



**ASSESSMENT OF THE GROWING IMPORTANCE OF
SHALE GAS IN THE USA: AN ANALYSIS FROM ENERGY
SECURITY PERSPECTIVE**

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Thesis for the Master's Program in Sustainable Energy

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ETHICAL DECLARATION

I hereby declare that I am the sole author of this thesis and that I have conducted my work in accordance with academic rules and ethical behaviour at every stage from the planning of the thesis to its defence. I confirm that I have cited all ideas, information and findings that are not specific to my study, as required by the code of ethical behaviour, and that all statements not cited are my own.

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ABSTRACT

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Advisor: Prof. Dr. Muhittin Hakan DEMİR

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Energy is of immense value to the functioning of the world. However, its uneven distribution globally creates the necessity for states to provide its abundance and perseverance. This is how the concept of energy security emerged initially. Overtime it evolved as new obstacles came up and countries have to address a growing demand of emerging technology innovations, international energy dependance and the instability it creates during conflicts, and modern-day factors like climate-change and the urgent need for sustainable energy resources, cybersecurity and terror attacks. Shale gas granted the U.S. with the unique opportunity to become self-reliant and to be an energy exporter. The process of hydraulic fracturing is proven to have an immensely negative impact on the environment. This thesis research will aim to analyze both the benefits and downsides of shale gas industry from the United States energy security concept point of view. The research is based on a complex literature content analysis which combines quantitative and qualitative data, as the reader will examine in the upcoming chapters. According to the carried-out research there

numerous benefits and drawback to the hydraulic fracturing process for shale gas extraction. Shale gas has a vital role within the Unites States energy security policy. However, throughout the past few decades as a result of environmental impacts and political and social involvement, shale gas appears to have a transitional role for the future as the United States is trying to gradually adopt and adapt to the generation and use of sustainable energy.

Keywords: renewable energy, shale gas, hydraulic fracturing, energy security, USA, policy making



ÖZET

ABD'de Kaya Gazının Artan Öneminin Değerlendirilmesi: Enerji Güvenliği
Perspektifinden Bir Analiz

Alisiya Hristova CHERNOGOROVA

Sürdürülebilir Enerji Tezli Yüksek Lisans Programı

Tez Danışmanı: Prof. Dr. Muhittin Hakan DEMİR

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Enerji dünyanın işleyişi açısından çok büyük bir değere sahiptir. Devletin rolü, tüm tüketicilerin talebini karşılamak ve ekonominin dengeli işleyişini sağlamak için sürekli arzını uygun bir fiyatla yönetmektir. Enerji güvenliği kavramı ilk olarak böyle ortaya çıktı. Sürdürülebilir enerji kaynaklarına duyulan ihtiyaç, siber güvenlik ve terör saldırıları. Kaya gazı, ABD'ye kendi kendine yetmesi ve dahası enerji ihracatçısı olması ve enerji güvenliği politikasını güçlendirmesi için eşsiz bir fırsat verdi. Bununla birlikte, hidrolik kırma işleminin çevre üzerinde son derece olumsuz bir etkiye sahip olduğu kanıtlanmıştır. Bu tez araştırması, kaya gazı üretimi ve tüketiminin hem faydalarını hem de dezavantajlarını Amerika Birleşik Devletleri enerji güvenliği konsepti açısından analiz etmeyi amaçlayacaktır. Bu araştırmanın başarılı olabilmesi için, enerji güvenliğinin çeşitli açıları ve yıllar içindeki gelişimi incelenecek, ayrıca Amerika Birleşik Devletleri'nin enerji, enerji üretimi ve dağıtım konusundaki yıllar içindeki tutumu ve bu durumu etkileyen farklı faktörler incelenecektir. Bu araştırma, okuyucunun gelecek bölümlerde inceleyebileceği gibi, hem niceliksel hem de

niteliksel verileri birleřtiren karmařık bir literatür ierik analizine dayanmaktadır. Yapılan arařtırmalara gre kaya gazı ıkarımı ve tketimi iin hidrolik kırma iřleminin hem ok sayıda avantajı hem de dezavantajı bulunmaktadır. Ancak řimdilik kaya gazı ABD'nin enerji gvenliđi politikasında hayati bir role sahip. Katılımı kaınılmaz olarak ABD'nin iřleyiřine katkıda bulunmaktadır, ancak son birkaç on yıl boyunca hem evresel etkiler hem de siyasi ve sosyal katılım sonucunda kaya gazı, ABD'nin kademeli olarak benimsemeye alıřtıđı gelecek iin geiř niteliđinde bir role sahip gibi grnmektedir.

Anahtar Kelimeler: yenilenebilir enerji, kaya gazı, hidrolik kırılma, enerji gvenliđi, ABD, politika oluřturma





**I DEDICATE THIS THESIS TO MY FAMILY, THANK YOU FOR YOUR
ETERNAL SUPPORT**

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CHAPTER 1: INTRODUCTION

Energy is of immense value to the functioning of the world, it is the generator of the different activities that we perform, it allows us to power technologies, it gives us the opportunity to learn, to grow and to improve our lives every single day. It is of no surprise that since energy is the fundamental requirement for sustainment of life and its protection it is therefore of utmost importance. Energy is a crucial element to the operation and development of any state and its citizens. However, its uneven distribution globally creates the need for governments to aim towards its provision and perseverance, and what is more their role is to manage its supply at an affordable price for the end consumers and for the balanced operation of the economy and other industries. This is why overtime countries had to come up with ways to safeguard the provision of energy whether that would be internally or by relying on foreign imports and make sure that availability of access affordability of resources was to be secured at all times.

