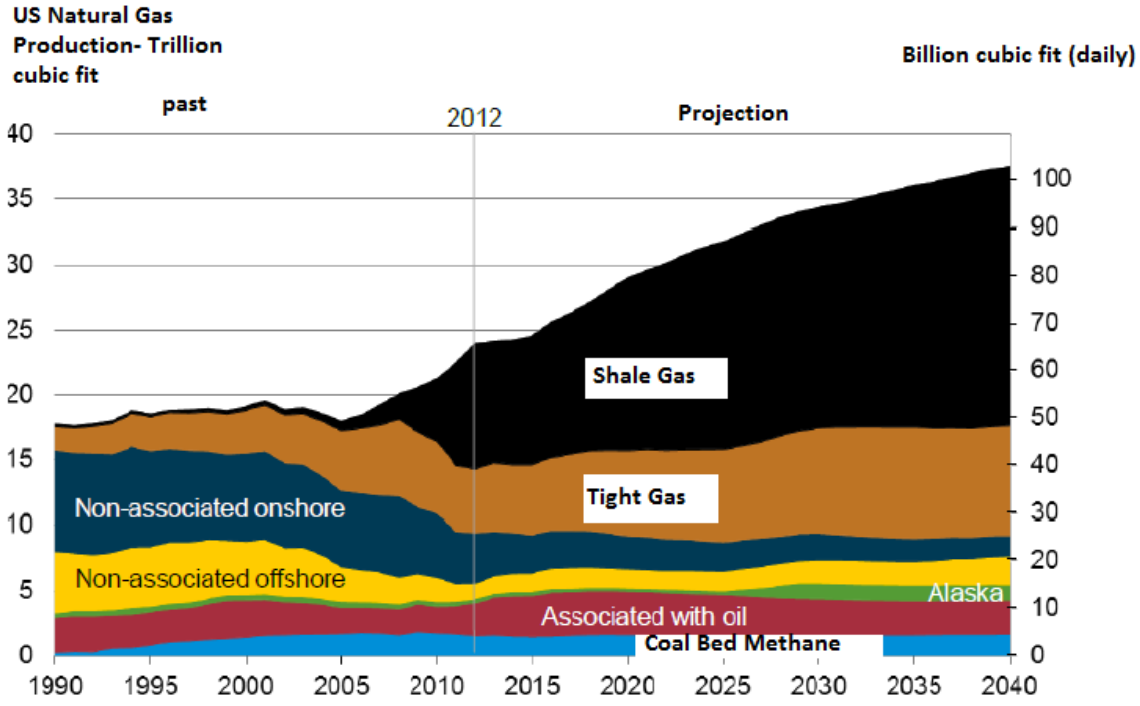
Yet, one of the aspects which depends on researching the economic effects, is the added-value provided for the household. The added-value created for both the household and the local management is one of the elements that should be evaluated when making these calculations. How much dollar is reserved and if reserved, in which fields it is accumulated, play important notes when determining the economic effects.

In an article published by Kelsey, he reached a result which indicated that the 66% of the profits provided from the intellectual rights and extracted gases were reserved or invested, and which shows that the rental and copyright profits are not spent in Pennsylvania State. Naturally, this decreases the economic effect in the region. (Kelsey, 2011, p. 4)

5.1.3 Shale Gas Sector Development

In this chapter, shale gas sectors development will be indicated. It's not possible yet to talk about the shale gas globally. Reason of that is the global production is not very common yet. Thus, examining shale gas sector, we will be talking about USA shale gas development. There will be comments about how USA natural gas consumption changed by years, how the sources about the natural gas sources were changed by years and how the usage rating of shale gas was increased by years among the total consumption of natural gas in USA by looking at the tables.

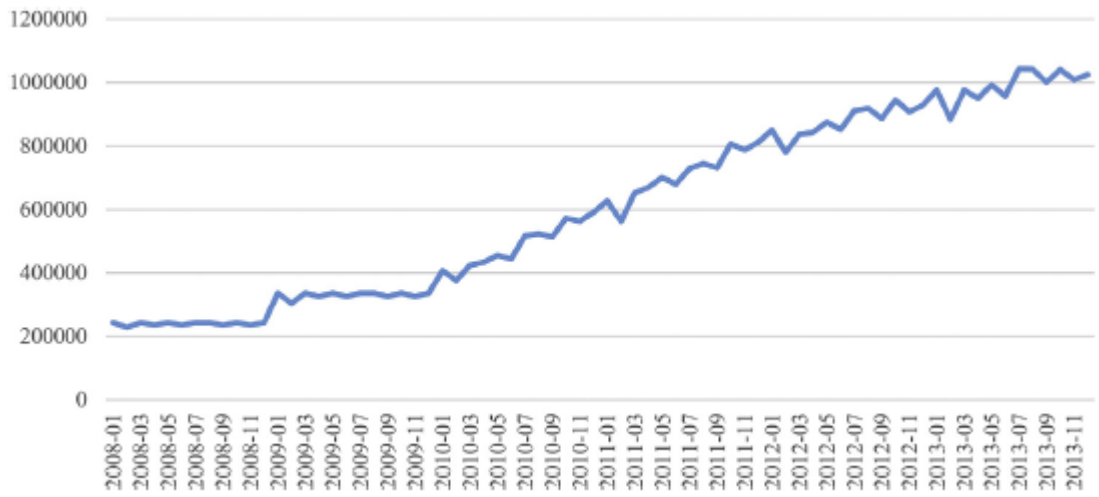
Figure 11: USA Natural Gas Production by Years and Sources



Source: EIA Report, 2013

By EIA's published report, the development in usage by years can obviously be seen. In the image above the ratio of the sources of USA natural gas production is indicated .Among these sources looking at the shale gas, dramatically change by years draws the attention. Between 1990 and 2005 natural gas production of USA can't even get 5%. After 2005 though, with the technologic development, USA seriously started to get use of shale gas and the ratio of the shale gas among the total natural gas production is increased. Especially since 2008, there have been dramatically increases in shale gas production. By 2012, the ratio of the shale gas among the total production of natural gas increased to 40%, the biggest ratio ever. In the EIA report, there are also future scenarios about the future of the shale gas production. According these scenarios, it will keep going to have the biggest ratio in total gas production. The point that draws the attentions though, the increase in the production of pressurised gas production amounts. Pressurised gas productions since 1990 have an upward tendency. By 2012 the pressurised gas production of USA was second after the shale gas production. It is predicted that by 2040 pressurised gas will have the second biggest amount after the shale gas. It also predicted that by 2040 shale gas production will supply 50% of total natural gas production alone. Pressurised gas is predicted to supply the 25 or 30% of this production. The most general comment to make from this graphic is shale gas and pressurised gas production will be greatly increased in USA in the future. According to this shale gas production increased the total production by 40%.

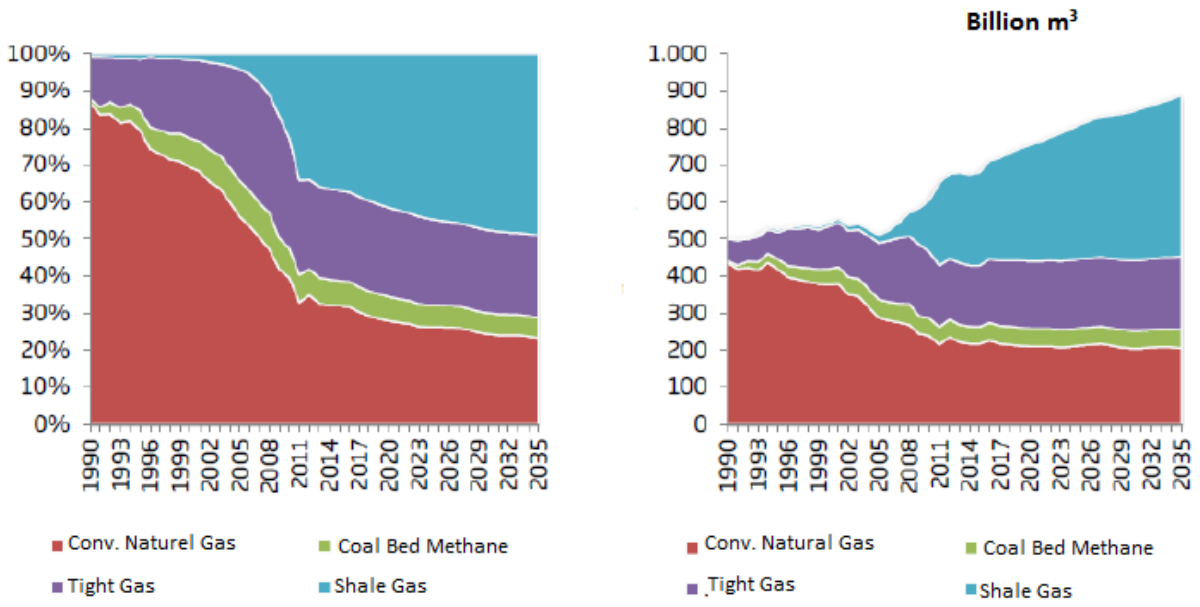
Figure 12: US Natural Gas Gross Withdrawals from Shale Gas (million cubic feet)



Source: Bilgili, 2016, p.965

By 2040 it is predicted that shale gas production will increase the total production more than 50%. Looking at the 2006 year, the start of the shale gas revolution, it can be seen that shale gas production has quite a few amount among the total production. Looking at EIA's 2040 projections though, the activities to bring up shale gas will be increasingly continued.

Figure 13: Distribution of USA Natural Gas Production by the Sources



Source: EIA Annual Report,2013

5.1.4 The Influence of US-Energy Policy on the development of Shale Gas

Production of Oil and natural gas by the USA from the rock formation in its own territory includes order modifying means possibly to affect its foreign policy as well. USA has imported 45% of its total oil requirements as of 2011 (EIA). Also as described in the introduction chapter, one of the most important determinants of the US's foreign policy includes energy sources. In this context, the fact that USA produces its own oil and natural gas in its own territory may change policy and effect of such country on the Middle East. In this scope, after shale gas production increases, it is expected that the US's LNG import requirement is eliminated for at least twenty years, and furthermore LNG supply implemented in the Middle East reduces due to competition in the market. A reduction in dependency of USA and China on the natural gas suppliers in the Middle East also means limitation of the geopolitical and commercial competition between such two consumer countries. These developments shall ensure that the natural gas prices are moderate and promote more natural

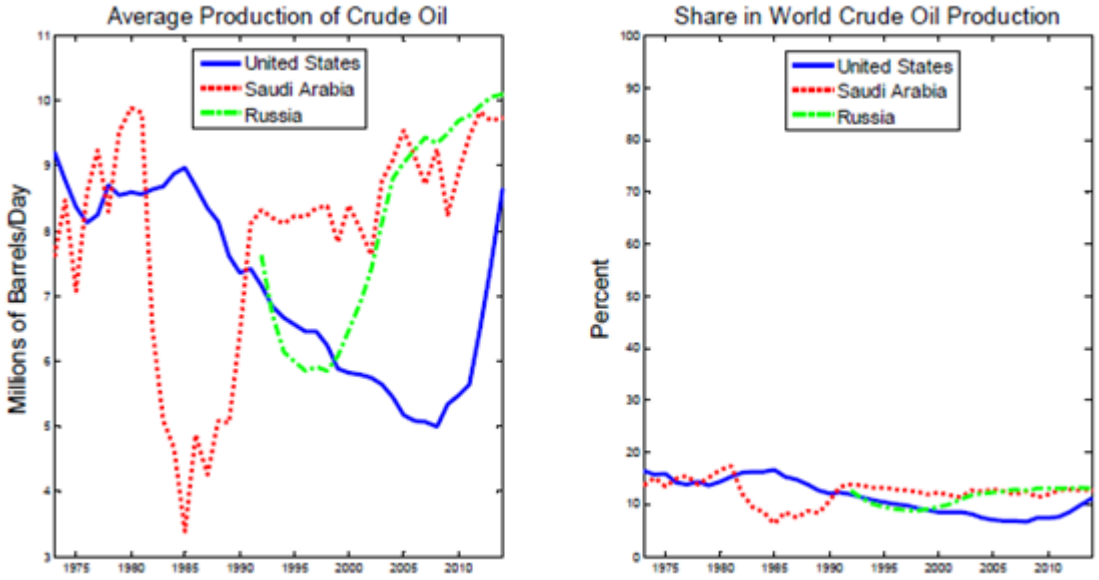
gas consumption. On the other hand, it is anticipated that the shale gas extracted around the world also weakens the possibility that a potential monopoly power to be created by an organization like "Gas OPEC" or only one producer like Russia may establish a domination on consumers in a long term (Medlock et al, 2010, p.2).

As a result of these developments, most countries have begun any shale gas research and production activities in various countries and signed any partnership agreements in any countries having high production capacities such as Poland, China, Australia, etc. However, Poland has attempted to make any change in the legislation on evaluation of the resources in the country. Moreover, it is estimated that, if China having the largest reserves shall generate a large amount of shale gas, this shall cause any variations in the energy balance of the country and global trade natural gas routes (Turkish P.A.O, 2013).

On the other hand, one of the most important powers, which direct the global natural gas industry, is Russia. Russia has supplied natural gas to European countries for long years, and when necessary, Russia has created a political pressure especially on European countries by using its role as a natural gas supplier. In this context, the expected developments a considerable increase in the shale gas production and a change in the global natural gas market, after the countries, which were natural gas importers in the past, now become exporters, and a reduction in influence of Russia as a natural gas supplier on Europe.

Any technological developments are used in any boring activities for the shale oil production. USA has increased its shale oil production quickly after 2003, and has been promoted by high price of the conventional crude oil which makes this new technology competitive. This production consists of highly vulnerable processes. It is difficult to reach and exceed the shale oil production levels obtained in USA in other countries as well. Ones of reasons of this are boring towers and qualified labor. Actually qualified technical labor is required. Upon this growth in shale oil production, the decision makers notice that USA changes to an independent oil import position. According to a report published by the International Energy Agency (IEA), we may say that USA intend to take leadership of the global crude oil production from Saudi Arabia in 2020s, and to become an oil producer in 2030(IEA, 2012). Average crude oil production volumes of top 3 crude oil producers are given in the following chart. As you see, 3 countries increased their production after 2002. Furthermore, when we come to 2014, we may see that Saudi Arabia and Russia make more production than USA. (Crook & Raval, 2014)

Figure 14: World´s Largest Oil Producers during 1973-2014



Source: Killian, 2016

5.1.5 Background: Refinery and its transportation in the US-Oil Industry contra US-Shale Gas Industry

Crude oil is purchased by the refineries, which change crude oil to any refined products such as diesel, gasoline, jet fuel, etc. If we want to understand effect of the shale gas revolution on oil prices, first we must look at the refining structure of USA, because each refinery has different characteristics and these differences affect the price directly. We may say briefly that technical structures of the refineries determine which crude oil may be required. They have more suitable structure for gasoline production as we call light sweet crudes. Heavy fuel oils are among types of crude oil suitable mostly for vessels and power plants. Heavier crude oils may be produced by a more advanced technology and their price is high proportionally. But, also there are any refineries which use an advanced technology, because a lower price policy is implemented in heavier crude oils compared to lighter crude oils like Brent oil vs. WTI benchmark. It may be seen that there are 3 important factors in reduction of American oil prices: Firstly failure to export such oil, secondly capacity restrictions in transportation infrastructure, and finally restrictions in refining, namely treatment infrastructure. While any unconventional crude oil supply from USA or Canada to any point of the world must be excess, many reasons shall hinder this. We must give priority to crude oil in Canada on this matter. Canada has no necessary treatment infrastructure to process crude oils locally, and this

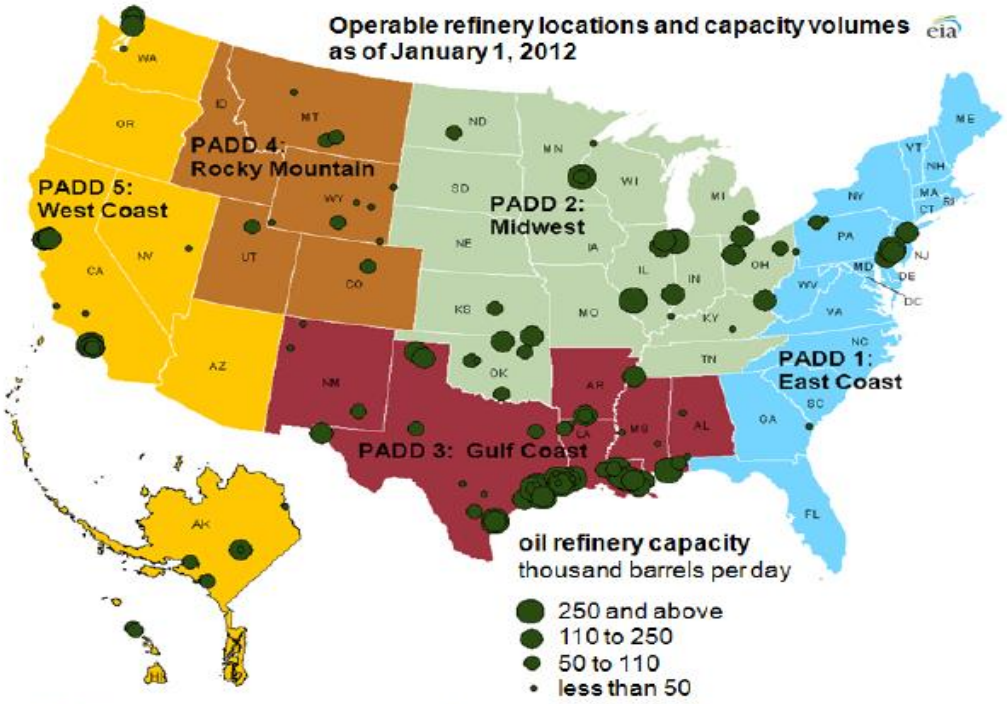
is a factor hindering such excess supply. As stated before, extraction and refinery operations of such crude oils actually require more advanced labor and an expensive technological process. In USA, only Gulf Cost Company has so-called standards. Meanwhile, the problems of Canada are not only technological costs or advanced labor. Also, Canada has not a pipeline and port infrastructure to export products to any port of the world. Because Canada has not a sufficient pipeline capacity to transport crude oil to the Pacific Coast ports, it conducts transportation to America instead of Asia (Killian, 2016, p.7-8). Canada's chance is only that it has to transport its crude oil production to Texas. This may create a European market for Canadians. But, the researches show that Europe does not tend to adapt their refineries to purchase Canadian oils. A relevant alternative shall be to transport Canadian oils from the Gulf coasts to Asia. But, when we shall also add such excess costs to the transport, this shall put Asia in a competitive environment for oil suppliers in the Middle East. We must address that the oil tankers used for long journeys shall also be necessary in case of extra maintenance during journeys. First of all, USA never took any political step to export Canadian oil. According to these indicators, a positive atmosphere never formed for export of Canadian oil. The necessary for export of this crude oil is not transportation. In addition to transportation, finding a buyer for such goods reflects the other side of the medallion. (Hackett et al, 2013, p.3)

Figure 15: World Oil Shipping Routes

Source: U.S. Energy Information Administration, 2014.