Energy security as a concept has always been of immense importance to every individual, state and globally. However, since the Industrial Revolution, the wide variety of resources and technology innovations that people came up with, the additional needs and consumption rates had to be met at a lot higher rates.

Academically, energy security has emerged as a concept by Kazutomo Irie in his article on the evolution of the concept which official origination he dates back to 1956, (Irie, 2017). He explains the notion of defining energy security initiated as a result of the Suez Crisis that took place in 1956 and immense effect it had on the global distribution of oil and therefore primary factor in the need of having to establish it as an official concept.

Within the USA, the first event that had a significant impact on their energy supply and distribution was the 1973 Oil Crisis and the applied embargo on behalf of the OPEC, (Douglas, 2019). Ranged by the help provided by the United States towards Israel during the 1973 Yom Kippur War, the OPEC member countries used the foundation principles of the energy security concept mentioned above in their favor as

a supplier to weaken the United States, (Andre, 2007). Ever since then, as this thesis will illustrate, the United States has done everything possible to strengthen their energy security towards a direction of independency and resource self-sufficiency.

While initially the concept of energy security was one based on reliability and affordability, overtime the meaning behind it has grown to evolve and encompass the additional challenges that the United States was faced with like cybersecurity, violent non-state actors and natural disasters, (Irie, 2017). The roots and the evolution, the notion of energy security has gone through will be thoroughly discussed, as well as the different measurements the U.S, has taken over the years to safeguard their energy supply and distribution.

Shale gas extraction and the innovative technological method of hydraulic fracturing is one the key contributors for the stability and strength on which the USA has built their energy policy to rely on. The industry has brought for immense economic, domestic and international benefits that the USA has and still gaining benefits from. Nevertheless, there is a notion of controversy behind the fracking shale gas extracting process as opposed to the multiple positives it has brought to the U.S., it also has a wide variety of negative impacts on the environment which both in the short and long term have and will be related to causing detrimental health issues and significant contamination to the areas where hydraulic fracturing is performed, (Ellman, 2015).

The purpose of this thesis is to try and provide the reader with an in-depth illustration of the historical development behind the meaning of energy concept for the United States and the development of shale gas as a natural gas resource for energy generation that allowed for the United States to not have rely on foreign sources of imports and be fully independent, while at the same time, also provide them with the opportunity to become energy exporters. The aim behind this thesis is to try and establish what the future role of shale gas would be in the U.S. and whether its importance and participation as part of their energy portfolio will maintain its growth and value or would the natural gas rather be used as a transitional fuel over the next few years until the state become reliant on the generational and consumption of clean renewable energy. It is important to study this relationship, as shale gas, as it will be elaborated within this thesis, poses extreme danger to the environment while its being collected

and distributed through the use of hydraulic extraction – a highly controversial practice which involves the spread of toxic chemicals and contaminants within the soil, air and water of the surrounding area of each fracking location. While shale gas today is looked upon with high regards, this thesis will try to evaluate whether that would be the same for the future or if the United State would aim to comply with global efforts for climate mitigation and be more inclined towards the use of shale or would it maintain its practices since the pass few decades of reliance on shale gas for meeting their energy needs. In order to carry our such thesis, each chapter contains questions that would provide valuable information that addresses each aspect regarding energy security, the shale gas industry evolution and hydraulic fracturing process, the negative impact they have on the environment, and the evolution of the different energy policies that were passed overtime within the USA and whether they and the presidents who served at the time and to what extend their personal outlook on policy-making influences the final decisions, also the evolution of climate mitigation activism. As this explores all of the above aspects, the thesis aims to achieve a deep understanding of each matter and to gain an idea of the overall picture, and to try and see if there is a correlation between them that could be used to successfully predict the future trends within the energy security making process of the United States and the future role of shale gas.

The importance and purpose behind this thesis are to establish whether shale gas will be more important and present in the future within the United States, or would the environmental protection prevail, and the direction of their energy generation would transition to options less contaminating resources such as renewable energy. It is important to find out what the future energy trend would be in the United States as they are a leader within the global politics whereas they are naturally regarded as an example and guidance for the rest of countries, therefore it is highly likely that the future of the entire planet could be determined based on their direction of action.

The master thesis is based on seven chapters each with an aim to address a different area from the ones mentioned above. The first chapter of the thesis which is the introduction has covered the main topic of the thesis and generally the different aspects that will be covered. It also states the research question and the incentive and purpose for this area to be studies further in detail. It will also, as the reader will find below,

state what each chapter contains and the main questions and aspects that will guide the thesis.

Chapter two is the literature review where the reader will be able to gain an elaborate understanding of the meaning behind energy and its contribution, as well as the reasons behind the emergence and evolution process of the energy security notion. How that concept developed in the USA and in accordance to which events was its development shaped and what measurement they took to strengthen it, also the boom of the shale gas industry and its contribution to country's economy and energy security global stance. It will cover in depth the evolution of energy generation and consumption and shale gas' government incentives for its continuous development and value within the state.

Chapter three is the Methodology chapter and Chapter four will be covering in depth the role and foundation pillars of energy security within the USA. The chapter will be doing so by perceiving energy security as part of national security while going into an in-depth discussion about the different aspects of national security within the USA and with what high regards the state maintains them. The chapter will explore whether that is the same for energy security by illustrating in depth their energy portfolio and its evolution overtime, as well as the percentage of dependency on foreign resource imports overtime. The chapter will examine how the U.S achieved its status of energy independent and exporting country, as well as some important energy policies that they passed that contributed for their status today and the different way in which they incentivized the use of shale gas.

The fifth chapter will be examining the rise of shale gas from a financially challenging to extract one to a natural gas of utmost importance to the stable functioning of the United States. How did it gain this status and how technological innovations allowed hydraulic fracturing to become a preferred method of extraction. How beneficial was shale gas not only from an energy security stance but also it financially contributed to the United States' economy and people's income. While the previous chapter had focused on the discussing the importance and desire of the U.S to strengthen their energy security at cost in order to achieve stability, affordability an independence, they didn't address in detail the negative impact the fracking industry has on the

environment and climate. For this reason, chapter six will be illustrating in detail the way in which hydraulic fracturing and shale gas generation and distribution actually work and how they harm the surrounding areas in which the activity is being performed. It will also address how detrimental the process is towards the underground drinking water and the one they use for the fracking, the contaminating effect it has on the soil and in return in the surrounding agricultural and stock development activities and how the toxic chemicals released in the air cause long-term pollution.

Chapter seven will be the final chapter of the main body before the thesis reaches the final two results and conclusion parts. The fifth chapter will aim to examine every president who came to office within the United States since the 1970s as this thesis examines that since this time onwards the formation and evolution of the term energy security came about and so did shale gas extraction. For that reason, this chapter will focus into each President and the according energy policies they adopted during their time. On the other hand, the chapter will trace the emergence and evolution of the climate change mitigation movement. By carefully examining these two processes the thesis will try to find if there is a correlation between the head of states' passed energy policies and the ongoing environmental change efforts. If in fact, the connection between the two is positive in a direct or even partial way, this could aid the thesis when trying to conclude on the future role and participation of shale gas into U.S.' energy portfolio.

CHAPTER 2: LITERATURE REVIEW

Energy and its significance have a wide spectrum of definitions as a considerable number of sources, dictionaries and research in multidimensional fields have searched for ways to synthesize the meaning behind it. However, perhaps the most straightforward and inclusive version of its characterization given by scientists would be - “energy is the ability to do work”, (IEA, 2022). As simple as it may seem, this description manages to encompass all the ways in which energy has allowed for us to evolve and create the world we live in today. Without energy and its contribution to our development economies around the world would not be able to advance, technologies would not be able to evolve and thus allow for us to live better by the day and sustain and improve our lives for longer. Energy is a crucial element to the functioning and development of any state and its citizens. However, its unequal distribution around the world creates the need for governments to aim towards its provision and perseverance, and what is more their role is to manage its supply at an affordable price for the end consumers and for the balanced operation of the economy and other industries.

The importance of energy for the proper functioning of life and its unbalanced distribution around the globe, is how the emergence of the energy security concept can be observed. The need for affordability of resources and availability of access are amongst some of fundamental aspect of the energy security concept. This literature review is yet to focus on the historical development of the above-mentioned concept and the different political and economic events that shaped its evolution until today. What is more, another discussion will be brought, this time with a focus on the importance of energy security in the USA and regarding their decision to extract shale gas in order to maintain their stability but contrary to what environmental protectors would advise due to the detrimental effects that hydraulic fracturing has on the climate. The consequences of their choice, the growing significance of shale gas to the Unites State’s economy and consequently the direction of their energy security policy will be additional topics on focus in the following paragraphs. Is shale gas here to stay or is it passed its peak time and time for the USA to generate energy via more environmentally resources? This master thesis will focus on all the above topic and aim to provide an

answer as realistic as possible to what the future holds for the North American state and its citizens with regard to their energy policy and the future of shale gas.

Energy and its generation and consumption were much more simplified than the systems we are used to rely on today. Prior to the Industrial Revolution, societies mainly relied on manual labour, used animal for agricultural and transportation purposes and biomass to provide for their heating needs. However, since the 18th century and onwards, or as the Industrial Revolution began in 1760 and lasted for approximately another eight decades, people expanded and gradually developed their use of energy to more complex methods and systems, (Horn, Rosenband, Smith, 2010). As Europe began its period of evolution, the United States was still focused on its agriculture and natural resources sectors and relied on the use of horses to put their machinery into use until they gradually joined the revolutionary initiatives. The transportation systems were vastly enhanced, hydropower and steamboats were introduced, all of which allowed for the United States to further improve its industrial and agricultural sectors, introduce the opportunities for business development and improve its economic functioning and the well-being of their population as much less manual labour was needed, (Atack and Passel, 1994).

The advance of energy use right after the damages the Civil War had caused on the American nation and into the Industrial Revolution allowed for a major advance in their economy and gradually turned the USA into a leading world power. Following the Spanish-American War in 1898, the United States began further expanding their territorial gains via the treaty of Paris through which they established with the Spaniards to have rule over Puerto Rico, Guam and the Philippines. These events further contributed for the growth of their economy and expansion of foreign control which set the beginning of the United States' days as world power, (Hayes, 2022). However, as a state grows and expands its economy and improves the functioning of the rest of its sectors so do consequently at the same rate energy needs and the demand for more and cheaper availability of resources for energy generation.