Source: Killian, 2016

Figure 16: Location of US Refineries



Source: EIA, 2012

5.2 Economic Impacts of Shale Gas Exploration and Production

5.2.1 Definition: Economic Impact Analysis

The efforts of taking better decisions are getting continuously increased in all over the world. Considering that the arrangements made have affected a great number of domains, the importance of cost-benefit-effect analysis for both reviewing the current arrangements and for the arrangements to be made, cannot be ignored. Positive-negative results that will be brought by the arrangements to be made, and how they will be met by the society and how the designs will be reacted, have a crucial importance for the decider persons. First, the economic effect analysis examines the effect of a thing in an economy from the smallest point of effect to everywhere it can be found. Everything can be analysed but generally these analysis are used in the projects. States and companies want to see the profits and losses of the thing to be performed before passing to a new application. This method which is used for measuring the potential effects just measures and predicts and does not contain the exact results.

It performs examinations on the subject which is interested directly or comparatively from time to time in order to investigate the economic events. The effect of an economic event can be separated into various titles such as effect on the unemployment, the effect on GDP, effect

on the prices, the effect on the household and the effect on the taxes. It is used to search what kind of a profit that the investment will bring which is planned to be done by a country or private institution, and its effect on the economy and society. In the broadest sense, they are examined as direct, indirect and induced impacts.

Direct Impact: Direct impact is the added value that it creates in the industry to which it belongs. The examples such as the employees in gas concentrate and production, namely the employment or the taxes paid by the companies which works on the region by obtaining licenses, that we cannot define as an additional activity, are inside the direct impact.

Indirect Impact: Indirect impacts are the changes in the sales, profits or employment in the sectors which provide goods and services for the sectors in the region. It is an increasing impact due to the needs of more workers, construction and other requirements due to the increase in gas production (the important thing is the sector to which the test depends, it can be a sales of anything). Induced impacts are the sales which increased in the region due to the expenses of the incomes by the household which are gained in for example tourism (restaurant and accommodation) and support sectors. Namely, they are the result of business-trade transactions which are caused by the direct impacts.

Induced Impacts: This is the result of increasing personal income caused by the direct and indirect impacts. For example, the company which is operated in the region when the concentrate and production are positively concluded, will bring profit (by sales) and will perform another searches in another regions, it will need more workers for this or will give a raise for the workers by its increasing income and this will affect the household positively. (Oxford Economies, 2015)

Apart from this, Input-Output analysis is an experimental method of analysing which is another important indicator, which examines the production relations between the sectors or industries of the economy and presents these relations on an internal consistency basis.
National income and partial balance analysis cannot form a satisfactory basis in examining several experimental problems in the economy. For example, an increase on the automobile demand will cause different effects from the increase of demand on consumer durable goods or cloth products and other parts of the economy. However, it is not possible to show these differences in general balance models such as national income analysis. Likewise, for example when predicting the future demand of electrical energy, the partial balance analysis of the current energy market is not efficient and it is necessary to take the possible changes

into consideration in the production of the industries which use energy. In this respect, it is a must to examine the mutual dependency relations between the different sectors or industries of the economy and to present them in a consistent basis.
IMPLAN which is one of the important tests is explained in the previous titles.

5.2.2 Direct & Indirect Economic Impact of Energy Policy

When talking about the economic effects after drilling, it is necessary to mention the effect that is created before the drilling process. Contracts that were made before starting the digging works between the landowners and the companies should be arranged and legal procedure should be followed. In the field on which the existence of the source is expected, drilling process is started after the field preparation and in connection with this, other services are required. For example, with the formation of the pipelines, local businesses take actions and gaining process is started. When the source is extracted from the well, it should be remembered that the copyright is paid. As per the contracts and rental agreements that are signed between the landowners and the companies, payments are made in proportion to the determined ratio. After this, income channels are created for the local administrations between micro and macro levels with the payment of the taxes. As well as the incomes of the local administrations, health, education and charity institutions which are conducted by them benefit from this income. This process can be considered as the rings of a chain.
This natural gas production stage provides direct and indirect effects for the economy. When the responsible company which has a mission in the region, needs workforce in any development activity, it assigns the employees from the staffs that are determined by the local administration or from the other business sectors. Or if any support is needed in any technical issue, it may form this effect by purchasing goods and services from the societies within the borders of the local administration (institutions, organisations, companies etc.). It affects the unemployment rate by assigning the employees, and the employee who have the work, increases the income. As the individual who earns money, will definitely spend money within the economic order, consumption is indirectly contributed by the added value. The measurement of this added value is predicted after investigating the indicators such as variability in tax incomes of the local administrations and total consumption rates. Briefly, as per the predictions that are obtained with the input-output model, it is also predicted how these expenses affect the other sectors. In the following table which is a summary for the created added values, obtained added values are showed sector by sector.

Table 7: Gross Output by Sector (millions of dollars)

Sector	Direct	Indirect	Induces	Total
Ag. Forestry. Fish & Hunting	13.5	11.8	6.3	31.6
Mining	991.9	19.4	3.8	1,015.1
Utilities	42.2	43.7	38.3	124.2
Constructions	829.2	18.6	14.0	861.9
Manufacturing	139.4	239.3	123.1	501.9
Wholesale Trade	455.7	102.2	84.8	642.7
Retail trade	228.2	16.3	197.7	442.2
Transportation & Warehousing	90.0	77.7	39.7	207.4
Information	22.1	129.5	92.9	244.5
Finance & Insurance	44.3	159.6	214.4	418.4
Real estate & rental	220.6	143.9	315.8	680.3
Professionals-scientific &tech.	174.0	310.9	87.1	572.1
Management of companies	0.0	84.1	19.5	103.6
Administrative & waste services	26.6	93.0	43.0	162.5
Educational services	87.9	1.7	39.2	128.8
Health & social services	190.8	3.3	290.9	484.9
Arts- entertainment & recration	35.3	6.0	34.1	75.5
Hotel&food services	87.6	26.1	81.0	194.7
Other services	63.3	39.0	83.8	186.2
Governmental	25.8	30.9	34.5	91.2
Total	**$3,768.6**	**$1,557.2**	**$1,843.8**	**$7,169.6**

Source: Watson, 2009

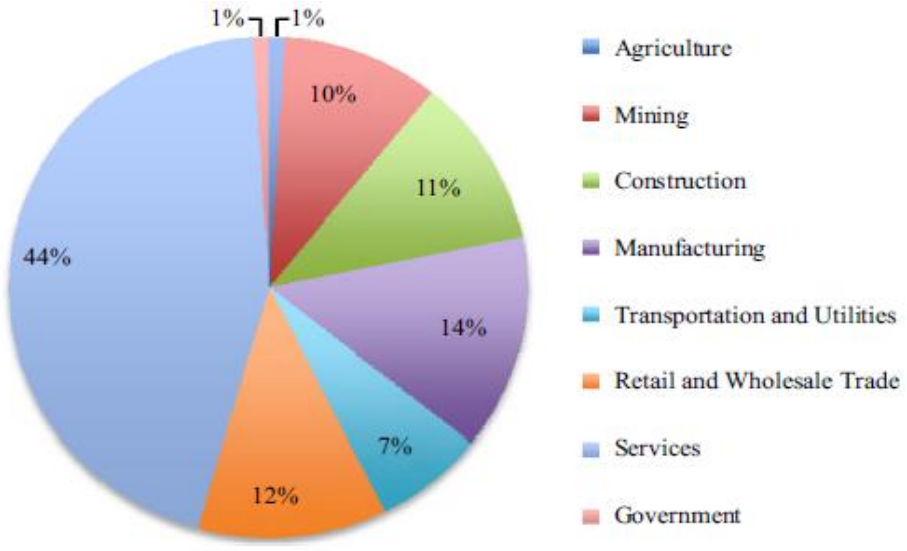
Shale gas, especially within the economy of USA, created serious effects. USA which is formerly was the biggest energy importer throughout the world is nowadays became the self-sufficient country in energy demand by virtue of shale gas and shale oil. One of the most important economic results of that is the decrease in natural gas prices. Natural gas prices which show decrease inside the country, sectors that use the energy intensively had both impacts on employment.

5.2.3 Macroeconomic Effects of Shale Gas Exploration

When we compare economic effects of shale gas we need to examine them in three different categories. Direct effects are output, employment and income effects of core industry. For example, direct effects of shale gas industry are consisted of sub factors of searching, production, transport and delivery or provide in-situ service. Investments carried on over such activities have direct contributions on natural level of outputs (number of employees who are employed, prices paid to said employees, etc.). Any change occurred during direct and off-the-shelf procurement activities of shale gas industry provide indirect effects to entire supplier industries that support shale gas production activities. Changes generated on demands (in

direct industries), output in supply chain, cause mutual changes in employment and income. Affected supplier activities cover the majority of the industry in economy of USA. Employees who are employed in both direct and indirect sectors and their families spend their incomes on food, housing, entertainment, automobile, household appliances, furniture, clothing and other consumer goods. Additional output, employment and income effects that were arisen from such consumer expenditures are being categorized as induced economic effects. As well as direct economic developments which occurred in industry sector, low and stable gas prices which have a positive effect are being encouraged. Macroeconomic Model simulation of USA Economy involved in IHS Global Insight, showed that existing low and stable gas prices, in short term caused; 10% decrease in power generating costs, 1.1% increase in Gross Domestic Product (GDP) of 2013, 1 million of employee increase during 2014 and in 2015 employed worker number shall increase around 809.000 more. In long-term (more than 15 years), balancing trends of the economy have employment effects of gas prices against low gas prices and GDP became included in more low levels, however, gas prices may still provide significant benefits. For example, there will be economic recoveries in competitiveness of domestic producers due to low natural gas prices and power generating costs. First influence of this state shall be; until 2017 there will be 2.9% and until 2035 4.7% more higher industry production. Additionally, short term employment effect coincides with the period where USA economy shall be remembered with low growth and high unemployment.

Figure 17: US Shale Gas Employment Contribution in 2010



Source: Wang, 2014, p.13

5.2.4 Employment Creation in Shale Gas

One of major effects of the shale gas production on economy incudes incentives and their contribution to employment. As a result of the researches, it is determined that the shale gas production contributes to unemployment more than finance and construction industries.

The results also assume that the saving amount containing the low gas prices shall reach 2,000 US Dollars in 2035 Upserge or heavy increase in shale gas production which is effective in economic development and employment creation in USA has strong economic impressions (Weber, 2012, p.1580). One of the economic effects of traditional gas activities is 58 employment field – more than 600.000 people – is being created by virtue of shale gas. It is estimated that this number will be more than 870.000 totally in 2015 and more than 1.6 million in 2035. Root cause of strong economic effects which are generated from shale gas is high "employment multiplier/factor" which is generated by virtue of employment created as direct and indirect in order to support industrial activities. Contribution of USA's shale gas to its GDP was more than 76.9 billion dollars in 2010; this number will be 118.2 billion dollars during 2015 and be 231.1 billion dollars when we reach 2035, tripling 2010. Shale gas industry, for the next 25 years, will create a tax income of more than 900 billion dollars for domestic, federal governments and states. Savings emerged due to more low gas prices and gas procurement of other consumers with more low prices created an additional increase of annually more than 900 dollars as average in disposable income per domicile between years of 2012 and 2015. (IHS, 2011)

Table 8: Studies Executed Relevant To Effect of Shale Gas On Domestic Economy

Researchers	Shale Deposit	Main Result
CBER	Marcellus Shale (Arkansas)	It is predicted that in 2007 shale gas extraction activities increased total incomes of Arkansas State as 2.6 billion dollars and created 9,533 pcs of employment.

Considine vd.	Marcellus Shale in West and North Pennsylvania	Industrial activities regarding shale gas extraction in 2008 generated an economic activity of 2,263 billion dollars and 29,284 new employment. A payment of 238.5 billion dollars is made to state and local taxes in Pennsylvania.
Considine vd.	Marcellus Shale in West and North Pennsylvania	i)It is predicted that shale gas industry created 44,098 new employment to Pennsylvania economy and state and local taxes of 389 billion dollars were paid. ii)It is forecasted that shale gas industry shall emerge economic consequences such as added value of 18.85 billion dollars until 2020; 1.87 billion dollars of state and local taxes and employment area of 212,000 person.
Permanent Group	Barret Shale (Dallas)	i) Industrial activities in Barnett Shale corresponded to a product of 6.1 billion dollars in 2006 and created an employment of 60,820 persons. ii) Industrial activities in Barnett Shale corresponded to a product of 8.3 billion dollars in 2007 and created an employment of 83,823 persons. iii) Industrial activities in Barnett Shale corresponded to a product of 11 billion dollars in 2008 and created an employment of 111,131 persons. This was the highest level of all passed years.
Scott	Haynesville	It is forecasted that seven companies in Louisiana, through shale gas extraction activities in 2008 has

	(Louisiana)	executed a commercial sale of approximately 2.4 billion dollars.

Source: Wang, 2014

Table 9: Employment Gains in Number of Jobs

Sector	2010	2011
Forestry, Fish & Hunting	590	740
Mining	7,367	9,369
Utilities	312	319
Construction	13,061	16,601
Manufacturing	2,113	2,660
Wholesale Trade	7,449	9,507
Transport & Warehouse	3,293	4,156
Information	1,224	1,538
Finance & Insurance	3,364	4,226
Real Estate	2,851	3,556
Tech. Services	7,229	9,145
Management of companies	812	1,025
Administrative & waste services	4,716	6,002
Educational Services	2,441	3,006
Health & social services	8,438	10,507
Arts- entertainment& recreation	1,540	1,915
Hotel & food services	5,355	6,658
Other Services	4,567	5,693
Government & Misc.	1,024	1,284
Total	**88,588**	**111,413**

Source: Considine et al., 2010

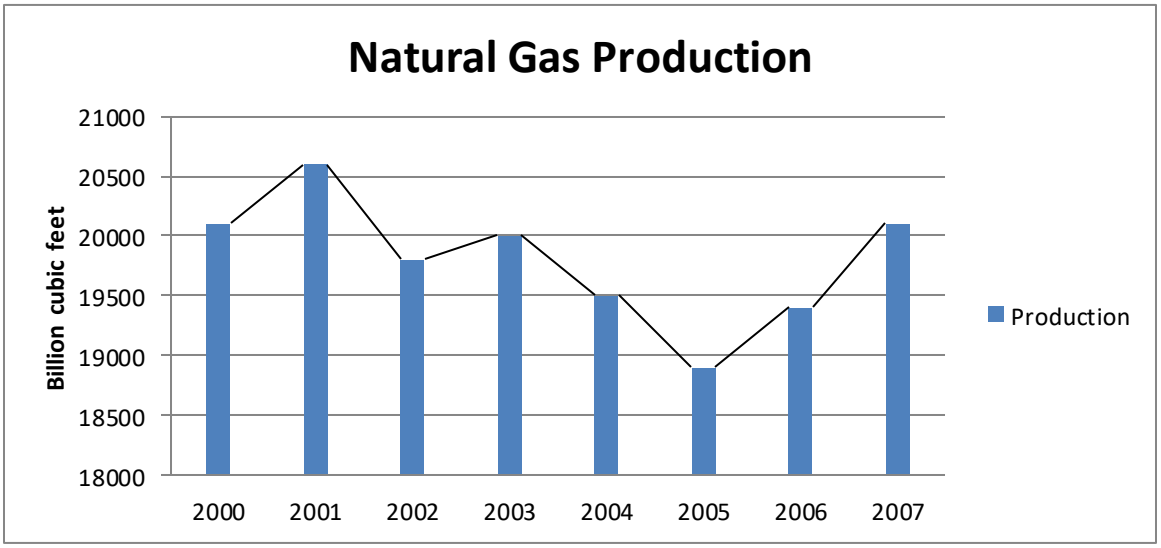
5.2.5 Impact of Shale Gas Extraction in Domestic Markets

The gas extracted underground got the profit ratios up in line with and developments in the boring technology. In fact, many reports supported by the gas industry address the financial effect of these activities on unemployment and taxes. If we talk about size of the effects in general meaning, it is true for us to put the regions, where crude oils are extracted, in first ranks. However, the power supply extracted by these unconventional means has any financial and environmental effects primarily on the region where it is found. The processes used in extraction of this power supply firstly create a local economy and then submit any job opportunities to the local economy. But, another thing to be addressed is that, excess amount of water is used during extraction of this power supply, and this water is mixed with

chemicals, this has also any environmental effects. When any uncertain financial advantages and environmental effects are considered, any differences occurred in the extraction process. Safer and more environment-friendly applications were started especially around Texas and Pennsylvania. But, it is not possible to say so for New York.

To research any probable financial effects of this resource, most reports were published, and both consulting companies and education institutions, which are interested in this matter, have contributed in this process. But, the politicians or the persons and organizations, who and which are authorized to make any decisions on these matters, pay attention sufficiently to any academic and special studies, and have knowledge about the used methods. But, thus such studies achieved this goal and also any conscious steps may be taken.

Figure 18: US Domestic Natural Gas Production between 2000 and 2007



Source: Wang, 2014

The IMPLAN input-output model is used in researching any financial effects of the shale gas extraction. Ones, who prefer this used model, include consulting companies and governmental authorities. Miller and Blair who contribute to development of this model, address that a large number of data must be used to obtain a rational result. Talking about the numerical results of this research model, the contribution of the gas extraction to economy was only 2,263 billion US Dollars in 2008. Moreover, about 30 thousand job opportunities emerge. A tax income of about 238 million US Dollars is obtained in the Pennsylvania state. According this model, it is estimated that number of wells drilled in Pennsylvania shall be 2800 in 2020, while it was approximately 1000 in 2010. Another subject to mention is the Marcellus project in

Pennsylvania in a specific meaning; the IMPLAN model divides any expenses in the Marcellus project into many categories: Incentives, research costs, boring expenses, costs incurred during the gas extraction process, copyrights and other expenses respectively. The result obtained from the research shows that these costs increased up to 4.5 billion US Dollars in 2009, while they were 3.20 billion US Dollars in 2008(Miller & Blair, 2009, p.1). In the study conducted by Considine it is stated that the Marcellus process made a contribution of 7 billion US Dollars to the regional industry. Another result prescribed in the study is an increase in the value added by these power supply exploration activities to the Pennsylvania state (3.88 billion US Dollars). Additionally, these activities provided about 44.000 job opportunities, and obtained a regional income tax of around 390 billion US Dollars. However, it is estimated that 3,500 wells shall be drilled 2020, and gas production in Pennsylvania shall reach 13.5 billion cubic feet in 2020, while was 1 billion cubic feet in 2010. As a result, it is estimated that a value increase of about 18 billion US Dollars shall provide a tax income of about 2 billion US Dollars and approximately 20.000 job opportunities. As seen, the researches may show any differences in terms of location, where the resource is extracted, and type and volume of the resource.