The concept of energy security is one which this thesis will thoroughly explore, yet, as we begin to investigate its historical emergence, one must not leave out the initial signs of its occurrence especially embedded within the United States post Industrial

Revolution's growth. Energy security has several fundamental grounds which have to do with reliability and affordability of all energy resources, as defined by the International Energy Agency (IEA, 2022). The USA's economic growth due to the enhanced use of energy allowed them to become a powerful state, their population grew and so did their needs which is why naturally they had to establish international dominance and cooperation in order to maintain stable access to energy resources. The first time the emergence of the energy security term in the academic world can be seen as discussed by Kazutomo Irie in his article on the evolution of the concept which official origination he dates back to 1956, (Irie, 2017). He maintains, the idea of establishing the concept was as a result of the Suez Crisis that took place in 1956 and immense effect it had on the global distribution of oil. At the time, the author claims the perception of energy security was solely connected with a provision of a stable supply of energy regardless of geopolitical relations. Nevertheless, over the years many more international and instate geopolitical conflicts and environmental crisis' took place in addition to the observance of the introduction of new actors which had influence on the understanding of energy security we have today. Together they helped shape the concept which today is a multi-dimensional area of study covering numerous natural resources, state and non-state actors that could have detrimental effect if not under surveillance.

Following the 1956 oil instability in Europe, the next event that had its impact on global energy security was the 1973 Yom Kippur War and the subsequent Oil Crisis. The conflict between several Arab countries, amongst which the Organization of Arab Petroleum Exporting Countries (OPEC), and Israel – militarily backed up by the United States, had not only an inner-state but an international devastating effect on the supply of oil and consequently economy of multiple states like the UK, the USA, Japan and Canada, (Painter, 2014).

As mentioned earlier, one of the fundamental concepts of energy security is availability and affordability of resources. Ranged by the military and financial support of the United States towards Israel, the OPEC member countries used the exact two principles of the energy security concept mentioned above in their favour to weaken their opponent. Until 1970s, the USA was used to importing oil from several sources in Canada and Venezuela. It also relied on self-production, whereas it reached its peak

of domestic output by 1969, and seldomly until that moment did it rely on importations from the Middle East, and they were simultaneously connected with high transportation costs, (Douglas, 2019). However, as Richard Nixon became the President of the United States in 1969, he came up with the idea of implementing price ceiling on oil consumption. Production and life standard of people in the USA was on the rise which meant that so was the demand for energy, however, decrease in domestic produce directly led to increased interested in foreign imports and this time from the Middle East. As in a matter of fact, between 1969-1973 the United States began relying on oil importation from the Middle East amount to 83% of their total imports, (Andre, 2007).

Before we continue to explore how the rest of historical events had an effect on the evolution of energy security, one may already notice, how the above Nixon policy was recipe for a disaster. From relying on domestic output and several foreign states for oil imports, overnight the USA became predominantly dependent on Middle Eastern oil. As mentioned earlier, the concept of energy security is fundamentally rooted withing the idea of affordability of resources and availability of access to them. As Nixon implied his policy, the USA gave up its most valuable pillar that their energy security used to rely on – diversity.

In 1960s OPEC, also known as the Organization of the Petroleum Exporting Countries, was formed by Iran, Iraq, Venezuela, Saudi Arabia and Kuwait. Within this union there are several states historically known for believing in the practicality of using oil as a weapon, however, Saudi Arabia was for a long time not amongst them and openly disagreed with the above-mentioned tactic. Nevertheless, as Nassar was succeeded by Anwar Sadat in 1970, the new heir of Egypt managed to build strong relations with at the time king of Saudi Arabia – Faisal. Unlike his predecessor, Sadat and King Faisal both shared deep devotion to Islam and it is what is considered as the reason for their strong bond, (Cohen, 2021). The weakened energy security policy of the USA, at the time, and their inability to properly judge the power of oil and the sudden friendship between Egypt and Saudi Arabia which did not receive the attention it needed on behalf of the West, would innately serve as an unfortunate match for Nixon's presidency and the millions of Americans who would suffer the consequences of it.

There is a wide range of factors which can have an influence on energy security, amongst them some have received more attention today as they are connected to uprising issues such as terrorism and cybersecurity. However, others have had direct influence on the concept of energy security since its initiation. Namely, ongoing political instability within producing states and additionally, manipulation of energy supply. As the text continues to explore the evolution of the energy security concept, in the following paragraphs the reader will have a chance to explore how the above two factors came about to be of significant importance.

As mentioned earlier, the author of the “The First Oil Shock? Nixon, Congress and 1973 Petroleum Crisis”, takes us through Nixon’s policy which led the USA from a diverse energy supply policy towards a narrow one concentrated on imports from the Middle East. However, Cohen mentions how, at the time, the United States’ Secretary of State and National Security Advisor Henry Kissinger failed to understand Egypt’s motives to befriend Saudi Arabia and create what was eventually the first financially detrimental economic crisis through the use of oil as a weapon, if the USA was not to support them in their conflict against Israel.

On October 1973, Egypt and Syria launch an attack on Israel, whereas the United States provides an immediate military and financial support to its long-time Zionist State ally. In return, as one may already predict, the Saudis took advantage of their “oil power” and initiated an embargo on the USA followed by a decrease in production, (Cohen, 2021). The imposed sanctions in consequences resulted in approximately quadrupled drastic increase, forcing the consumer to pay a sudden difference of 3\$ per barrel to instantly 12\$, as reported by the US Department of State. As the literature review has covered so far, the United States had been experienced nothing but prosperity and growth ever since the Industrial Revolution mainly due to its proper adaption towards technological innovation, economic growth and political influence. However, as Nixon introduced his policy and the US began relying massively on the Middle East, America inevitably decreased its energy security and naturally positioned itself in a weak spot. The “long summer”, or as Robert Lacey and several other authors describe the decades of economic prosperity in the USA, ended abruptly with the 1973 oil embargo, which ended up resulting in extreme recession, drastic unemployment rate rises and worldwide inflation, (Lahey, 1981).

One of the main purposes of this thesis is to track the relationship between energy security within the US and its controversial view on shale gas extraction and use, however, in order to do so objectively the evolution of the above concept must be studied in-depth and applied when evaluating their relation to the matter. At first, the fundamental meaning behind the energy security concept was its purpose to guarantee uninterrupted access to affordable energy. As we continue to explore the events that shaped the modern-day meaning behind the concept, it's only natural that factors such as manipulation of energy supply and instability within the producing states were added as having direct effect and part of the energy security evolution.

The 1956 Suez Crisis, as well as the 1967 one, alongside the 1973 oil crisis not only served as a valuable example for states to further strengthen their energy security policies but as pillars in the evolution of the concept and determination for the establishment of the 1974 formation of the International Energy Agency, commonly known as the IEA. Today, the International Energy Agency is comprised of 31 member states and has additional 11 Associated countries part of their organization, together they encompass 75% the world's demand for energy, (IEA, 2022). Over the years, the emergence and functioning of the association, as well as its efforts towards strengthening energy security and the relationship between the producing and consuming states has proven to have been of immense value. For instance, one of their requirements towards member states is to maintain a 90-day reserve of energy in case of sudden political or economic turmoil, or as we will examine later environmental crises and digital resilience. Such prerequisite helped affiliate states to maintain their energy security during the following 1991 Gulf War and more recently, during the ongoing Russo-Ukrainian War. As Iraq invaded its neighbour Kuwait, the Gulf War directly involved the harm and restriction of access to oil previously sold around the globe and presented a potential international harm to energy security.

However, as discussed earlier, unlike during the previous ongoing conflicts within the Middle East which cost plummeting price fluctuations and had direct effects on economies worldwide such as the 1973 and 1956 crises', now that the IEA was created with its energy security policies the Gulf War did not have the same effects. For instance, the 1973 oil crisis brought a 300% increase while in comparison as a result of

the Gulf War the overall gas price grew with 11%, (Setser, 2004). One thing for sure is that prior to the creation of the International Energy Agency, the previous crisis which were in direct connection to energy consumption had a much more detrimental effect on its distribution and pricing than the ones which took place after. It can be seen that the meaning of energy security at this point had gained value and countries alongside the United States who took measures at the time to protect their economies by relying less on import and increasing their storage had benefited from it by maintaining a less critic price fluctuations.

The early understanding of the meaning behind the concept of energy security was one based on geopolitical conflicts or internal state disputes which in one way or another had a direct effect on the production of consumption of oil and gas, consequently all of which contributed for the above-mentioned price shocks. Over time, states managed to unite and come up with better policies that would protect their use of energy and respectively their economies. However, the 21st century presented countries and their national policies with a wide variety of new challenges and shifted the understanding of the energy security concept from one based on the sole provision of uninterrupted energy supply during geopolitical conflicts to one which suddenly also had to face new threads like natural disasters, cyber security and violent non-state actors, (Irie, 2017).

As this thesis will focus on the in-depth exploration the evolution of the energy security concept in order to provide a justification behind the United States' national policies, the timeline has reached a point of the concept's modern day meaning. As Kazutomo Irie describes in his article on the evolution of the energy security concept, the past two decades fully transformed the idea behind energy security as we see through direct and non-physical attacks. For instance, the 9/11 attack which took place in the US served as an additional element of thread by presenting the opportunity for violent non-state actors (VNSA) to pose an attack on national facilities which would in return have a direct effect on the economy and therefore could have detrimental outcome for energy consumption.

Following the 9/11 catastrophic accident, the US took immediate measurements to improve its national security including the enhancement of its energy security policy as an important factor of former. In general energy supply systems, all experienced a

closer observation for their security, especially due to its hazardous nature nuclear power gained a high status for protection from damages caused by VNSA. Another factor which contributed for the definition of the new understanding of the concept is the newly emerging cyber security thread making the otherwise complex digitalization of energy systems even more vulnerable. Therefore, the addition of new type of actor, high-risk energy systems and the new means of cyber thread are all new but prominent factors of the energy security concept.

Some of the more recent events which took place and some of which are still an ongoing pressing matter within world politics and in relation to this thesis have an immense effect on the distribution of oil are the Asian Crisis of 1997, the Arab Spring which took place in 2011 and the international conflict between Russia and Ukraine which has been occurring since 2014.

Asian Crisis of 1997:

The crisis once again caused a global distribution of energy by having a direct reflection on global demand for oil which significantly dropped at the time and decreased the price of barrel of oil to fall to 11\$. As states and their economies gradually began to recover in the upcoming years, demand increased and barrel prices increased to 34\$, (Kutlu, 2015).

Arab Spring 2011:

As this thesis has already examined thoroughly the Middle Eastern region is known to have a massive detrimental impact on energy distribution especially at times when there was an ongoing unrest within the region. For that reason, as the Arab Spring began there a global concern that prices, which at the time were on the rising trend, were to experience a further instability due the political unrest within the region. Gladfully, the short-term consequences were not as harmful as expected and the long-term ones were met with resilience, reliance on oil reserve and LNG supply. While Egypt only closed the use of the Suez Canal for a day, another country which provoked much concern was Algeria which at the time was one of Europe's largest LNG suppliers, only behind Russia and Norway, (Hakim Darbouche, Bassam Fattouh, (2011). The constant instability within the Middle Eastern region is a concern import countries will always have to deal with. Today, Europe's largest LNG importers look

a lot different, the United States takes the first place followed by Russia and Qatar, (European Commission, 2022).