Table 10: Tax Impacts of Shale Gas in 2009(millions of dollars)

State and Local Taxes						
	Employes	Proprietor	Business	Households	Corporations	Total
Dividens					22.38	22.38
Social Insurance						
Employee Contr.	0.76					0.76
Employer Contr.	3.26					3.26
Indirect Business						
Sales			117.85			117.85
Property			124.32			124.32
Motor Vehicle Lic.			2.59			2.59
Other			36.37			36.37
S/L Fees			8.16			8.16
Corporate Profits					14.95	14.95
Personal Income						
Income				47.14		47.14
Fines & Fees				6.89		6.89
Motor Vehicle Lic.				2.25		2.25
Property				1.09		1.09
Other (Fish/Hunt)				1.06		1.06
Total State & Local	4.02		289.28	58.43	37.33	389.06
Federal Taxes						
Social Insurance						
Employee Contr.	241.96	50.54				292.51
Employer Contr.	244.70					244.70
Indirect Business						
Excise			35.79			35.79
Custom Duty			16.67			16.67

Fed Fees			27.52			27.52
Corporate Profits					124.61	124.61
Personal Income				315.02		315.02
Total Federal	**486.66**	**50.54**	**79.98**	**315.02**	**124.61**	**1,056.8**

Source: Watson, 2009

About the research conducted CBER for Fayettevillle gas in Arkansas: This research conducted in this region, is also based on the questionnaires of many companies, and the IMPLAN model is applied as in other researches. The used IMPLAN model is focus on output and employment. If we focus on figures again, an income of 2.6 billion US Dollars is obtained and approximately 10.000 job opportunities are created in Arkansas. This study is also focus on the effect of taxation on investment planning, and the effect of 5% taxation on investments is examined. Consequently, it is observed that the company investments reduce by 13% due to such taxation. According to Considine, it is observed that the resource exploration and extraction taxes may decrease any investments by 30%. (Kinnaman, 2011, p.1244)

As a result of the above study, the results are summarized in the following table:

Table 11: Comparison of Assumptions Related to Shale Gas Plays in US

Shale Play	**Estimated Impact**	**In the year**	**To the economy of**	**Assumptions**
Marcellus	$4.2 Billion in output 48,000 jobs	2009	Pennsylvania	100% royalties spent immediately "The location of all these suppliers and income recipients were determined using the company profile databases References U.S.A and Manta, which also provided the economic sector for each purchase" (95% of direct spending)
Marcellus	$8.04 Billion in revenues 88,588 jobs	2010	Pennsylvania	100% royalties spent immediately "The location of all these suppliers and income recipients were determined using the company profile databases References U.S.A and Manta, which also provided the economic sector for

				each purchase" (95% of direct spending)
Barnett	$11 Billion in revenues 111,131 jobs	2008	Dallas	"The amounts were fully adjusted to reflect those funds that are paid outside the region (and state) and are further reduced to account for out-of-area spending, savings and taxes"
Hayensville	$2.4 Billion in revenues 32,742 jobs	2008	Louisiana	All direct spending in state
Fayetteville	$2.6 Billion in revenues 9,533 jobs	2007	Arkansas	Survey asks the firms to report state of residence of employers, but not whether spending occurs in state or out of state.
Marcellus	$2.06 Billion in revenues 2200 jobs	Gas Production per year	Broome Country, NY	Assumes 15% of royalty earnings remain in local economy

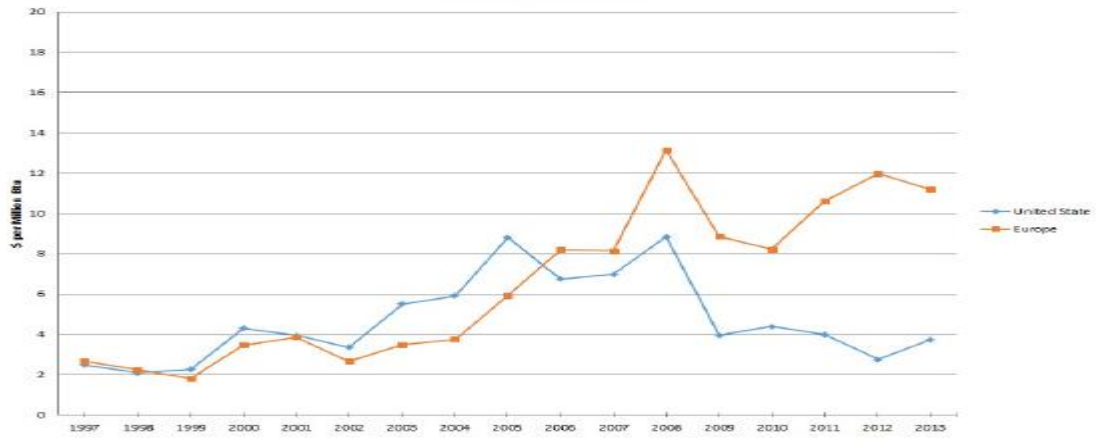
Source: Kinnaman, 2011

5.2.6 Shale Gas Effect on Natural Gas Prices and Petroleum Prices (Other Energy Industries)

Here we shall discuss how natural gas prices became cheaper by virtue of shale gas revolution occurred in USA and why shale oil production which is described as subsequent revolution did not decrease petroleum prices. There exist two important consequences of shale gas and shale oil that were described as revolution in USA. First one of these consequences is the fall in natural gas prices, together with the increase in shale gas production, that were higher in the past and the second is increased petroleum production. The reason of the fall in natural gas prices, that is to say natural gas prices becoming cheaper is that USA is consuming produced

shale gas domestically. USA meets the inland demand with the natural gas produced from shale gas and consequently gets rid of the costs in liquefying, condensing and transportation of natural gas (LNG). Thus natural gas prices became cheaper in energy market of USA. USA, at the same time, makes serious investments to shale oil reserves and by this means increases petroleum production. However this increase which occurred in petroleum offer due to shale oil did not decrease petroleum prices. The reason for this is that cost in transporting of petroleum is higher when compared to natural gas. Accordingly, increase of income in states where shale oil is being produced is more than states where shale gas is produced.

Figure 19: Natural Gas Prices in US and Europe



Source: Kirat, 2016

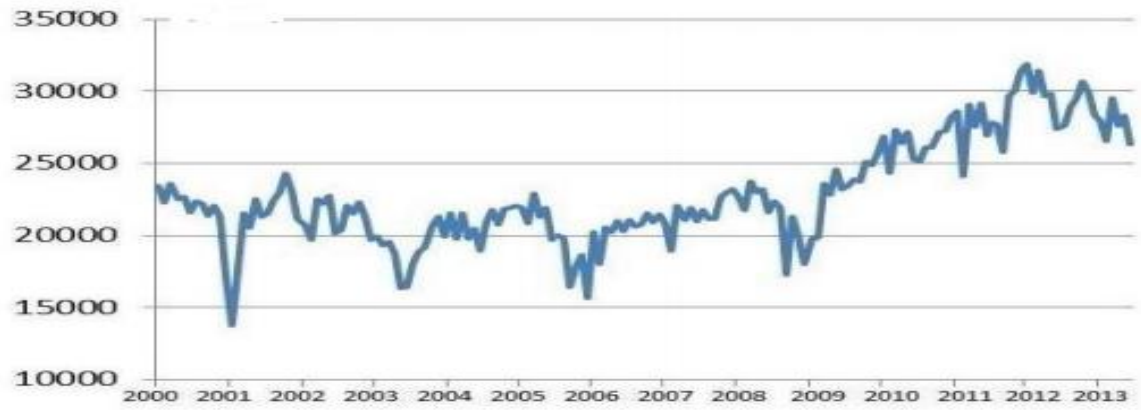
The fall in natural gas prices for producers make their incomes fall also, on the other hand petroleum prices being stable caused higher increase when compared to natural gas in states where petroleum is produced (Coleman, 2014).
In the report published by PWC (Price Waterhouse and Coopers) under the heading of "Next Energy Revolution: Shale Oil" it was stated that global shale oil production will change energy balance of the world. According to the report shale oil production has the potential of reaching up to 12% of the share within global petroleum production, and this rate corresponds to around 14 billion barrels daily. Additionally, it was stated that this surplus which is being realized may reduce prices around 25-40% in 2035, but will increase global GDP between 2.3-3.7% (over 2012 GDP values: 1.7-2.7 trillion dollars).

5.2.7 Sectorial Effects: Shale Gas Effect on the Chemical Industry

When we observe effects emerged after shale gas extracting in USA, it will be inadequate to say only natural gas prices became cheaper. Industry sector – especially chemical industry – is

seriously affected as positive from fallen natural gas prices by virtue of richness of natural gas production. When natural gas price becomes cheaper for industries which benefit and use natural gas as input; products, outputs of these industries increase and their competitiveness goes up. In this section we will mention about positive externality of leading industries of manufacturing industry such as chemical industry, iron and steel industry and cement industry received by means of shale gas and especially we will mention about chemical industry. Reduction in prices of natural gas directed producers to make investments on stratums and deposits where natural gas liquids (NGL) are richer such as ethane which offers better income when compared to methane (Gandolphe, 2013, p.4). Natural gas liquids are kinds of gas that are produced as natural gas and liquefied. Ethane production reached up to 355 billion barrels in 2012 by increasing 38% when compared to 2008 due to fast increase in wet gas manufacturing. Number of gas distillation facilities in USA increases day by day. These facilities execute separating of methane from other liquefied gases. Methane is used as a significant input that is utilized in petrochemical, industry and construction sector. Ethane (C2) is an input especially used in petrochemical industry. Propane (C3) is used as raw material in petrochemical industry in order to produce propolin and ethylene. At the same it is used in common within housing industry and transport in order to meet heating requirement. Butane (C4) is another raw material used in petrochemical industry and also being used refineries where it is mixed with natural gasoline. Propane and butane are liquefied petroleum. Pentane + (C5+) is used also in petrochemical industry but has other functions too; for example, in Canada it is used as diluting agent in extracting of heavy oils and in their transportation (EIA, 2013a).

Figure 20: Ethan Amount of U.S



When we assess above figure, it is observed that ethane amount produced in USA is being seriously increased as per years. As of 2006 in which gas shale revolution is started, it is observed that quantity is being considerably increased. Natural gas liquids being practical

convenient and useful, created revolution in the petrochemical industry of USA. Ethane is used mainly to obtain ethylene which is one of the most important intermediate inputs in plastics manufacturing. Its increasing practicability and usefulness provides revival and recovery of USA's petrochemical industry which depends on cheap and rich ethane.

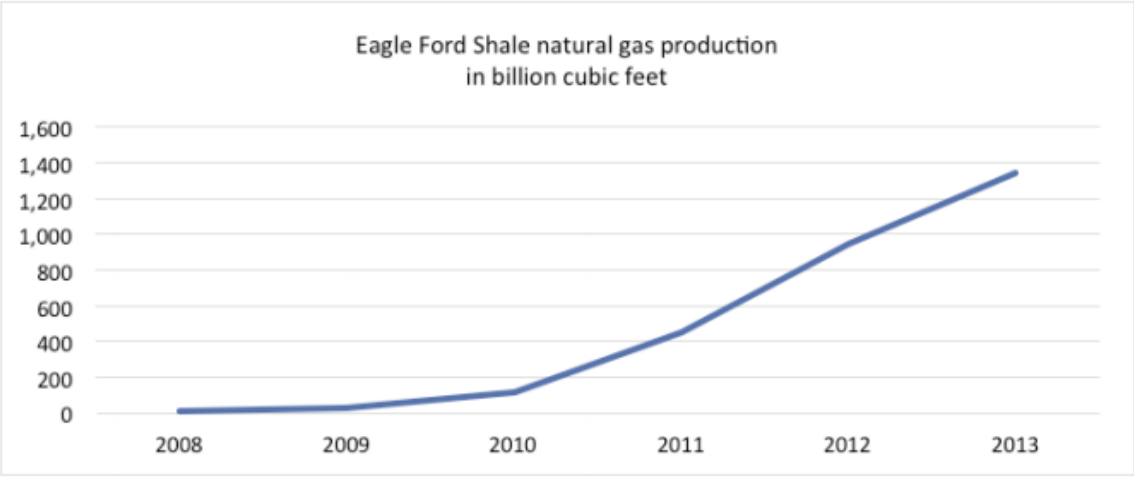
Cheap natural gas provides an advantage to the USA chemical industry on the foreign competitors who make oil based production instead of natural gas. Shale gas boom not only decreased the natural gas prices but also decreased the natural gas liquids prices. One of these liquids is ethane. Ethane is being used for producing ethylene and this is a common organic mix that is being used in chemical industry (Wang et al, 2014, p.14). USA chemical sector on contrary to their international competitors who use more expensive oil based raw material, use natural gas based ethane. Thus, the biggest factor that USA can compete in chemical market is the price difference in natural gas and natural raw oil. For instance, in international market, barrel price of the fuel oil is eighty dollars and natural gas is only about two dollars. So, USA chemical industries have price advantage in 7 to 1 ratio. Chemical companies, by expanding their plants and building new ones, take the advantage of cheap natural gas (Achilladelis et al., 1990, p.535). In May 2012, to build new facilities and expanding the current ones, 25 billion dollars of capital investment was made. One of the biggest investments was done by Dow Chemical Company to build cracker and propylene production facility in Freeport, Texas. 1.7 billion dollars of facility expanding investment was only a part of 4 billion dollars investment. Facility in Freeport won't be operating till 2017. This situation shows that there will be cheaper and more abundant shale gas in the future of the Texas. Such a project could not be thought until 5 or 10 years before, when the natural gas prices were more expensive and the gas supply was more limited (Medlock et al., 2011). Expansion investment of DOW creates employment for USA economy and USA needs employment. DOW predicted to employ 4,800 personnel during the building processes. Constant supply of cheap natural gas has been lying behind this chemical projects. For the chemical market investment to encounter problems in Freeport Project natural gas prices have to increase up to 10 dollar ratio and this is beside the mark. For sure, DOW does not expecting the current natural gas prices which are currently in 2 and 2.5 dollars per BTU ratio, to increase up to peak prices in long years period. Shale gas boom makes the ethane cheaper. Thus, this situation creates an international sustainable price advantage to USA chemical companies (Gilbert, 2012).

5.2.8 Impact of Regional´s Developments in the Oil & Gas Industry

The horizontal and hydraulic fracturing methods make possible to reach a large volume of shale gas. However, they contribute to local and state economies. Improvement of the shale gas defined by us as a financial activity provides undoubtedly any financial advantages in both local and state managements and causes any new employment projects. However, the decision makers have to consider that incomes and employment earnings may be exaggerated, because the results differs from any expected ones in the long term processes (Barth, 2013 cited in Kinnaman, 2011).

Another fact that must be kept in mind that the industrial infrastructure and workforce of Texas in natural gas and oil industry are fairly more than ones in New York and other states. It is clear that Texas has more experience than New York and other states with regards to any financial benefits provided by Texas. Head offices of most companies, which maintain their oil and natural gas activities, and business areas of the research and development companies are located in Texas. This is another proof that Texas is well ahead in the industry. New York must pull not only qualified workforce, but also production, management, and technology in Texas toward itself to develop itself. Dallas FED states that, because Texas has any advanced oil and natural gas exploration machineries and also advanced energy services, the state earns income exceedingly (Barth, 2013 cited in Thies & Yucel, 2011). Actually, tendency to the regions, which have more population and a large industrial variety, is higher (for example, Marcellus Shale) (Hustedde et al., 2012, p.11). Figure below shows how rapid the production level of Texas Basin had increased after 2010.

Figure 21: Natural Gas Production Output in Texas



Source: The University of Texas, 2014, p.42

This increase generated almost 115,000 full-time jobs which induced to create nearly $ 2 billion both for state and local governments. Speaking about number of economics impacts of shale gas boom in Texas gave its neighborhoods nearly $ 72 billion that include 15 areas which are in the figure below. There is also a future estimation in the figure below.

Table 12: 2013 & 2023 Estimated Output Impacts By Country

	Country	***2013****	***2023****
15-Country area	Atascosa	$3,309,321,673	$5,888,831,097
	Bee	$382,452,255	$1,473,241,220
	DeWitt	$4,947,708,860	$7,288,946,345
	Dimmit	$8,552,982,031	$12,341,837,612
	Frio	$684,849,735	$1,016,801,803
	Gonzales	$7,463,132,427	$11,369,005,382
	Karnes	$10,964,709,282	$16,752,660,184
	La Salle	$9,001,341,991	$13,574,778,927
	Lavaca	$1,607,274,019	$2,661,190,775
	Live Oak	$6,954,129,494	$8,646,546,519
	Maverick	$175,394,311	$260,171,485
	McMullen	$8,276,163,149	$12,518,235,902
	Webb	$5,008,394,112	$7,051,104,091
	Wilson	$1,444,745,649	$2,109,895,697
	Zavala	$661,926,101	$1,036,509,227
	Total 15 Country	$69,434,525,089	$103,989,756,266

*Includes direct, indirect and induced impacts

Source: CBR, 2014, p.7

Expansion and adverse activities in the mining industry are known and must be examined carefully (Putz et al., 2011, p.7). In the study conducted by Weber, any increases are determined in employment, general income level and salary-based and household income in Texas and Colorado (Weber, 2012, p.1580). Any negative results given by the economic recession may create any positive effect in the expansion period. McKinnish and Sanders review coal developments in 70s and according to the result obtained by them, they determine that this figure reduces to 2 in the regular product industry; while it is 10 in the energy

industry (the regular product industry means resale, procurement and services). Although 10 business losses occur in the recession periods in the coal or energy industry, this figure corresponds to 3.5 in regular services (Black et al., 2004, p.449). Seydlitz and Laska examine any movements in the oil industry, and determine that the economic welfare of the developed communities is temporary, and such fluctuations lose their value after 2nd or 3rd year (Seydlitz & Laska, 1994, p.1).

When a new economic stream is launched, any uncertainties are observed in local and regional economies especially in a long term. The workforce created in a long term, unemployment rates and incomes are considered. The Texas commission states that it is still early to talk about the long-term effects of the shale gas in a report published in 2012.

It is possible to say that the economic data and indicators vary from region to region. For example, this growth is between 10 and 16% in other main regions (Denton, Johnson, Tarrant, and Wise), while the household income is around 21% in Texas in the process from 2003 until 2010. This figure is 1.5% in Texas, while the unemployment rate between 1.8 and 2.4% in above 4 regions in a particular time period.

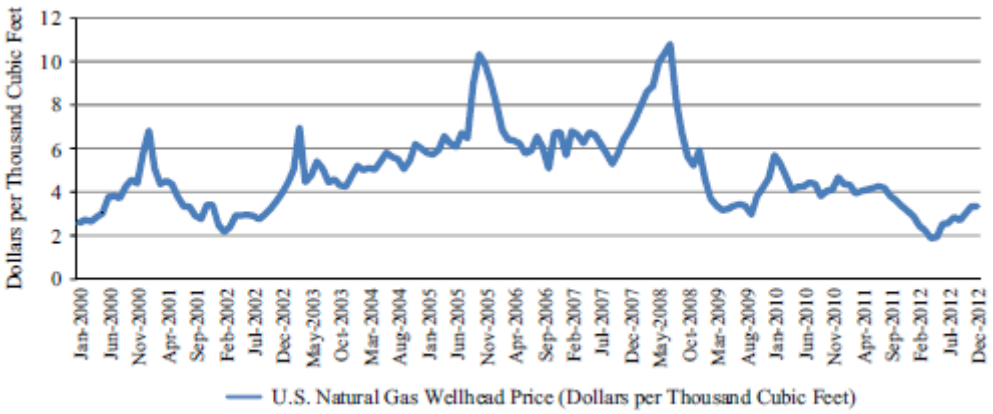
5.2.9 Factors that Affecting the Natural Gas Prices

Similar technology used in production of two products like natural gas and oil, which direct the global energy policy, and afterwards is associated with prices of two products. When the correlation between such two products are considered, questions that cheap oil comes to the end and then cheap natural gas period approaches the end come to mind. However, upon its contribution to emergence of a new and cheap natural gas period, the shale gas revolution distinguish the US local natural gas prices from the crude oil prices, and this creates a great effect on gas pricing in a global context. (Asche et al, cited in Wang, 2014, p.12) Regardless prices, the US's natural gas demand is fairly even in last 10 years. The consumption rates of 4 main important industries showing the natural gas demand are given. A growth is determined in consumption of the buyers only in the power industry among them. Despite low figures in 2011, total gas consumption shows a growth of 2.2% only compared to one in 2010. On the other hand, the acceleration in the shale gas production also causes a growth in the natural gas production. In this system established on the supply and demand basis, any conflict between such two determinants shall affect the prices downstream and upstream. A high volume of natural gas production caused a decrease in the US natural gas prices after 2005. Of course, consequently perhaps low prices of last ten years are encountered in first two quarters of 2012 in USA. But, it shall be wrong to attribute these price movements only to

high production. It must be remembered that the demand deficiency as well as high production shall be another reason behind this dramatic reduction. (Wang et al., 2014, p. 5)

An EIA project anticipates that the prices arisen from the annual average prices for natural gas shall remain $5.1 lower than million BTU until 2023. According to the prices prescribed in the EIA, it is assumed that the country maintains its success in the industry in improvement of the comprehensive shale gas supply. Despite such low natural gas prices, resistance of the boring levels is a result of the crude oil prices, which develop the natural gas economy having a high rate of crude oil and natural gas attitude. It is assumed that the natural gas prices shall increase in line with the drilled tight gas and shale gas wells after 2023. The natural gas prices increase due to a high cost. According to 2011 and 2012 EIA reports, the natural gas prices shall increase from $6.61 to $6.64 in 2023. In the same report, it is estimated that the crude oil prices shall reach $120 in the same time period. As stated above, the EIA specifies that the shale gas revolution contributes to the cheap natural gas revolution in USA. (Wang et al., 2014, p.12)

Figure 22: U.S Natural Gas Prices



Source: Wang, 2014

5.2.10 US Policy Changes on Shale Gas in 2017 due to the Trump Administration Goals

It is early to make comment on Trump's energy policy; however I will make my evaluation on what he said for energy or specifically for the shale gas during the campaign process. We know that he assigned the former Texas governor Rick Perry as the Minister of Energy. Other than that, the assignment of the former ExxonMobil CEO, Rex Tillerson, who is related to energy, as the Minister of Foreign Affairs can give the message that perhaps he will bring energy to the foreground in the relations with other countries.