Ukraine-Russia, 2014-present:

What began at the time in 2014 as a territorial conflict between the two Slavic states over Russia's annexation of Crimea, escalated into a full-blown war causing immense human loss and economic damages. In a matter of fact, Russia's invasion was the first of its kind since WWII and it cost the lives of nearly 15 000 people, the most harmful one in the region since the 1990s Balkan Wars, (Masters, 2023). In February 2022, the following invasion of Ukraine by Russia was a mile stone for their ongoing deteriorating relationship and can be marked as the biggest attack on a European country since WWII which has caused for over 8 million Ukrainians to emigrate their country, over 300 000 casualties on both side which grow by the day, and it led to multiple global economic, food distribution and energy crisis', (Troijanovski, 2023). Russia's invasion brought for immense impact on the European Union's energy consumption specifically regarding fossil fuels distribution and their climate change plans. Furthermore, it instituted a focus towards the dependency the EU has towards Russia and the need for more internal reliance, for instance, on renewable energy. Statistics show that in 2023 the EU managed to successfully step away from their previous staggering 31% of oil imports from Russia and decrease them to only 3%. Amongst the states which benefited the most from EU countries decision to walk away from Russia's supply were the United States, Norway and Saudi Arabia. Whereas, the US was the number one biggest energy exporter to the EU after Russia's invasion of Ukraine, (Suzan, Bounfour, 2023). As global energy supply chains have been shifting since the Russia-Ukraine War in 2022, the United States pledged to maintain Europe's energy needs by increasing production and providing 11.1 million barrels of crude oil in comparison to 9 million a year before that, simultaneously becoming the largest liquified natural gas (LNG) exporter globally within the first half of 2022, (Domm, 2023).

LNG is a type of natural gas which has taken a liquid form after a process used to cool it down which allows for the substances to be transported in a much easier state than natural gas. After undergoing the liquidation stage, LNG becomes six hundred times more compact than regular natural gas and is also not readily flammable unlike the

later. What is more, its transportation can be done in long distance via tanker trucks or via sea unlike traditional natural gas which has to pass through a system of pipes which makes LNG a lot more convenient for use and does not bound states via piping systems which need building in advance, (Ulvestad, Overland, 2012). Since the 2022 Russia invasion of Ukraine, Europe imposed sanctions on the oppressing Russia and ceased gas importation on behalf of the Slavic state. To meet its energy needs, one of the countries Europe turned to as mentioned earlier was the United States. In specific, the US initiated exportation of liquified natural gas which they process from shale gas extractions mainly from fracking location within Texas and Louisiana. Once the hydraulic fracturing stage has finished, they transport the shale gas via pipes to the Gulf of Mexico where it transformed into LNG. Thus, the USA continues to expand and take of advantage of their internally extracted shale gas and via the process of liquidation allows themselves to export it globally and reach new markets and volumes of trade. The Obama administration was the one to approve LNG in 2016 and ever since then approximately 370 billion cubic meters of liquified natural gas have been exported globally. Prior to the Russian invasion, in 2021 the USA would supply 22 million tons of LNG to Europe annually, in 2022 that number rocketed to 46 million, (Donnelly, 2023).

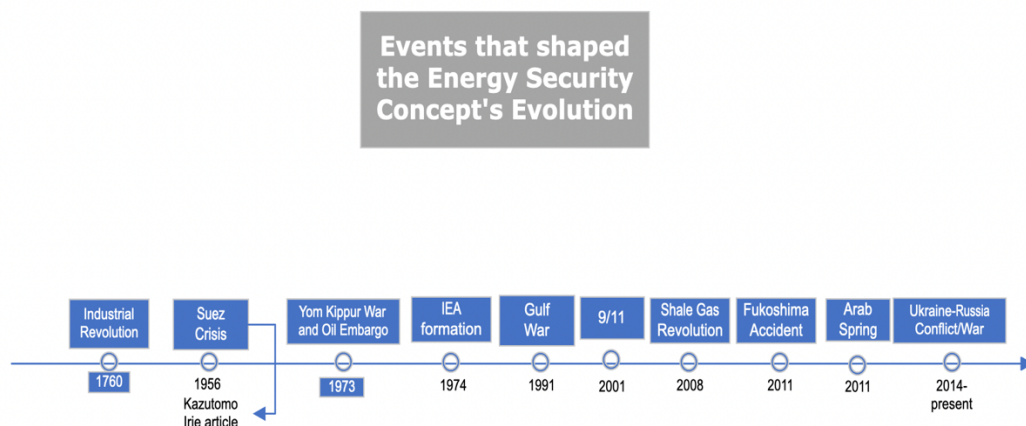


Figure 1. Events that shaped the Energy Security Concept's Evolution

While this thesis will focus on the evolution of the energy security concept within the USA, its prime goal is going to be to evaluate the extend of the future presence of shale gas within the energy portfolio, while taking into consideration its valuable contribution towards the years but also its controversial influence on the environment. Shale gas is an unconventional natural gas resource which is found and extracted from shale rock formations. Technological developments within the hydraulic fracturing and horizontal drilling process have allowed for an immense increase in its extraction and therefore consumption which have aided countries to focus on developing its participation into their energy sector.

This is especially the case for the United States, whereas, in last few decades via the implementation of a wide variety of government policies, entrepreneurship and investment in innovative technologies focused on shale gas extraction and privatization of land ownership and the significantly higher prices of natural gas in the 2000s have all contributed for what can be described today as “shale gas boom” effect, (Wang, 2013).

A brief outlook on the historical development of the shale gas evolution in the United States would have to begin in the 1825 when the first extraction of the natural gas can be observed, however, at the time the process was only relying on obtaining it from shallow fractures rocks while later in 1965 we can trace the addition and implication of the infamous fracking method, commonly known as hydraulic fracturing. Hydrofracking is a process involving drilling horizontal wells which includes the use of high-pressure fluid injected into shale rock formations located deep underground and create cracks through which they can extract the source, (D. Howell, 1993). Hydraulic fracturing provided undisturbed access to shale gas which allowed for the US to achieve resource surplus and decrease in prices. Alongside, the above-mentioned factors aiding the development of shale gas, the United States managed to gain a status of producing and net exporting country in 2011 (Bellelli, 2013).

Shale gas and hydraulic fracturing were not always considered a revolutionary and economically beneficial incentives. Technological development in the extraction process were not the only factors that led to their important role today, as part of their success there is a wide spectrum of federal government policies which aided their

functioning. Since the 1970s, the US government introduced policies promoting the development and use of unconventional gases which initially benefited production of tight gas and methane and only later brought for the rise in shale gas. Some of the incentives amongst natural gas policies include R&D programs, tax credits and pricing, programs aiding industry restructuring, for instance, open access to government pipelines and royalty payment to householders' whose land is being used for extraction.

The driving force between the newly introduced government policies in the 70s and production of unconventional gas was the shortages which occurred for a decade starting since the 60s due to the price ceiling regulation, at the time, which created what is known as the energy crisis in the 70s. What is more, events which followed in the next few years, such as the 1973, further on strengthened the need for internal production and supply of energy, (Wang, 2013). It is of no surprise, that by 2008 the term "shale gas revolution" was coined, due to the immense number of economic benefits that followed by the development of the industry. By 2008, the shale gas industry alone accounted for the employment of nearly 600 000 people and this number is predicted to grow to a million in the upcoming decade.

On the other hand, the industry has allowed for a larger disposable income due per household of approximately thousand dollars per unit and is expecting to increase that amount to 2000\$ by 2025 as the overall payroll experienced a higher rise than the employment rate. Local energy fees, specifically in areas with unconventional gas reserves, also demonstrated a drop in pricing by 30%, (Fetzer, 2014). Hydraulic fracturing and the shale gas industry have played an integral part of the United States' national security and economy in the past few decades. Via the integration of its numerous benefits, shale gas has earned a status of a revolutionary resource that is not only part but an immense interest for the development and safeguard of the US' energy security policy. For the above-mentioned reasons, the following thesis will be studying in depth the connection between the unconventional shale gas industry development and respectively, the importance it holds and how it influences United States' energy security policy.