In the course of the campaign, he did mention that supporting the shale gas would increase the tax revenues. In addition, the plans regarding the Keystone and Dakota pipelines, which annoyed the environmentalists, were welcomed by the industry. Trump, who created a plan of $ 100 billion for the energy infrastructure, gave the message that the American energy infrastructure needs to be invested. (Forbes, 2017)

It is also worth mentioning that if we are talking about a $ 100 billion investment, we can consider that the decision is beyond the pipeline laying for only 2 regions. The image that the he supports the local production will be obviously welcomed in the inner market. Trump may also bring constitutional arrangements to minimize or remove the costs caused by legislative regulation. In this regard, many concerns about the energy industry will soon be eliminated and will be an important incentive for production.

In an article published by the White House in order to demonstrate the point of view of the Trump administration towards energy, they stated that energy is indispensable for America, and that he is committed to implementing policies that reduce the costs of working Americans and eliminate the external dependence of energy. In this sense, it was pointed out that, firstly, any kind of implementation to cause deceleration in the energy sector or to bring to a standstill will be reviewed and, if necessary, it will be abolished completely. And the number was given. The abolition of these practices would create an added value of $ 30 billion. In this article indicating that the point of view of the Trump administration towards Shale Gas & Oil Revolution, which will provide employment to many people is quite positive, it was stated that these resources in American´s oil are worth $50 trillion and that it is a necessity to evaluate it for American people's welfare.

Indicating the profits and taxes acquired from the energy sector will be used in order to carry out the necessary road, school, bridge and infrastructure works, the Trump administration believes that cheap energy prices will help the American agricultural sector to grow. (White House, 2017)

It is also true that some measures will be taken against the coal independent from the Shale gas. It is highly likely that the new technologies will be brought in with an aim to revive the industry, which cut off the coal production due to high carbon release and therefore suffer damages.

6. Worldwide Shale Gas Development – Amounts and Challenges in Exploration

In this part, the regions and countries which possess shale gas resources apart from America are examined, depending on the literature. The energy structure in the countries and regions where they are located, whether they have sufficient infrastructure in order to extract unconventional resources, the reserve amounts, the supply and demand regarding the natural gas are stated. Apart from these, the attention given to the shale gas detection and production works has been indicated separately for each region in partnership and investments realized in addition to this. I also benefited from their own local publications of the countries other than the sources I gathered, most of which were EIA. I have not experienced shortage of sources in the regions other than Australia and southern Africa.

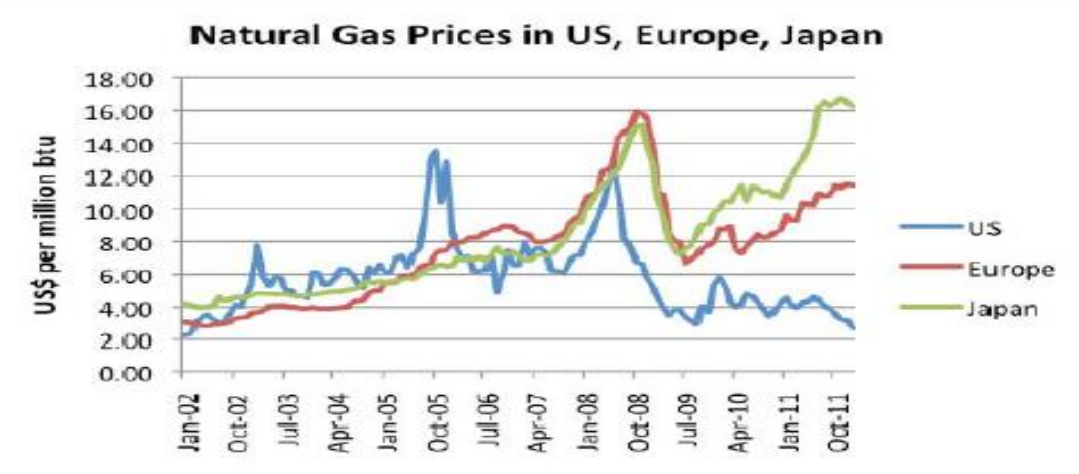
6.1 Shale Gas Development in Europe

Effect of Shale Gas Boom in Europe and Consequences

Although some commentators have placed negative opinions about the gas market in Europe, the majority has a positive opinion. As known, decreasing in the costs of producing the shale gas based on technology, means regaining the sources back in United States. Of course, this situation affects the gas market in Europe negatively. Reason is simple: Increasing Production!

Cera (2010) determined that the gas prices in Europe differentiate from the oil prices more than ever before and stated that the prices and especially the projects which determine the prices will be affected from this situation after the increasing competition. For example we may place Russia to the first line. Besides, he stated his faith to conduct the new projects in order to satisfy the demand.

Figure 23: Natural Gas Prices in USA, Europe and Japan



Source: Our Finite World, http://ourfiniteworld.com/2012/03/23/why-us-natural-gas-prices-are-so-low-are-changes-needed

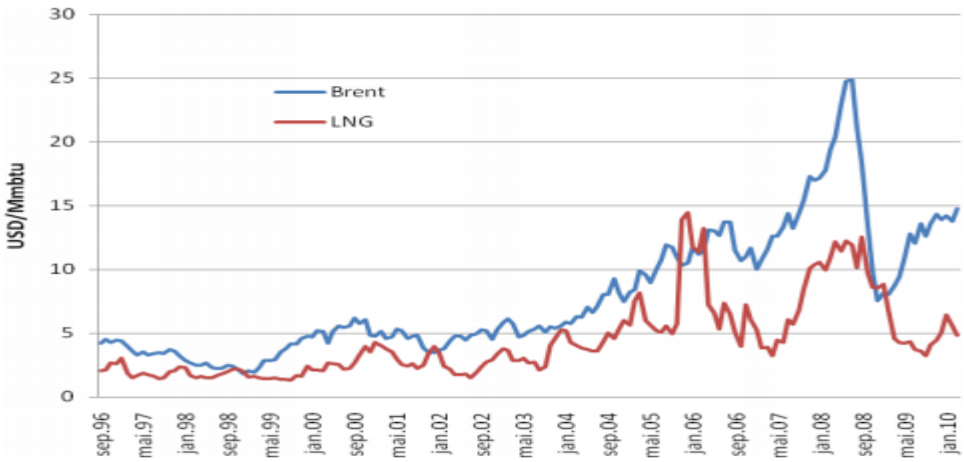
Another point that has to be discussed here is the uncertainty environment that the budget problems trigger due to the financial crisis (Mcghie, 2011). As known, there are some differences between gas and oil prices from time to time. However, market actors will take actions in order to eliminate these price differences. For example when gas is far cheaper than oil as a part of intervening this fall of gas some removals may be observed in the projects of oil domain. This situation is valid in vice-versa conditions. When examining the price differences first significant difference of gas against oil occurred in 2011 as a result of increasing liquefied natural gas (LNG), coal bed methane (CBM) and shale gas production in United States and the demand that decreased due to the financial crisis. As a result of trusts of the leader companies in the sector for the gas prices, Helge Lund, CEO of Statoil: : "*We believe we can secure higher gas prices in the future. This means we're holding back some of the gas for a few years".* (Directcited in Oglend, A., 2011, p.117) Actually, it is good to look at what they did instead of what they said. For instance; there aren't any evidences that Northern Europe got panic at this point and they stopped the investments on gas projects. More specifically, decisions of ENI administration confirmed the statements we mentioned in the previous line. Such that, ENI started new studies on this subject and the value of their investments is round 470 million dollars. Another example is that the cost of gas development in Papua New Guinea performed by Exxon is around 15 billion dollars. It is necessary to underline that there are suchlike projects which are waiting. Nowadays in Europe, gas prices are prepared by basing on the long-term contracts and oil prices and cost formulas are taken into consideration (Oglend, 2011, p.117).

Pricing in European Market

It´s known that the gas prices have a regular falling trend from 2008 to 2012. Knowing that this may be compensated, it is necessary to take attention on the difference after 2008 between the gas and oil prices given in the following table. After they caught each other in 2006, there aren't any differences between them until 2010.

It´s known that the gas prices have a regular falling trend from 2008 to 2012. Knowing that this may be compensated, it is necessary to take attention on the difference after 2008 between the gas and oil prices given in the following table. After they caught each other in 2006, there aren't any differences between them until 2010.

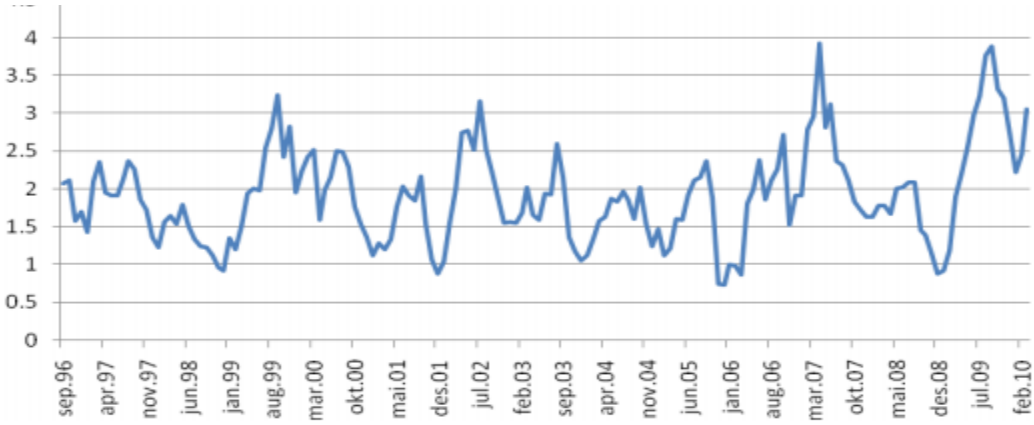
Figure 24: Spot Prices for Gas and Oil



Source: Asche, 2012

It shows that the difference between them is growing. However, this situation caused a rise in gas prices. For a better analysis, it is good to look at the results that became apparent by dividing the oil prices into the gas prices as follows:

Figure 25: Relative Sport Prices between Oil and Gas



Source: Asche, 2012

As seen in this figure, oil prices are more than the gas prices, and the reason of this may be the usage and application fields of oil are more than the ones in gas and transportation possibilities are easier. If it is necessary to add another reason, it is the market considers the oil as a rarer source. We know that the rare-found sources are more valuable than the others as per basic economic rules. As seen in the figure, peak value is 3.9 and bottom value is 0.7.

As seen in the figure that is taken from the article of Asche the reason of the gas prices that decreased after 2008, originates from the shale gas production that we called as unconventional. While the production rate was one per cent at the beginning of 2000's, this number reached 20% in 2012. It is expected that this number will have reached 50% by 2035. As a result of this, expected LNG demand remained inconclusive. We may consider the fall in gas prices resulted from the weakness of demand due to the economic contraction. However most of the specialists say that when the energy demand comes back, positive price development will be provided and current lull will be over (Asche, 2011, p.6).

Of course, when mentioning the market and economical influences, it is necessary to remind that there is another indicator which affects these structures. As mentioned in the previous titles, environmental effects of shale gas and shale oil create a real worry in United States. Concern of chemical materials that are injected under the ground via the pipeline, mix with the drinking water is very important. As known, studies continue concerning the liquid which is pumped under the ground with a compound of an amount of water and chemical materials through the pipeline, will mix with the drinking water or not. In addition, mixed and contaminated water will be purified and will be healthy again or not, is another question to be answered. At this point, it is good to focus on the situation from the point of view of European perspective, because the Europeans who have great differences from public conscious of

United States, approach to this situation more cautiously. High population in the region may be considered as another reason. Besides, companies that search for shale gas in France, decided to stop the research until the government finds out the environmental and economic effects of shale gas research and extraction. Similar steps with this application came from England before. Authorities in England stated their opinions to stop the gas extraction activities until the exact results are obtained by the researches. In Germany, there are conflictions on this subject. Although there is a general consensus on the subject of which country has how much reserves, a wide research has never been performed until 2012 as a resource potential. Other aspect in shale gas development is the discovery of the proper and cheaper digging methods that may decrease the production costs in United States. On the contrary, when we look into Europe, we cannot state the existence of such development. We know that shale gas extraction is a difficult process. We may consider the qualified personnel with technical knowledge instead of qualified personnel, reaching the suppliers, special work tools and equipment and the substructure as the most important one, as a part of this process. However, in the study made by CERN in 2009, in addition to the aspects that are stated before, CERN draws attention to the point that there won't be any profit in a place where no natural gas pipeline exists. It is good to remember that there is another chain of each factor. If we talk about the pipeline, it is necessary to investigate these ones under a different title as per their securities.

Intensified researches and assessments to determine the presence and volume of the possible natural gas sources have been increasing day by day. Researches of the Local monks, energy ministries of the interested governments and international energy agencies about this issue have been increased in the recent years. For sure, shale gas improvement researches of USA are guiding other nations about this issue. Especially, researches that are made to determine economical effect, are contributed a lot to determine the economic effect of the other shale gas sources. Briefly we can say that USA is a role model country about this subject. Biggest risk of the shale gas development is local substructure problem. (Weijemars, 2013, p.100)

Weijemars (2013) is his research, modelled 5 important shale gas basins in Europe and presented to us. (Turkey, Germany, Austria, Sweden and Poland) According to that, each one is on different levels by means of quality and quantity. Image below shows us the shale gas development basins.

Table 13: Reserve Comparison of 5 Countries

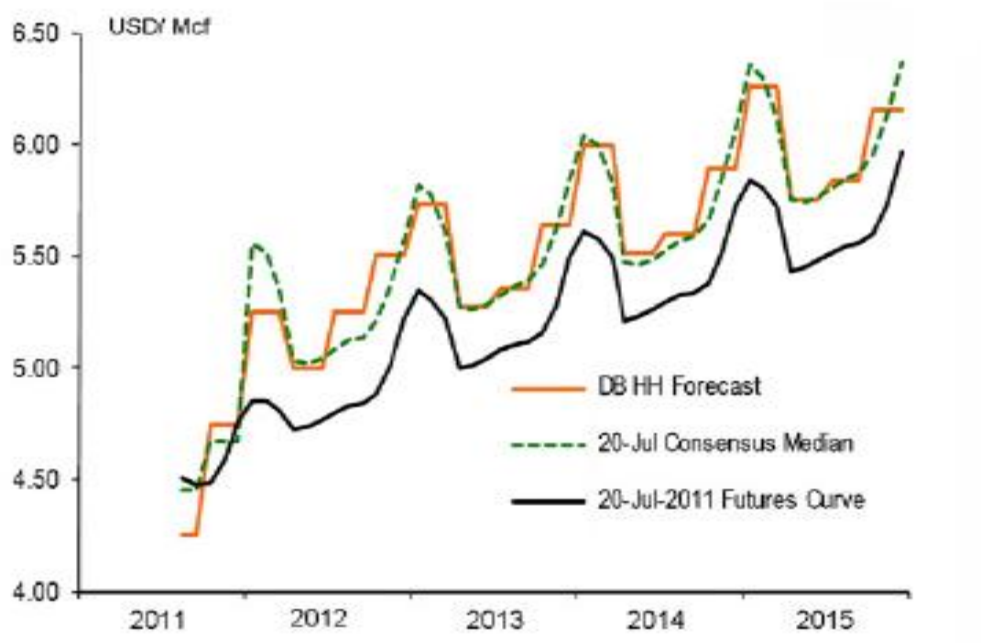
Property	Sweden	Poland	German	Austria	Turkey
Basin area(km)	2,010	23,816	7,500	900	18,000
Depth (m)	100-3,500	2,000-4,000	0-2,500	4,500-8,000	2,500-3,500
Thickness(m)	30-100	30-300	20-500	1.500	100-400
TOC (%)	2-25	7	2-12	1.5-2	4
Ro (%)	1.4-3	1-4	0.5-1.5	0.7-1.6	0.5-3
Tcf	39	844	94	750	151
RF	0.14	0.17	0.18	0.04	0.15
EUR/Well	4.18	4.8	4.8	8	2.2

Source: Kuhn cited in Weijermars, 2013

Primarily, Rogner have researches on the natural gas production in Europe. According to that he estimated that there has been approximately 1,255 cubic feet of gas on the European continent. 43% of this gas is shale gas, approximately 34% is tight sand and the rest is consisted of coal-bed methane. Unconventional sources of the Europe compared to other countries, looks quite few. Such that Rogner indicated in the research in 1997 that only 18 tcm of the total 425 tcm is belongs to the Europe. USA being placed near the top, its revenue obtained from that constitutes 25% of the gross internal products. In the research published by Wood Mackenzie in 2009, indicated the transitable shale gas amount between 150 and 200 tcf. In a similar research in the same year, indicated that this level can go up to 423 tcf. (CERA) American energy institution published this amount as about 634.5 level in the reports. Besides, this level has been approved by German authorities. Natural gas prices are dynamics that are affected by not only the obtained region but also from the occasions in the environment. In the constitution of this dynamics which has different characters in the different regions of the world, regional occasions play efficient role. In Europe, as the gas prices are indexed to the fuel index, reflects in the same way on the prices with every positive and negative occasion on the fuel side. As the dynamics that constitute the USA and Europe gas prices are different, they can be priced differently and can differ significantly. (Weijemars & McCredie, 2011, p.7)

USA short term gas price estimation has been presented in the table below. Essential assessment of the New York Mercantile Exchange (Future contracts for natural gas are traded daily on the NYMEX) and Deutsche bank is approximately as median.

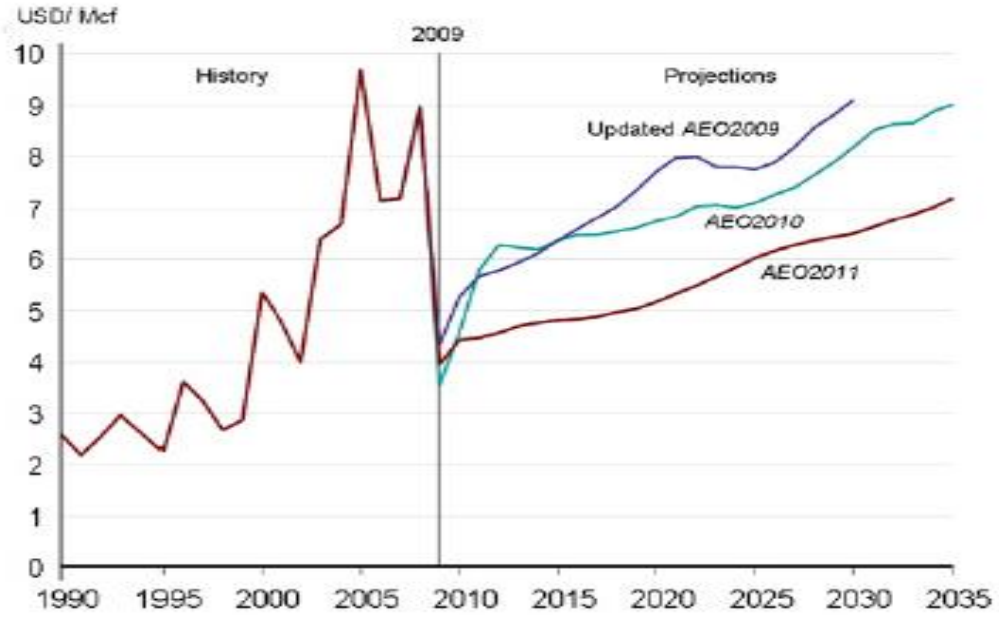
Figure 26: Short Term Gas Prices Estimation



Source: EIA, 2011 cited in Weijemars, 2013

In the table below, medium and long term assumption of the American gas prices have been presented. According to the model in the table, it is being assumed that the price pressure due to the shale gas production in USA, will keep the prices low in the next 10 years period. Technological developments have been increasing our dependency on the energy. By the way, Europe and Asia, to create solution for the supply deficiency, have started substructure researches. To say that gas prices will increase due to these reasons, will not be a wrong assumption.

Figure 27: US Gas Price Projection

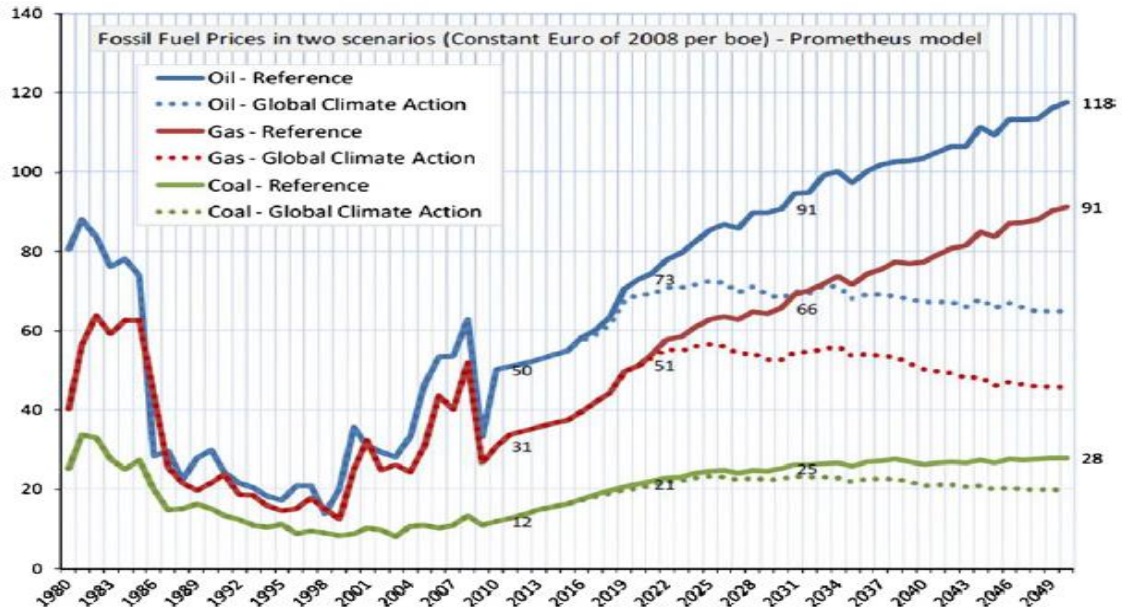


Source: Weijemars, 2013

Especially Europe is paying significantly more for the gas issues. Stern (2007), it has been shown that natural gas prices in Europe are five times more than USA prices. As indicated recently, because the energy demands will be going on for a long period, there is no downtrend in the gas prices is being expected in Europe for short term.

Future fossil fuel prices for Europe have been modelled in the European Commission Energy Economics- Environment System, Prometheus model that is being developed in the E3MLab of the Athens National Technical University. Another publication of the same university have been presented in the table below. It has been assumed that if the global climate does not change unexpectedly, natural gas prices will increase during the 20-30 years period. One of the targets of the energy sector is switching to the renewable sources. But realization of this can only be achieved by long term plans and projects that should already have been started. Also the significant costs must be taken into consideration.

Figure 28: Future Estimate of Oil, Gas and Coal



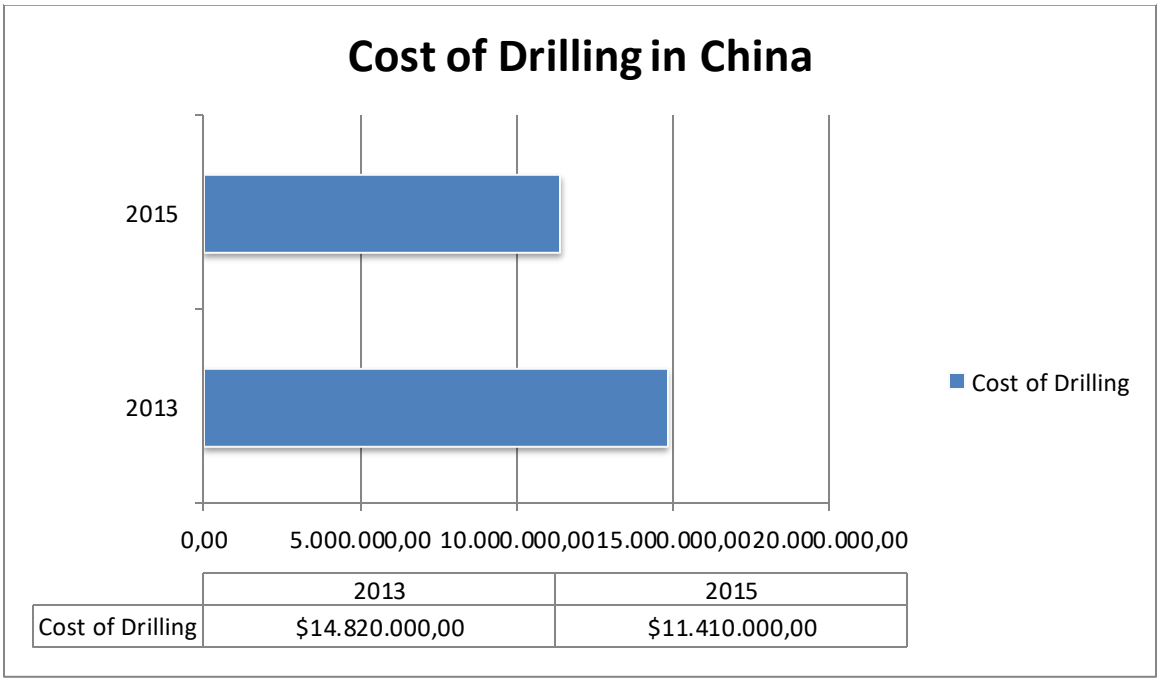
Source: EU Energy Trends to 2030, 2010

6.2 Shale Gas Development in China

China needs/will need natural gas more than ever these days and in the future. It is clear that Shale Gas Revolution in the US made many changes in energy policies but there are still some uncertainties for China despite its rich resources which is 1115 trillion cubic feet according to IEA report for world shale resource assesments. These amounts of "estimated" shale gas resources give China a better hand in energy policy if the government of China use this opportunity. In order to meet its growing demand, China has focused to search a new energy sources. As mentioned above, having a rich shale gas resources do not mean that they are ready for extraction.

However, China has continued to invest in shale gas production and achieved to fall the cost of drilling for shale gas wells. Figure below shows the decrease in drilling a shale gas well.

Figure 29: Cost of Drilling in China

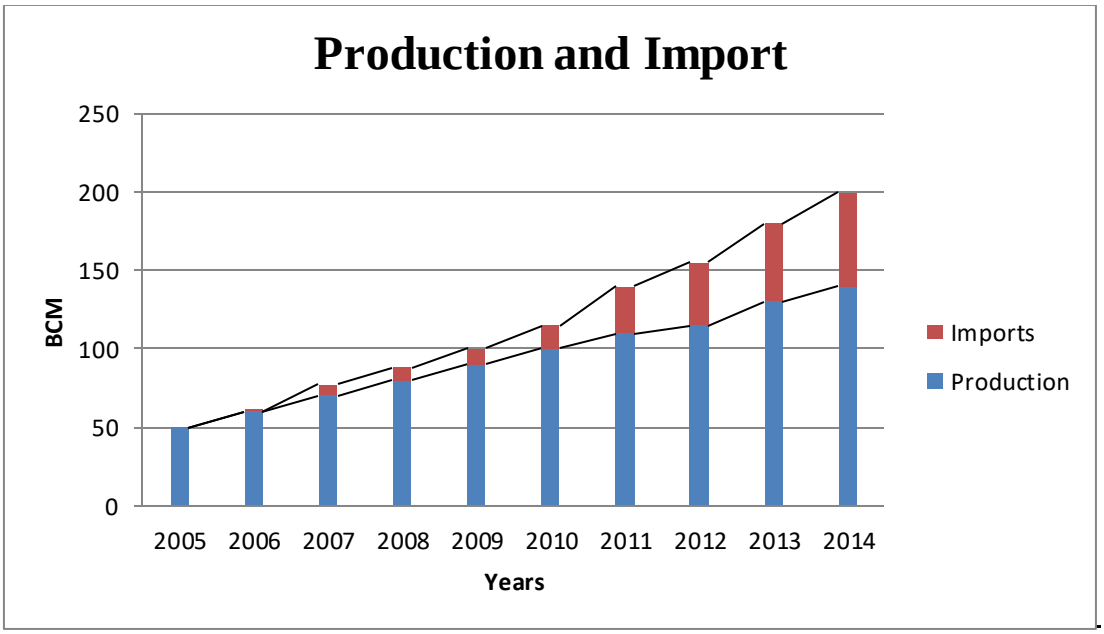


Source: IEA, 2016, p.46

China´s production is quite weak and this makes them an import-dependent by 2030 according to IEA (IEA, 2010). On the other hand, it is already planned that China will increase shale gas production to 2.1 trillion cubic feet until 2020 (Bellelli, 2013, p. 10). State-owned company Sinopec has started drilling first shale gas wells in 2012 which will provide 6% of country´s energy need by 2020. (Yang, 2012)

Despite the pollution problems in the country and the promises given to the international environments, its role in development of natural gas, is behind the role model country U.S.A. Despite explaining its projects, realisation of these projects is directly proportionate to resource research, extraction, establishing the substructure and having the efficient capacity to sell them. (Ratner et al., 2016, p.11). Although China has really great amount of shale gas resource, geopolitical factors make it difficult to produce it (Sandalow et al., 2014, p.5). Energy needs of China and the amounts of production according to these needs may be seen in the table below. According to this, China increased its production in–proportion of 150% from 2004 to 2014. China, which provides most of its energy needs by importing, is the fourth greatest exporter of the world nowadays.

Figure 30: Production and Import of Natural Gas in China



Source: BP Review of World Energy, 2015

Energy sector of China is conducted by the government and some decisions about increasing these effects, was taken in the 13th FYP meeting. Likewise, if China performed the precautions that are to be taken against environmental pollution, it is predicted that it will play a more important role in world's energy policies. (China Economic Developments Report, 2016 cited in Ratner et al, 2016, p.12)

China has taken important decisions for shale gas. However, geopolitical factors are the factors which make it difficult to apply these decisions. Namely, shale gas of China is on the mountainous terrains and the cost of this situation is an actual problem. Besides, another disadvantage for the economies which are conducted only by the government is being far from the competition environment. It is a known fact that the encouragements are very few. When the environmental problems are added on this, it forms a risk for foreign investment companies. Despite all these negativities, it is wrong to say that there are no foreigner investors. There are studies that are conducted by the important companies such as Shell and Exxon with the Chinese authorities. In the assessments made by comparing the opened wells, the specialists state that China is far behind U.S.A and expect that nothing will happen to make up this difference for the next a few years. Even if the drilling works that were performed by 2 public institutions (Sinopec and CNPC) of the government, succeeded in the

regions of China where shale gas reserves are found, as per the abovementioned provisions, it was determined that the cost factor overshaded this success. In fact, Tian (2014, p.7) stated that the losses of these two companies were around 1 billion dollars. By mentioning the success of United States in this field, the things that have to be done by China are determined;

- One of the greatest advantage is the competition environment
- Right of private property
- Supports and encouragements made by the government and local management,
- Presentation of taxation advantages by the government and incentive activities
- Accessible data base
- A wide pipeline, it means a substructure
- Entrepreneur structure of American people

Provincial directorates in China are very interested in this subject. And it is necessary to underline that they play an important role in shale gas development. They oriented at benefiting from the shale gas structure within their borders, thus increasing their local incomes and producing the natural gas which will be sufficient for their local consumption. There are 3 important public companies in China and these ones invested 8 billion dollars for shale gas extraction in United States. In the background of these investments, it is targeted to increase the financial income and investment areas, and to see the applications of the United States in this field and to benefit from these applications on this subject as well. If China wants to achieve a sustainable success in this field, primary role belongs to central government. Government should provide the necessary regulations for the public institutions in the country and for the foreigner energy companies which has a crucial importance in this development. It should invest efficiently in the innovative activities which will contribute to this development, and should form an American model. In our technology world nowadays, each cent which is not invested in innovation and technology will increase the cost items.

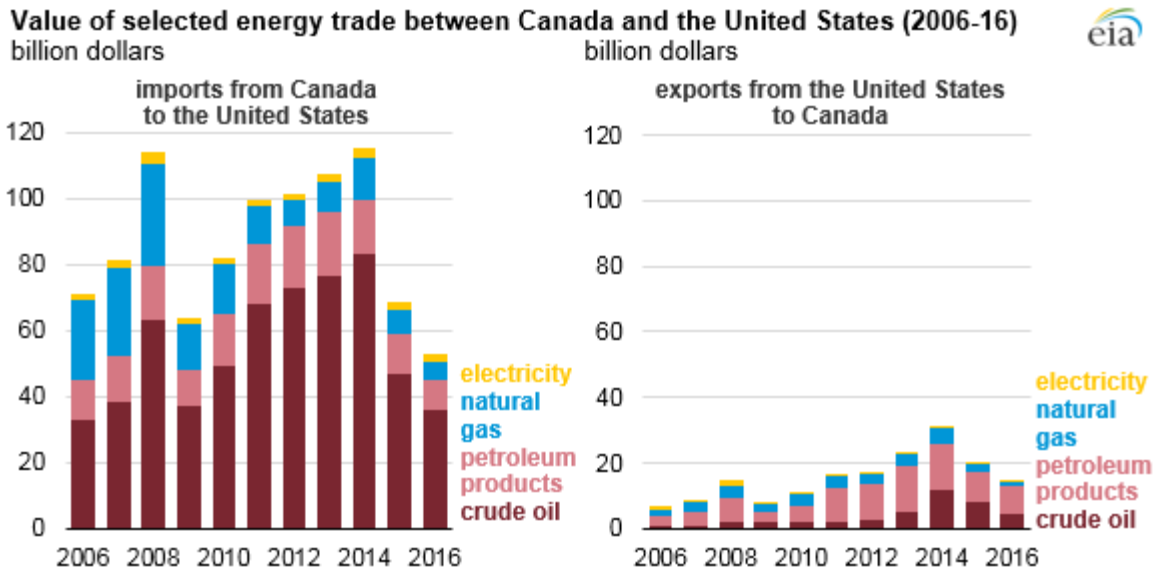
6.3 Shale Gas Development in Canada

Shale gas reserves in Canada are mostly found in faecal basins. Most of these basins are found in western part of the country. However, United States, which uses the unconventional sources most effectively, have become less and less dependent and when the conventional natural gas extraction become slower, the industry gives more importance to LNG trade. In this sense, Canada may contribute to its economy by using its own natural gas sources.

Investing to the regions in which the sources are found, should be considered as an important opportunity for both creating employment and long term investment.

Canada and United States are strategically important allies in terms of trade and the contribution of Canada to the importation of United States in 2016 was around 20%. The value of this 20% part is more than 50 billion dollars and the value of energy sources that were imported by Canada from the United States was around 14 billion dollars. A great part of American importation is formed by crude oil of Canada. With the decrease in oil prices in 2015, a profit decrease was detected in trade and the value of that decrease was around 11 billion dollars. (EIA, 2017) Shale gas and crude oil are sent to United States via pipelines. Actually the size of this trade may be more and more but Canada does not have the required substructure in order to process this crude oil, and this situation makes the situation difficult. As known, these kinds of substructures require expensive technologies. Apart from this, political authorities of Canada, which is out of required pipelines and ports that are necessary for transcontinental trade, have great missions.

Figure 31: Energy Trade between Canada and the US



Source: EIA, 2017

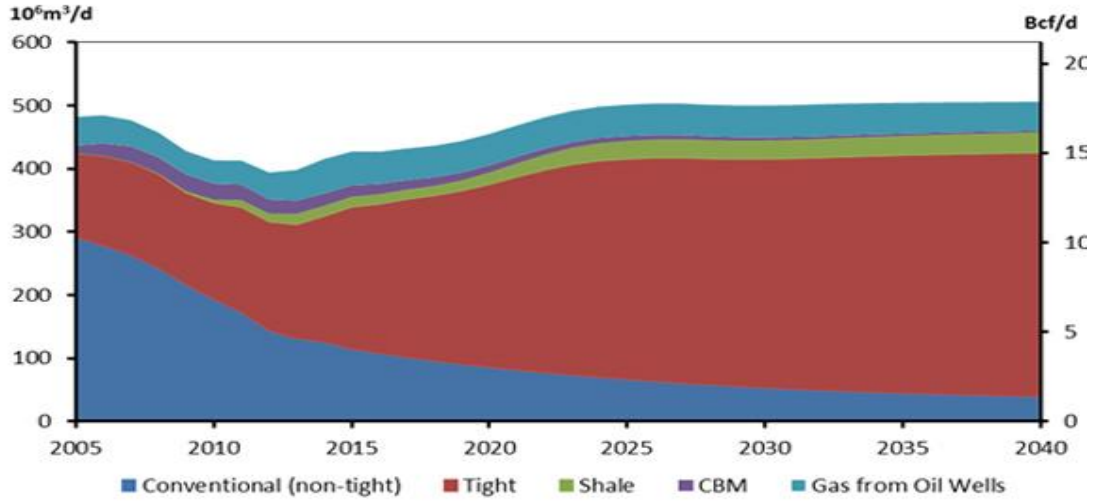
Natural gas trade among United States and Canada is also performed via pipelines. Canada, which exports 8 billion cubic feet daily, forms 97% of total natural gas importation of United States. (NRC, 2016) In effect, with the increase of production in United States, it will be

useful to remind that the dependence of United States to Canada decreased. In addition, Canada is the third biggest natural gas producer country in the world.

Around 90% of total natural gas production is produced with conventional methods and the remaining part is produced with unconventional methods which are mainly shale gas and tight gas. Canada reached to an important expected reserve of 573 trillion cubic feet of shale gas which has been produced since 2008. In these periods, while the contribution of shale gas for the total production was 5%, it is predicted that the share of shale gas will have reached to 30% of total natural gas production by 2040. (EIA, 2016)

Canada has focused on digging activities in recent years, and concentrates on tight and shale gas production which is not conventional. When the economic effects of conventionally extracted sources, we can understand why they give importance to tight and shale gas. On one hand with the developed technology, the decrease in the costs of producing these unconventional gases is another factor. As mentioned before, the importance of LNG increases day by day and LNG production in some of these wells will provide an important profit for Canada or its producers. Besides, for the sources which are found in deeper places, the same technologies cannot be used. The example in China is also valid here. The handicap that is created by the areal conditions is an important factor for the development of technology. Except for these lands, with the gas obtained from the wells that were opened, Canada seems to increase its production until now. Profitable shale gas and tight gas sources which were hard to reach previously reversed the fall tendency in natural gas production.

Figure 32: Gas Production Levels in Canada



Source: NRC, 2016

On the figure above, it is possible to figure out the fall of conventional natural gas which decreases as of 2005. And generally it is possible to understand that the fall tendency started from 2005, gained acceleration with the tight gas and shale gas which are produced unconventionally in 2014.

As a result, production activities in energy sector and turning these sources and transportation have a great importance for this sector. The fastest and most profitable method to do so is the investment made on the technology. The steps that United States took towards this direction, have become an obligatory situation in terms of following and application for each country. As it is necessary to consider not only economic situation but also the environmental issues, using the renewable energy and investment on this domain will provide advantages for the source-owner countries in terms of both a better environment and more economical value.

6.4 Shale Gas Development in South Africa

The economic benefits that shale gas will bring to the Southern Africa with the hydraulic fracturing will be for the benefit of the local people. Known with the surplus of the unemployment rate, this region, where the labor force can be achieved through search and extraction work, is of vital importance to the government and the local community. The uncertainty in this matter is that the local community is unqualified. I did mention in some parts of the study that the shale gas extraction is not a simple process. Therefore the uncertainty in the matter still continues.

The local community who meet a large majority of their energy needs from coal; even if the shale gas extraction is realized, the substitution of the shale gas for coal is not within the bounds of possibility. A large part of the energy needs is met through importation. In this sense, every shale gas it produces with every drilling will reduce its dependence to that extent. In a model created by Shell, they stated that it is predicted that if the investment is made in the region, it will provide close to $20 billion worth of added value and jobs for 700,000 people. (Reuters, 2016)

The main Karoo Basin of South Africa is considered to be the best area for the shale gas situated in the region. Search permits have been obtained by various organizations and a serious research is being conducted in the region. The volume of gas in the region is uncertain; however it is possible that the gas-technically possible to be extracted-can reach up to 500 trillion cubic feet with possible scenarios. Karoo shale gas was only considered as a

potential source in 2013, and it would remain undiscovered until enough gas for the commercial interest was generated by a hydraulically broken test well. The economic value of the Karoo shale is known only by measuring good flow rates in statistically significant quantities. In addition, before South Africa becomes a major producer of shale gas, a significant investment in infrastructure will be needed. (Petroleum Agency of South Africa, 2013)

However, in the news that The Guardian made in May 2016, it was also stated that the exploration of the shale gas will begin within the next 12 months and the years of speculation about the project will come to an end. It is believed that Karoo region, the semi-desert of South Africa has at least 485 trillion cubic feet of(tcf) shale gas; however the drilling has been delayed with environmental and economic concerns. In addition, the government stated that the coal-fired power plants could be the answer to the energy challenges of the country because they fight for the shale gas in order to satisfy the rising electricity demand. (The Guardian, 2016)

6.5 Shale Gas Development in Argentina

In this part, the overall energy need of the country, the supply and demand equilibrium of the energy sector and investors' plans will be explained. First of all, it would be correct to indicate that Argentina has a very high quality shale gas reserves. According to 2013 forecasts of the EIA, the country with the largest gas reserves is Argentina after China. The table below demonstrates the shale gas reserves of the countries.

Table 14: Top 10 countries with technically recoverable shale gas resources

Rank	**Country**	**(trillion cubic feet)**
1	China	1.115
2	Argentina	802
3	Algeria	707
4	U.S	665
5	Canada	573
6	Mexico	545
7	Australia	437
8	South Africa	390
9	Russia	285
10	Brazil	245
	World Total	**7.299**

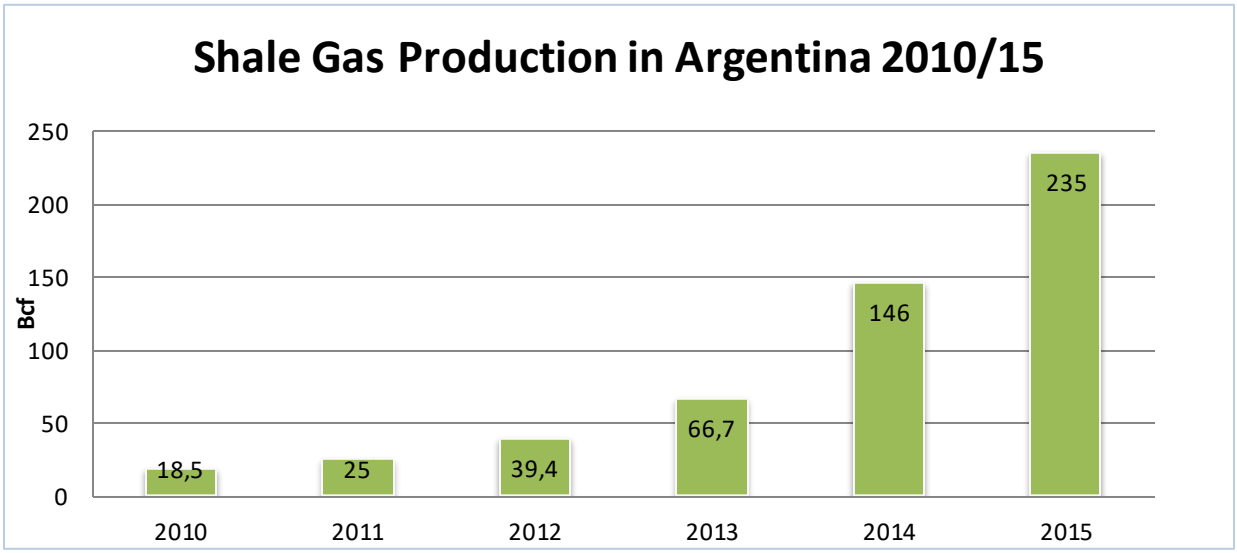
Source: EIA, 2013

50% of the country's energy needs are covered by natural gas and the amount of gas that is consumed exceeds the Brazil, it neighboring country. The fact that the country has the

necessary infrastructure will accelerate the steps taken for the development of shale gas. Apart from that, the 235 billion cubic feet unconventional gas produced in year 2015 is equivalent to 15% of the total gas production of the country. Even if shale gas production is carried out in unconventional ways, the tight gas has the big share. The reason for this is that the tight gas extraction activities have already begun. In 2015, the investments made for unconventional gas and oil extraction have reached up to 10 billion $. The vast majority of these investments are for the Neuquén region, which possess the majority of shale gas reserves.

According to the EIA, there are currently four countries that produce significant amounts of shale gas and oil. One of them is Argentina. (EIA, 2015) Argentina produces both shale gas and tight gas in substantial quantities. With the progress achieved by operators in Neuquén, the region, which is the largest shale gas reserve of the country, the trend of decline in conventional gas production has reversed. As for 2015, the shale gas and tight gas production has reached up to 235 billion cubic feet.

Figure 33: Unconventional Natural Gas Gross Production between 2010-2015



Source: Oxford Energy, 2016

As of the end of 2015, the number of unconventional gas and oil wells is 1101. 673 of them belong to shale gas wells and the rest belongs to tight gas wells. Just in 2015, 376 new wells have been drilled and 218 of these wells belongs to shale gas drilling. (Oxford, 2016, p.44)

The Vaca Muerta formation located in the Neuquén region is of great importance for many unconventional activities. Both the investments made to the region and the rocks it contains will also be sufficient to express you how important. Argentina national oil company YPF

monopolizes half of the activities performed in the region. Apart from the YPF which is an important character in the region, there are also international companies. Some of them are associated with the YPF and the others act independently. Loma Campana, another region in Neuquén, is also carrying out works on shale oil rather than shale gas. It is one of the most suitable sites for works because it is both situated in the oil region and near the largest gas production center of Argentina and also it possesses many water resources and infrastructures. It has gained popularity as the oil prices have fallen and the investors will reduce the costs.
Additionally, in the report that EIA published in August 2016, it is emphasized that the country has sufficient infrastructure but needs to be expanded with increased production.

By the end of 2016, nearly 600 wells were drilled in the region. About 200 wells were drilled only in 2015 and 173 of them belong to the Argentina oil company YPF. Hydraulic Fracturing was first started in 2010 and the development activities are still in progress. The operators, which have been operating in the region, are struggling to reduce the costs of drilling activities since the beginning. The works must have shown result that according to a report given by YPF; while in 2011, a well cost a total of 43 days and a total of 11 million dollars (including drilling and completion of the process); in 2014, the same transaction cost 7 million dollars and was completed in 25 days. In the report published by a company independent from YPF published, it is stated that the cost of the 7 horizontal wells was around 165 million dollars for the company. (Oxford, 2016, p.50)
As mentioned before, the drilling is a long and costly process. It could not be easy to extract an energy source from thousands of meters underground apart from the usual means. however the point here is always the investments in drilling. Due to the developments in drilling, it is now possible to achieve shale gas and shale oil which was a dream in due course of time. The more important thing is not to stop investments and to give importance to the technological developments. The problems that America has experienced with this expense matter bothered the operators in due course of time however they have made significant progress over time by lowering the cost of drilling. The table below demonstrates the cost of drilling the wells in America and the cost that they retrench within one year.

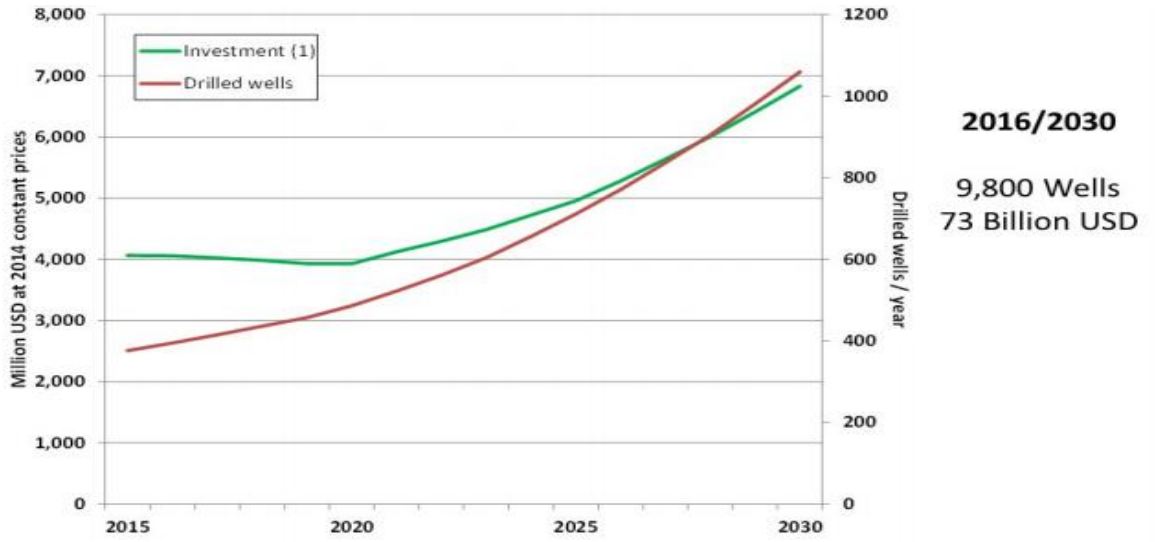
Table 15: Evolution of Drilling Costs in the USA Basins

Formation	Well Cost(USD Million) 2014	2015
Bakken	7.1	5.9
Eagle Ford	7.6	6.5
Marcellus	6.6	6.1
Midland Basin	7.7	7.2
Delaware Basin	6.6	5.2
Total Cost	**$35.6**	**$30.9**

Source: EIA,2016

In a report published by the Argentina Ministry of Energy on related investments made, a total of $ 9.3 billion has been spent in total for the extraction and production of shale gas and shale oil between 2012 and 15, and about 2 billion of this amount have been spent solely on discovery activities. As it is mentioned above, Neuquén, with the most important resources, had 90% of this $ 9.3 billion investment for itself.

Figure 34: Argentina Shale Well Drilling Assumptions 2016-2030



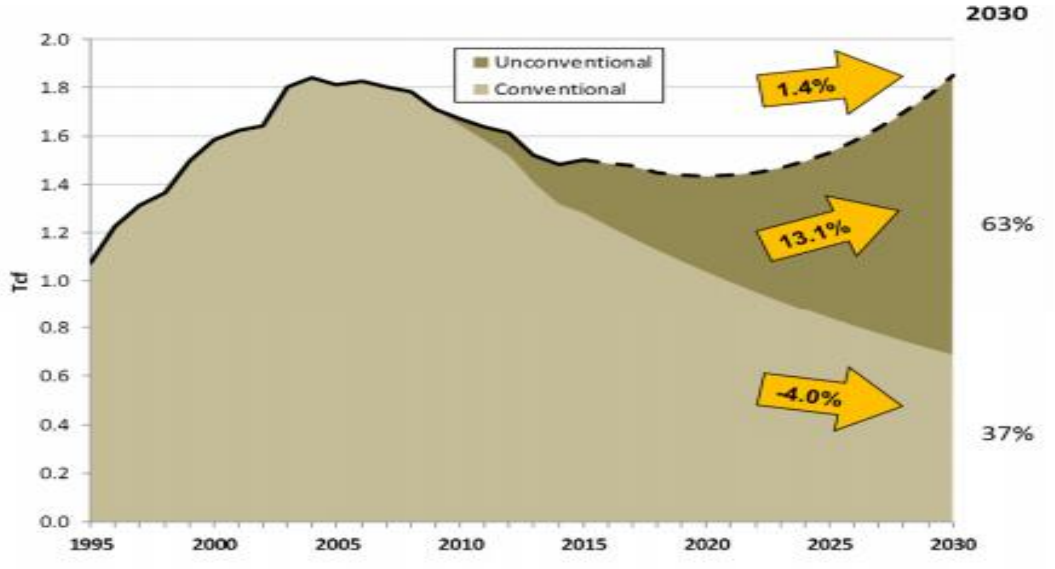
Source: Oxford, 2016, p.57

As can be understood from the diagram above, if Argentina uses the resources, which it possesses, in the coming years, it can both reduce the energy prices within the country by acquiring cheap energy in order to bring an alternative energy resource to the country and it

will affect the sector for a while longer directly or indirectly as the labor force, construction and service sectors which will be needed during this much drilling works. Thanks to its contribution in employment, people will increase their incomes and maybe the poverty levels will be revised downwards.

In addition, Gomes & Brandt predicts that in the coming years, the unconventional natural gas production will be drag down and instead, the importance attached to the unconventional means will increase. (Gomes & Brandt, 2016, p.57)

Figure 35: Argentina: Natural Gas Production Forecast until 2030



Source: Gomes, 2016, p.58

6.6 Shale Gas Development in Australia

First of all due to the shortage of sources that have dealt with the economic impact of shale gas in Australia in this part the areas with significant sources have been studied. The studies on these sources have stated the current situation and investment projects. The sources draw attention to the fact that the shale gas development in Australia is in its infancy. (Norton Rose, 2015) In recent year; also an increase in foreign investments due to the increased interest in the shale gas has been observed. Initially, as in the America, the small and independent formations proceeded more exploration and more production. But over time, the foreign investments have acquired an important dimension, along with the joint initiatives that large

players have carried out through such small organizations. Apart from this, the major energy companies of the country (DrillSearch Energy, Senex, Santos and Beach Energy) have started their exploration and production activities in various regions.) Australia is one of the potential countries that can produce shale gas after the USA and Canada due to its geological structure.

The regions which possess potentially rich shale gas resources are briefly mentioned below.

Cooper Basin: Cooper Basin, which is one of the several important regions situated in Australia, is the production centre for the petroleum and gas of the country. The fact that there are rich shale gas resources also in this region is confirmed by the EIA. Apart from this, due to the presence of the petroleum and gas industry, the technical infrastructure required for the production of shale gas is already available (EIA, 2013, p. 8). Until 2012, the production of conventional gas was reduced and the shale gas production was accelerated from 2014 on. In this way, an increase of 14% in the total production was provided. Providing that both the local and the foreign energy companies fulfil their commitments, this basin can be the centre of Australian shale gas production. This region, where Chevron and Australian Beach Energy have been working together, has high quantity (200 tcf) of shale gas reserves. (Oxford, 2014, page 70).

Maryborough Basin: Maryborough basin, which is another potential region for the shale gas production, is the smallest region for exploration in size and it is estimated that there are technically 19 trillion cubic feet of shale gas reserves.

Perth Basin: The Perth basin that produces active oil in the west of the country has rich shale gas formations in addition to the conventional oil. Its distinctive feature from other basins is that it has a simple structure that is ideal for the shale gas production. (EIA, 2013 Australia) In addition, it has a shale gas reserve of 26.1 trillion cubic feet. (Oxford, 2014, p.69)

Canning Basin: Located on the north-western side of the country, this basin posseses rich and organic shale gas reserves like the other regions, although it is not subject to important researches at the moment. At 7200 ft depth, there is primarily shale petrol, after this level fluid gas and dry gas at the lowest levels. The region generally has more than 60 wells that produce conventional oil. Technically it is estimated that it has a rich shale gas reserve of 235 trillion cubic feet, besides there are approximately 10 million barrels of shale oil. At the beginning of the title I mentioned about the foreign investments. The National Stock Exchange of India and the ConocoPhilipsle, the independent and multinational energy company of America have signed a joint agreement to be performed in this region.

ConocoPhilips declared that as a part of the agreement, they will invest 120 million dollars for the research and exploration for a four-year period from the year 2012 onwards.

Beetaloo Basin: There are evidences that both conventional and unconventional hydrocarbons are present in this region. The biggest handicap of this basin is the limited access and undeveloped infrastructure. Very few researches regarding the shale gas and oil have been performed and even if the resources in the required amount that are suitable to be extracted are found; the infrastructure in the region requires a serious investment. Due to a small number of demands of the region, there is a self-sufficient energy cycle. The pipelines need to be built to transport the gas produced by a new discovery. (Norton Rose, 2015)

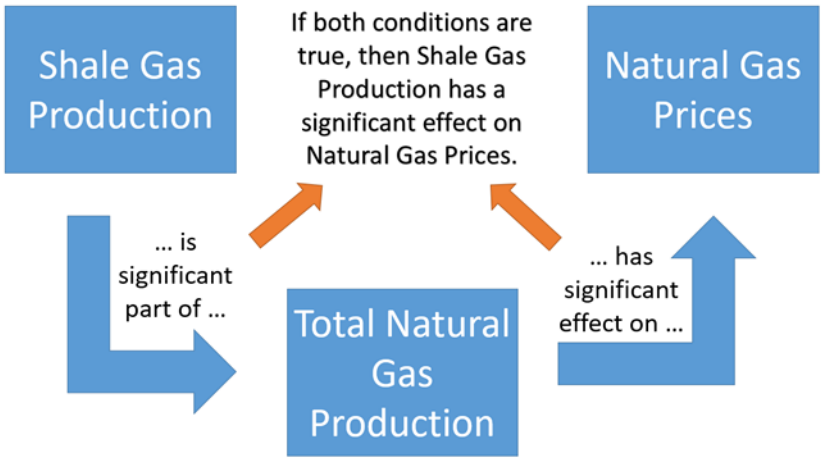
When it is examined from this point, it is obvious that the shale gas development will contribute to the economy of Australia in every way. According to Australian Petroleum Production & Exploration Association Limited (APPEA), one of three of the investments in the country belongs to petrol and gas industry. Otherwise, the labour force which is necessary for concentration and production in the aforementioned basis has a direct impact on the employment. The other advantages of shale gas development are the contribution to the regional development and economic contribution by the sales of extracted natural gas. (Tax incomes can be included in this group)

It is stated in the report made by Deliotte for Australia that the natural gas which is extracted by conventional and unconventional methods, employs over 100000 workers. Oil and Gas Industry constitute 2% of GDP and establish an exact added value of 28 billion dollars (2010-11). It is expected that this number will be 65 billion dollars by 2020. (Deliotte, 2012)

7. Empirical Study of a Statistical Relationship between Shale Gas Production and Natural Gas Prices in the US

As natural gas prices have a crucial role as a primary fuel in the residential and commercial heating market, and also serves as an important input for industrial application and electricity generation, it is of significant economic interest for various stakeholders. This section reviews the statistical connection between shale gas production and gas prices. The research subject is if the increasing shale gas production has a significant effect on the U.S. gas prices. However shale gas and non-shale gas are absolute substitutes, therefore it has to be considered if the overall natural gas production has a significant effect on natural gas prices, and if shale gas production is a significant part of total natural gas production. Figure 36 shows this relation.

Figure 36: Conditions for a significant Statistical Relationship between Shale Gas Production and Natural Gas Prices



Source: Own Illustration

Using logic operators, we can establish three statements, and in section *7.4 Quantitative Analysis, Results and Interpretation* their truth value will be examined with statistical methods:

- Statement A: US Shale Gas Production is a significant part of Total US Natural Gas Production
- Statement B: Total US Natural Gas Production has a significant effect on US Natural Gas Prices
- Statement C: USD Shale Gas Production has a significant effect on US Natural Gas Prices

If Statement A and B are true, then Statement C also is true. Using predicate logic, this relationship can be shown as

$$A \wedge B \rightarrow C.$$

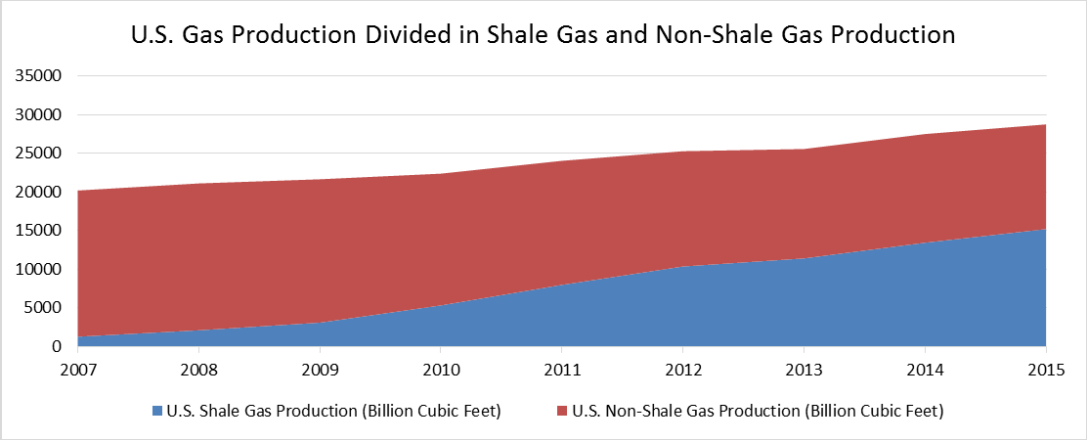
Table 16: U.S. Natural Gas Production Divided in Shale Gas and Non-Shale Gas Production in Period 2007 - 2015

Year	U.S. Shale Gas Production (Billion Cubic Feet)	U.S. Non-Shale Gas Production (Billion Cubic Feet)	Share of U.S. Shale Gas to U.S. total Gas Production	U.S. Shale Gas Production growth rates	U.S. Non-Shale Gas Production growth rates	U.S. total Gas Production growth rates
2007	1293	18903	6%			
2008	2116	18996	10%	64%	0%	5%
2009	3110	18538	14%	47%	-2%	3%
2010	5336	17046	24%	72%	-8%	3%
2011	7994	16042	33%	50%	-6%	7%
2012	10371	14912	41%	30%	-7%	5%
2013	11415	14147	45%	10%	-5%	1%
2014	13447	14051	49%	18%	-1%	8%
2015	15213	13540	53%	13%	-4%	5%

Source: www.eia.gov, 2017

By examining Table 16, it can be seen that the share of U.S. Shale gas Production has grown significantly over the period 2007 – 2015. In the end of 2015 over half of the Total U.S. Natural Gas Production stemmed from Shale Gas Production.

Figure 37: U.S. Natural Gas Production Divided in Shale Gas and Non-Shale Gas Production in Period 2007 - 2015



Source: www.eia.gov, 2017

Thus it can be said that US shale gas production is a significant part of total US natural gas production, as over 50% of the gas produced in US stems from shale gas production as of 2015. The trend of increasing share of shale gas production in total US natural gas production seems to be robust and continue further, and thus higher shares of US shale gas production in

total US natural gas production can be expected. Therefore it can be said that Statement A - US Shale Gas Production is a significant part of Total US Natural Gas Production – is true.

7.1 Theoretical Background of the drivers for Natural Gas Prices and Considerations

According to www.eia.gov natural gas prices are mainly determined by market supply and demand. To dissect the issue further, it is of interest to know what determinants of natural gas market supply and demand are. While the main determinants of natural gas market supply are natural gas production, net imports, and underground storage levels; the main determinants of natural gas market demand are weather (temperatures), economic conditions, and petroleum prices. (EIA, 2016)

By assuming relatively stable demand side over time, it can be expected that the market supply has an effect on the gas price, using the demand and supply dichotomy. In this empirical study it is further assumed that US natural gas production has a large enough effect to represent the supply side.

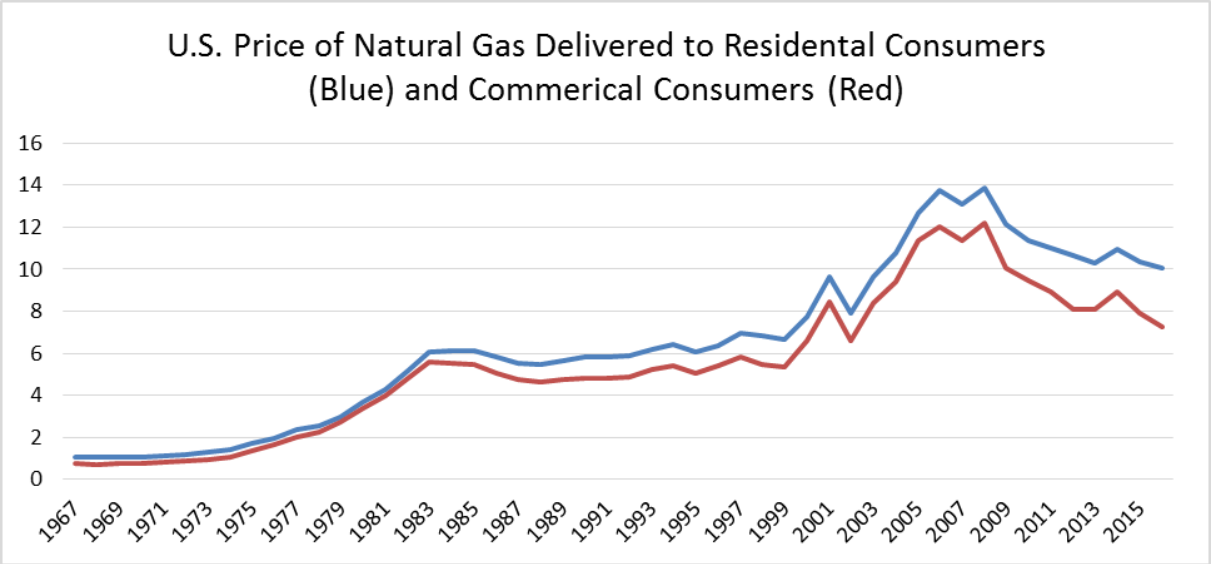
7.2 Obtained Data for the Quantitative Analysis

For the empirical study following yearly data had to be obtained:

1) US Natural Gas Production (Years 1967 – 2016)
2) US Shale Gas Production (Years 2007 – 2015)
3) US Natural Gas Prices (Years 1967 – 2016)
    - US Natural Gas Residential Prices
    - US Natural Gas Commercial Prices
4) Inflation Rates (Years 1967 – 2016)

1 to 3 was obtained from US Energy Information Administration (www.eia.gov). 4 was obtained from US Inflation Calculator (http://www.usinflationcalculator.com). Both US Natural Gas Residential Prices and Commercial Prices were collected to detect if there are structural differences in the prices. However this seems not to be the case, as a strong co-movement can be observed, as can be seen in Figure 38.

Figure 38: U.S. Residential and Commercial Price of Natural Gas



Source: www.eia.gov, 2017

7.3 Methodology and Statistical Methods used for the Analysis

The natural gas prices will be adjusted for inflation to eliminate the effect of inflation on the prices. The base year of CPI is set as 1967 with a CPI value of 100, and for subsequent years the CPI is calculated with

$$CPI_{year} = CPI_{year-1}\left(1 + inflation_{year}\right).$$

Both the residential and commercial gas prices will be adjusted for Inflation with the formula

$$Inflation\ Adjusted\ Gas\ Price_{year} = \frac{Gas\ Price_{year}}{\frac{CPI_{year}}{100}}.$$

To avoid spurious regression, residential and commercial inflation adjusted gas prices and natural gas production are transformed into stationary time series by calculating the growth rates with the formula

$$stationary\ time\ series_{year} = \frac{non-stationary\ time\ series_{year}}{non-stationary\ time\ series_{year-1}} - 1,$$

whereby the growth rates represent the stationary time series. Using this data transformation table 17 can be obtained.

Table 17: Data used for the empirical analysis for the Period 1968 - 2016

Year	U.S. Price of Natural Gas Delivered to Residential Consumers (Dollars per Thousand Cubic Feet)	U.S. Price of Natural Gas Sold to Commercial Consumers (Dollars per Thousand Cubic Feet)	Inflation	U.S. Inflation Rates	U.S. CPI with Base Year 1967	U.S. Inflation Adjusted Price of Natural Gas Delivered to Residential Consumers (Dollars per Thousand Cubic Feet)	U.S. Inflation Adjusted Price of Natural Gas Sold to Commercial Consumers (Dollars per Thousand Cubic Feet)	Growth Rates of U.S. Inflation Adjusted Price of Natural Gas Delivered to Residential Consumers (Dollars per Thousand Cubic Feet)	Growth Rates of U.S. Inflation Adjusted Price of Natural Gas Sold to Commercial Consumers (Dollars per Thousand Cubic Feet)
1967	1.04	0.74	3	3.00%	100.00	1.04	0.74		
1968	1.04	0.73	4.7	4.70%	104.70	0.99	0.70	-4.49%	-5.78%
1969	1.05	0.74	6.2	6.20%	111.19	0.94	0.67	-4.93%	-4.55%
1970	1.09	0.77	5.6	5.60%	117.42	0.93	0.66	-1.70%	-1.46%
1971	1.15	0.82	3.3	3.30%	121.29	0.95	0.68	2.13%	3.09%
1972	1.21	0.88	3.4	3.40%	125.42	0.96	0.70	1.76%	3.79%
1973	1.29	0.94	8.7	8.70%	136.33	0.95	0.69	-1.92%	-1.73%
1974	1.43	1.07	12.3	12.30%	153.10	0.93	0.70	-1.29%	1.36%
1975	1.71	1.35	6.9	6.90%	163.66	1.04	0.82	11.86%	18.02%
1976	1.98	1.64	4.9	4.90%	171.68	1.15	0.96	10.38%	15.81%
1977	2.35	2.04	6.7	6.70%	183.18	1.28	1.11	11.23%	16.58%
1978	2.56	2.23	9	9.00%	199.67	1.28	1.12	-0.06%	0.29%
1979	2.98	2.73	13.3	13.30%	226.22	1.32	1.21	2.74%	8.05%
1980	3.68	3.39	12.5	12.50%	254.50	1.45	1.33	9.77%	10.38%
1981	4.29	4	8.9	8.90%	277.15	1.55	1.44	7.05%	8.35%
1982	5.17	4.82	3.8	3.80%	287.68	1.80	1.68	16.10%	16.09%
1983	6.06	5.59	3.8	3.80%	298.62	2.03	1.87	12.92%	11.73%
1984	6.12	5.55	3.9	3.90%	310.26	1.97	1.79	-2.80%	-4.44%
1985	6.12	5.5	3.8	3.80%	322.05	1.90	1.71	-3.66%	-4.53%
1986	5.83	5.08	1.1	1.10%	325.60	1.79	1.56	-5.78%	-8.64%
1987	5.54	4.77	4.4	4.40%	339.92	1.63	1.40	-8.98%	-10.06%
1988	5.47	4.63	4.4	4.40%	354.88	1.54	1.30	-5.42%	-7.03%
1989	5.64	4.74	4.6	4.60%	371.20	1.52	1.28	-1.43%	-2.13%
1990	5.8	4.83	6.1	6.10%	393.85	1.47	1.23	-3.08%	-3.96%
1991	5.82	4.81	3.1	3.10%	406.06	1.43	1.18	-2.67%	-3.41%
1992	5.89	4.88	2.9	2.90%	417.83	1.41	1.17	-1.65%	-1.40%
1993	6.16	5.22	2.7	2.70%	429.11	1.44	1.22	1.83%	4.16%
1994	6.41	5.44	2.7	2.70%	440.70	1.45	1.23	1.32%	1.47%
1995	6.06	5.05	2.5	2.50%	451.72	1.34	1.12	-7.77%	-9.43%
1996	6.34	5.4	3.3	3.30%	466.62	1.36	1.16	1.28%	3.51%
1997	6.94	5.8	1.7	1.70%	474.56	1.46	1.22	7.63%	5.61%
1998	6.82	5.48	1.6	1.60%	482.15	1.41	1.14	-3.28%	-7.01%
1999	6.69	5.33	2.7	2.70%	495.17	1.35	1.08	-4.49%	-5.29%
2000	7.76	6.59	3.4	3.40%	512.00	1.52	1.29	12.18%	19.57%
2001	9.63	8.43	1.6	1.60%	520.19	1.85	1.62	22.14%	25.91%
2002	7.89	6.63	2.4	2.40%	532.68	1.48	1.24	-19.99%	-23.20%
2003	9.63	8.4	1.9	1.90%	542.80	1.77	1.55	19.78%	24.33%
2004	10.75	9.43	3.3	3.30%	560.71	1.92	1.68	8.06%	8.68%
2005	12.7	11.34	3.4	3.40%	579.78	2.19	1.96	14.25%	16.30%
2006	13.73	12	2.5	2.50%	594.27	2.31	2.02	5.47%	3.24%
2007	13.08	11.34	4.1	4.10%	618.64	2.11	1.83	-8.49%	-9.22%
2008	13.89	12.23	0.1	0.10%	619.25	2.24	1.97	6.09%	7.74%
2009	12.14	10.06	2.7	2.70%	635.97	1.91	1.58	-14.90%	-19.91%
2010	11.39	9.47	1.5	1.50%	645.51	1.76	1.47	-7.56%	-7.26%
2011	11.03	8.91	3	3.00%	664.88	1.66	1.34	-5.98%	-8.65%
2012	10.65	8.1	1.7	1.70%	676.18	1.58	1.20	-5.06%	-10.61%
2013	10.32	8.08	1.5	1.50%	686.32	1.50	1.18	-4.53%	-1.72%
2014	10.97	8.9	0.8	0.80%	691.81	1.59	1.29	5.45%	9.27%
2015	10.38	7.91	0.7	0.70%	696.66	1.49	1.14	-6.04%	-11.74%
2016	10.06	7.25		2.10%	711.29	1.41	1.02	-5.08%	-10.23%

7.4 Quantitative Analysis, Results and Interpretation

The inflation adjusted natural gas market price growth rate is defined as the dependent variable and the natural gas production growth rate as the independent variable. It is considered that the market needs time to adjust for the new production levels. Therefore different lags have been used, while the market price is being the lagged variable, however only for one year lag there can be found statistical connection below the 1% significance level for both residential and commercial inflation adjusted market price growth rates. By using the Excel linear regression Data Analysis tool on, the regression results can be seen in table 18.

Table 18: Linear Regression Statistics between inflation adjusted residential natural gas market price growth rates and natural gas production growth rates

Regression Statistics	
Multiple R	0.41228811
R Square	0.169981485
Adjusted R Square	0.151937605
Standard Error	0.035682108
Observations	48

ANOVA

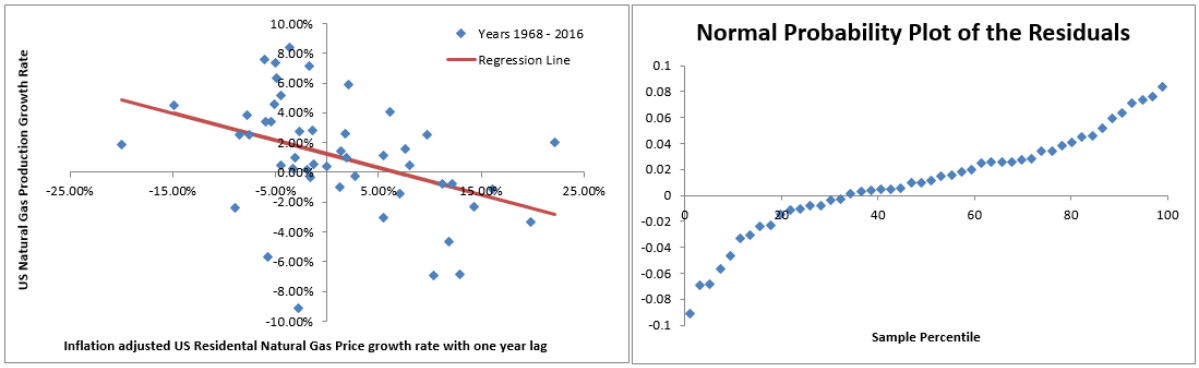
	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.011994239	0.0119942	9.420451	0.003592818
Residual	46	0.058567792	0.0012732		
Total	47	0.07056203			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.012365423	0.005192261	2.3815103	0.021436	0.001913944	0.022816902	0.001913944	0.022816902
US Natural Gas Production Growth Rate	-0.18336771	0.059743001	-3.069275	0.003593	-0.303624136	-0.06311129	-0.303624136	-0.06311129

Source: www.eia.gov & www.usinflationcalculator.com, 2017

The normal probability plot in Figure 39 suggests that residuals are approximatively normally distributed with slight fat tails.

Figure 39: Regression Line and Normal Probability Plot of Data used for Table 18



Source www.eia.gov & www.usinflationcalculator.com, 2017

Table 19 and Figure 40 show similar results for linear regression statistics between inflation adjusted commercial natural gas market price growth rates and natural gas production growth rates:

Table 19: Linear Regression Statistics between inflation adjusted commercial natural gas market price growth rates and natural gas production growth rates

Regression Statistics	
Multiple R	0.422186906
R Square	0.178241783
Adjusted R Square	0.160377474
Standard Error	0.035504111
Observations	48

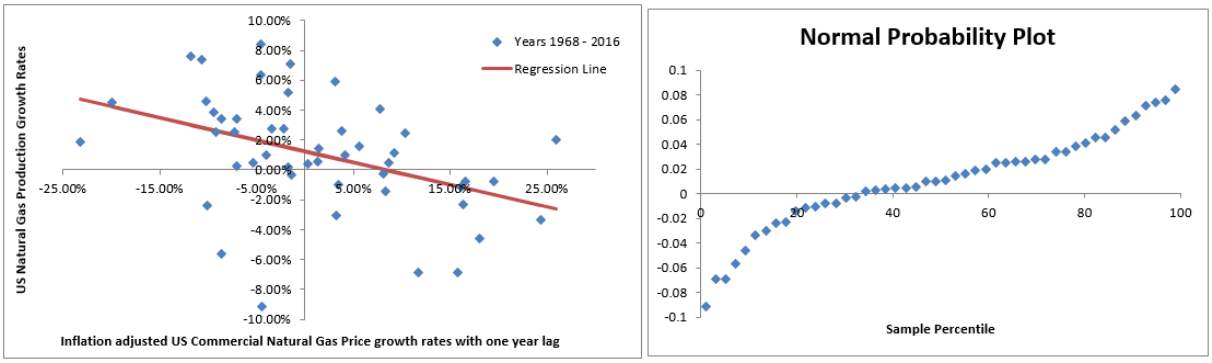
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.012577102	0.0125771	9.977536	0.002798791
Residual	46	0.057984928	0.0012605		
Total	47	0.07056203			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.012390003	0.005165402	2.3986524	0.020567	0.001992589	0.022787417	0.001992589	0.022787417
US Natural Gas Production Growth Rate	-0.14949886	0.047328881	-3.158724	0.002799	-0.244766956	-0.054230765	-0.244766956	-0.054230765

Source: www.eia.gov & www.usinflationcalculator.com, 2017

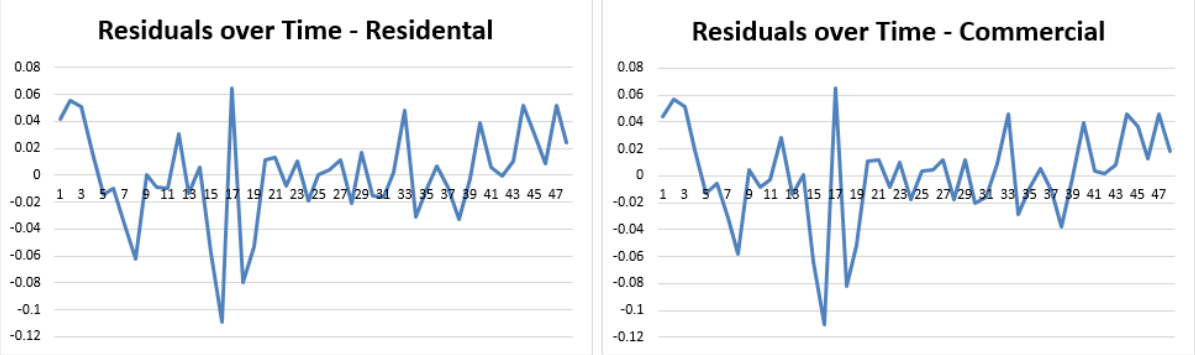
Figure 40: Regression Line and Normal Probability Plot of Data used for Table 19



Source www.eia.gov & www.usinflationcalculator.com, 2017

By observing the development of the residuals over time in figure 41, it can be concluded that the residuals are not dependent of each other over time. This together with the normal probability plot is a strong indicator for the robustness of the statistical test.

Figure 41: Residuals over time of the regression lines in Figure 39 and 40



Source www.eia.gov & www.usinflationcalculator.com, 2017

It can be observed that the residuals are very similar in both regressions. This can be explained trough the co-movement of the both prices, which could be observed already in figure 38.

Finally it can be concluded that there is a strong statistically significant evidence, that US natural gas production has a significant effect on US natural gas prices. The regression lines show a negative beta, which shows a tendency for falling prices when the supply increases, which is also consistent with the classical economics theory of demand and supply dichotomy. Given all the evidence, it can finally be concluded that US shale gas production has a significant effect on US natural gas prices, which subsequently answers the additional research question 2 of this thesis.

8. Summary & Conclusion

Summary

There is abundance of production of evolutionary shale gases, which are among the unconventional types of natural gas discovered in the United States of America. The precautions used to be taken in order to eliminate the emission of methane gas originating from coal deposits due to the fact that it causes fires after the accidents of firedamp explosion within coal mines. Later on, the emission of the methane gas, which has a powerful greenhouse effect was eliminated in the face of global warming and global climate change mechanisms' problems. For the past 10 years, it has been aimed to use methane gas emissions, which are considered as unconventional natural gas types, through capturing and storing methane gas emissions. In the meantime, due to the abundance of shale gasses production, for more than half a century, in addition to the coal-based power plants that provide power generation in America, the works have been initiated in order to build natural gas-based power plants. This situation is considered to be an important step in terms of reducing greenhouse gas emissions in America, particularly in terms of the perspective of limiting the country's carbon emissions and carbon dioxide emissions. American natural gas abundance and gas richness have become also the scene of some significant changes in the country. For example, emissions of greenhouse gases in the United States have broken the record of falling to the lowest level by decreasing 450 million tonnes in the last 10 years. For the first time in the world, a decrease in this level regarding the global greenhouse gas emissions has been experienced. While the United States is a great natural gas importer and the $ 100 billion expenditure for the LNG (Liquefied Natural Gas) terminal investments was at the planning stage, the country suddenly ended up with plenty of natural gas. The extraction and production of shale gas was seemed both economically and technologically impossible in economic terms although the existence of American shale gas was recognized by the geologists. Currently, American gas supply and procurement is being provided for the extraction and production of the new generation shale gasses by one-third. It is foreseen that the half of the American total natural gas supply and procurement, which is expected to rise to the level of 800 billion cubic meters per year by the year 2035, will be provided through the next generation national shale gas production. In addition, many factors contribute to the growth of evolutionary shale gas production of the USA. The experienced human resources, US capital which has high potential for advanced and innovative technological equipment along with the national oil industry taking action are considered among these factors.

However the vigorous efforts regarding the development of the hydraulic fracturing technology for the rocks and the hydraulic cracking method for the shale rocks of George Mitchell, who is at the head of an oil company, are demonstrated as one of the most important factors in the rise of American shale gas. After production, American natural gas prices have fallen to historic levels. Every actor which needs energy due to the low prices (it can include from the smallest family to the biggest firm) has benefited from it.

The abundance of American cheap gas and national shale gases has also brought vitality to the other industrial sectors. The American industrial sector uses one third of the natural gas extracted and produced in the country. (MIT, 2011 p.4) The industrial sector that derives the greatest profit from the natural gas is the American petrochemical industry. The USA petrochemical industrial sector used intensively natural gas for the production of methanol and ammonia, which are the main raw material of fertilizer production. Due to the fact that the oil prices are in rise, the petrochemical industry prefers the production of ethane extracted from the national cheap gas instead of naphtha produced from petroleum and petroleum products as raw materials. Thus, even though the global crude oil prices are increasing at an exponential rate, the USA petrochemical industry can provide the basic raw material needs at low prices from the domestic market. The chemical raw materials in question have also gained great benefits within the other industrial branches such as the automobile sector, the agricultural sector, the domestic appliance sector and the construction sector and increases extremely the competitive power of the export products of the country in the foreign markets. For example, in the Middle East countries, considered to be the world's lowest-cost producers, the American firms have reached the position of competing against the companies of the state petrochemical industry sector in the foreign markets thanks to the industrial raw materials produced through national cheap gas prices.

According to MIT, 40% of the total energy consumption in the United States, which is the approximate half of electricity or gas demand of the country, is in houses and business buildings. Low natural gas prices also state that the heating costs of the schools and the government buildings, which are indicated and listed in detail in local tax bills, will be reduced. The most effective area of low gas prices is the fuel storage of the vehicles in the US traffic.

Within the framework of the work carried out so far, the value added in the regions where the gas is extracted will be at favourable levels and will increase over the years according to the estimates. Its contribution to employment has created new income channels for the different

branches such as the land owners taking lease cost, its effect on employment in the surrounding towns and villages; and apart from these, other different branches such as construction, accommodation, service sector.

North American countries are in the richness and abundance of a new generation of shale gas reserves. Thus, it is predicted that the United States of America has overcome the possibility of the vulnerability and spiral of the energy supply security that it may encounter particularly in the future. In the United States and Canada, the new generation shale gas exploration, extraction and production techniques have become increasingly widespread and continue to being widespread. Thanks to the evolutionary shale gas production, the United States and Canada are expected to reach to the level of the countries that are global oil and natural gas exporters in the near future. The fact that Canada and the United States are included in the status of global natural gas and oil supplier countries also indicates that the effects on the global natural gas prices indexed to global energy market and oil prices will improve positively.

American and Canadian global shale gas exports to the Asian and European countries, which have dense global natural gas demand, will be realized through Liquid Natural Gas. Argentina has come a long way in the production of shale gas in recent years. It has been able to increase its production to a level more than 10 times in 2010(see Figure 33). And of course, the energy infrastructure of the country has a big contribution in the production. Independent of this, reducing the costs of the wells is positive news for every country that has reserves of shale gas, not just for Argentina. Moreover, the fact that the production of the natural gas extracted through conventional means has been gradually reduced, and instead, the shale gas and tight gas extracted through the non-conventional ways have been accelerated in Argentine is among the agenda items in the energy sector. China has really gained a great ground to extract shale gas in the last 10 years. The reserves that China possesses give great advantages to it. Due to the difficult extraction process, the Chinese companies became partners with the companies, which extract shale gas in the first place in the United States. Later on, developing the relations and the investments began to come to China. China has also succeeded in lowering the cost of drilling wells in the same way. Despite the works that has been carried out, the production is low and this low production rate will cause continuity of the energy dependency of China for the next 10 years.

In the global energy market scale, the European countries also have an important place in importing fossil fuels. European Union demand for fossil fuels and the European hydrocarbon

fuel consumption are increasing day by day. In terms of classical natural gas usage, the European countries are in a position dependent on Russian Federation, the natural gas exporter country. For example, 40% of the importation of the European classical natural gas are supplied by the Gazprom Company of the Russian Federation, which is the world's largest natural gas supplier country, and Norwegian Statoil Company. In addition to the nuclear power reactors, the basic energy resources which have completed their economic and technological life spans; the coal power plants and its units that cause problems due to global warming and global climate change problems in terms of human health perspectives and environmental pollution criteria will have to be closed in Europe within 10 to 20 years. Within the given time period, it seems also possible that European countries experience a dead end and dilemma of the energy supply security within the global energy projections. On the other hand, global innovative shale gas reserves have also been discovered in Europe. Although they have been experiencing serious energy supply safety dead end problems, in Europe the applications of hydraulic fracturing and hydraulic fracking techniques, which are the exploration, extraction and production techniques for the evolutionary shale gas, the unconventional natural gas type, face bureaucratic difficulties and problems. In addition to this the possibility of getting sidetracked of the extraction works for the next generation of shale gas and oil in Europe, which has a high population density, in comparison with the United States in terms of environmental safety and human health perspectives. Despite everything, European shale gas reserves and oil shale deposits have not yet been fully defined. It is still unclear whether shale gas resources and oil shale deposits in Europe are similar to America's richness. So far, only a small number of test shale gas drilling wells have been drilled in Europe. Since the claim of the Exxon Company, which is carrying out the works of drilling a shale gas borehole in Poland, could not achieve result, it is at point of halting its activities. In addition, the other companies that make shale gas research and drilling works continue their activities with great hopes. An up-to-date and detailed report about European shale gas reserves has been published by the Deutsche Bank, containing “which country is in abundance of cheap unconventional natural gas is speculative and at the same time the fact that many unknown and variables including new generation shale gas extraction technologies and modern shale gas production rate and efficiency have been taken into consideration”. Especially in the west of the Europe, different bureaucratic regulations are implemented regarding the innovative shale gas reservoir. Only England, a west European country, continue slowly its shale gas production efforts in the country despite the fact that it has lifted the moratorium on the new generation shale gas exploration and extraction technologies.

France vigorously opposes the application of shale gas exploration and production technologies. French nature-friendly organizations and environmental organizations are very strongly opposing the use of high-pressure water, sand and chemicals within the context of hydraulic fracturing of shale rocks.

Conclusion

Energy sources in recent years have a crucial importance. These are used in the process of industry and development of the technology, and have a great importance in the production of electricity which is the irreplaceable aspect of the daily life. Additionally, energy sources are in the limited reserves. With the existence of the primary energy sources such as fuel, natural gas and coal, in a specific reserve and with the rapid consumption of these ones which increases year by year, energy productivity issue comes to the forefront in the world and researches of new and renewable sources are accelerated. On the other hand, increase in world's population and industrialisation and urbanisation in the developing countries also increase the consumption of the energy sources.

However the world met a new energy source with the production of shale gas which will direct the energy policies in the near past. Its production is increased year by year, and changed the political balances. Thanks to the researches, shale gas, the existence of which is known but which is difficult to extract due to the economic and technical deficiencies, have changed the energy policies of several countries. With the development in the shale gas studies, energy-dependent countries provided their internal consumption needs especially with this method and they decreased the external dependence or ended it.

In this thesis, historical process of shale gas which started in USA, direct effects for the USA economy, are explained, and the projections concerning where the global markets take place in this revolution, are mentioned. Taking into consideration that the unit price which is paid for the natural gas by the countries which import natural gas globally, is 7-15 dollars and that USA decreased the natural gas cost to 2-5 dollars level, it will be clearer to understand why we used the word 'revolution' with the expression 'shale gas'.

In this thesis, it is also mentioned where shale gas can be found and in which countries and regions it can be found most as reserves. When we look into these indications, it can be seen

that the shale gas spread over a broader map when compared to the other fossil fuels. As a result, it is clear that the world will benefit from the shale gas economically.

When we consider the situation in terms of climate changes and environmental aspects, it is claimed that the shale gas production contaminates the underground waters and causes the earthquakes, and because of these reasons, it is forbidden in England and research activities are stopped until the definite results arrive in France. Pursuant to the researches, it is stated that the risks are low but serious and it is necessary to be cautious in the production process. In terms of environmental perspective, one of the chief economists of international energy agency Fatih Birol explained that a hope was expected in climate change meetings due to the fact that the United States decreased its shale gas emissions to the levels in 90's, that China invested serious amounts in renewable energy and that the Middle-East countries caught the developed countries in terms of energy consumption. Thus, if there is a hope in climate change meetings, it can be considered that the shale gas is a means for this hope.

In the thesis, it was found out that the shale gas revolution in USA caused serious economic effects. Another issue that should be evaluated except for the shale gas is the results which are caused by the shale oil in the USA. The effects which will arise from the recent political instability in the Middle-East, low levels of oil production in Libya, domestic disturbance in Syria, low levels of oil production in Iraq, which is less than the half of estimated values due to ISIS crisis, were firstly expected that the oil prices would increase seriously. However, the remarkable increase in shale oil demand of the USA stopped the possible increase in oil prices. Within this context, it may be predicted that the oil prices will be reduced in the future by the increase in the shale oil demands when the political instability in the Middle-East comes to an end, and the oil supply in this region reaches the previous levels. Thus, it is generally speculated that the increases in the shale gas and shale oil productions in the USA, affect the energy market of the world.

It is not a true approach to expect that the shale gas will affect the world's energy market and natural gas market within such a short time in this way. However, it *might be* correct to say that the effects of shale gas, which we have already seen as positive in United States, will continue, that the shale gas will cause a serious energy transformation in the United States and these results will affect the world's energy market indirectly. In case the United States continue to be a country which obtains the natural gas cheaply, this situation will cause that

the energy-based sectors will have a global competition priority. Thus, we may mention that the other countries will have problems in terms of competition due to this aforementioned advantage. If mass production is started in the countries in which serious amounts of reserves are found, such as China, the studies which found that the world's natural gas market would affect from this, will contribute to the literature in this field.

Finally it can be concluded that there is strong statistically significant evidence, that US natural gas production has a significant effect on US natural gas prices. The regression lines show a negative beta, which shows a tendency for falling prices when the supply increases, which is also consistent with the classical economics theory of demand and supply dichotomy. Given all the evidence, it can finally be concluded that US shale gas production has a significant effect on US natural gas prices, which subsequently answers the additional research question 2 of this thesis.

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Abstract

Energiepreise werden als die allgemeinen Parameter der Weltwirtschaft beschrieben. Die Schwankungen der Energiepreise verursachen Korruptionen in den ökonomischen Gleichgewichten der Nationen, die sich meistens auf externe Quellen verlassen. In unserer heutigen Zeit wird über die Zukunft der fossilbasierten Energiequellen diskutiert. Daraus resultiert sich ein Trend zu neuen und ökologisch weniger schädlichen, erneuerbaren Energiequellen. Hiermit tauchte ein neuer und aufregender Versuch im Energiemarkt auf. Aufgrund des steigenden Energiebedarfs, der effizient subtrahierenden und fortgeschrittenen Bohrmethoden des seit langer Zeit bekannten Schiefergas, sind in den Vordergrund gerückt. Neulich veränderte die unerwartet zunehmende Schiefergasproduktion als erste den USA und dann den Rest der Welt in Hinsicht der Energie. Diese Quellen tragen ökonomisch viel bei, und sie haben voraussichtlich in den kommenden Jahren mehrere Auswirkungen auf soziale und ökonomische Gebiete, obwohl sie von Millionen von Menschen protestiert wurden, da sie für die Qualität des Grundwassers und der Luft schädlich sind. Die Naturkatastrophen, vor allem die globale Erwärmung im 20. Jahrhundert ergriffen die Aufmerksamkeit der Menschen, wegen ihrer negativen Auswirkungen auf die Ökologie und der Menschlichkeit.

Dieser Arbeit hat sich das Ziel gesetzt allgemeine Informationen über (Extraktion von Methoden, Reserven etc.) des Klimawandels, der ökologischen und ökonomischen Auswirkungen der Schiefergasrevolution zu geben, die in den USA und anderen wichtigen Ländern auftraten. In letzter Zeit gab es eine stille Revolution im Energiemarkt. Diese Revolution ist in den USA aufgetreten, wird als "Schiefer-Gas-Revolution" bezeichnet und Schiefer-Gas-Energie wird als Spielwechsler im globalen Energiemarkt dargestellt. Als zweites wurde die Beziehung zwischen zunehmendem Schiefergas Produktion und Amerikanische Erdölgaspreise untersucht. Im Excel-Regression Test wurde aufgezeigt, dass die zunehmende Produktion die amerikanische Erdölgaspreise beeinflusst hat.