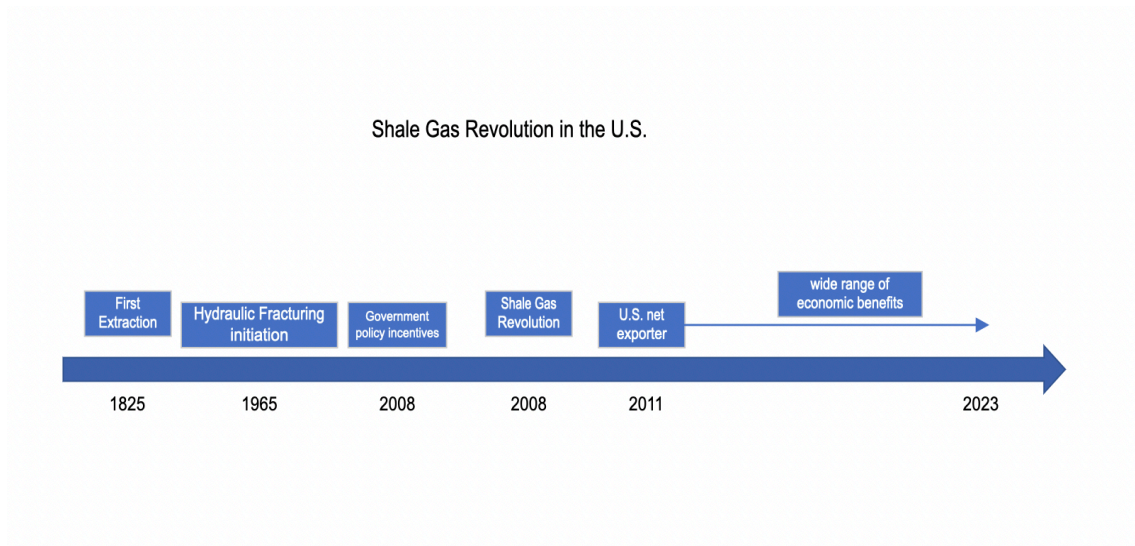


Figure 2. Shale Gas Revolution in the U.S

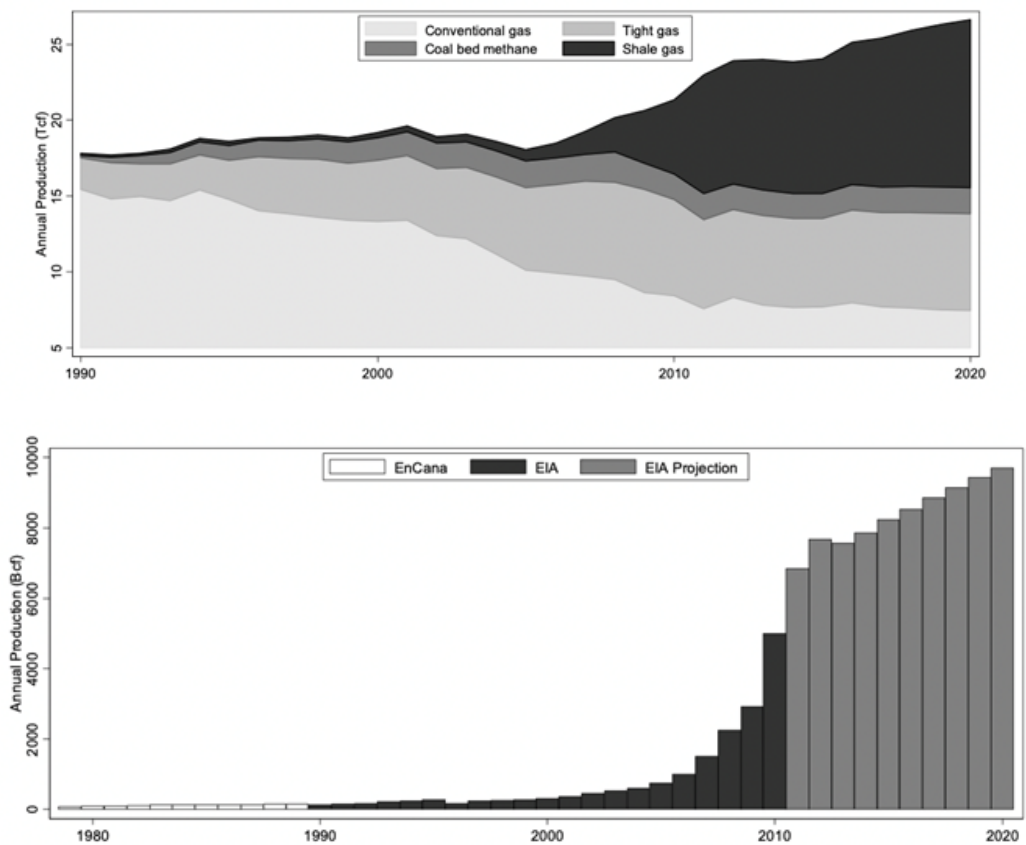


Figure 3. Annual U.S. Natural Gas Production 1990-2020 / Annual U.S. Shale Gas Production 1979-2020

CHAPTER 3: METHODOLOGY

This research is based on a detailed literature review, content analysis, and comparative analysis, which combines both quantitative and qualitative data, as will be seen in the upcoming chapters.

The thesis contains a wide variety of methods which were used to thoroughly examine the available data and carry out this research. Amongst them is literature review a method which contains extensive research, data gather, evaluation and analyse, alongside, summarize the collected content.

The literature review has been based on both scholar articles and journals, (Coughan, 2008). The method is used to address the different research questions of the thesis and aimed to provide the reader with extensive data on the research areas.

Another method used in the thesis is content analysis method which contains several different steps which I have also used on my research. Namely, identifying and collecting data, determining categories of research, categorizing the content, proof checking for the data's validity and reliability, as well as, finally analysing the gathered data and presenting the result from it, (Downe-Wamboldt, 2009).

These outputs of methods can be observed throughout the thesis and especially to create the charts and tables which are created after analysing and categorizing the relevant data. I have also used the qualitative research method known as discourse analysis to further examine in detail the structure and content of the literature review used when at times conclusions had to be derived from information and data was not direct but gathered from several different resources. An additional research method used for the thesis' methodology is comparative analysis which creates a system for comparing data regarding a certain subject where one needs to differentiate what the subjects have in common or how they differentiate, (Pickvance, 2001).

This method was especially useful when carrying out the research regarding the different head of states within the U.S. and the party they represented and respectively

how they differentiated or shared views on energy policy making. According to the carried-out research there both numerous benefits and drawback to the hydraulic fracturing process for shale gas extraction and consumption.

However, for the moment, shale gas has a vital role within the Unites States energy security policy. Its participation inevitably contributes to the U.S.' functioning, however, throughout the past few decades both as a result of environmental impacts and political and social involvement, shale gas appears to have a transitional role for the future as the United States is trying to gradually adopt and adapt to the generation and use of sustainable energy.



CHAPTER 4: THE ROLE of ENERGY SECURITY IN THE USA

4.1. An assessment of their initiatives and strategies over the years

Energy security and resources security are amongst the fundamental elements comprising the term national security. As discussed by Lester Brown, who maintains that oil depletion and climate change are amongst the rising spectres of the complex concept behind national security, (Brown, 1986). He points out, that these modern-day challenges may not only affect a state's internal economic and politic stability but furthermore the global functioning of financial systems development and relationships between countries. Whereas the other pillars are focused around the safeguard of defence and security of citizens and a stable functioning of the economy or as U.S. Secretary of Defence Harold Brown put it – “National security then is the ability to preserve the nation's physical integrity”. In the case of the U.S. and from the perspective of each element of national security, it can be seen that as a state they have invested the greatest number of resources in comparison to any other country in the world in development of their military power and presence, (Statista, 2023). Second to them is China with nearly three times as less resources dedicated to military spending, and only in 5th place we can observe Russia with approximately 66 billion dollars invested into military – an astonishing barely 8% from the tremendous 801 billion dollars provided by the United States. What is more, since the 9/11 accident took place, the United States has taken further measurement to expand in this specific case its internal defence strategies and implemented the use of the Patriot Act whereas it can be argued that controversially to an extend the citizens personal privacy rights were decreased but with the fundamental aim of increasing their protection against terrorist acts (PODESTRA, 2023). On the other hand, when it comes to financial stability and economy ranking since 1920s the U.S. has also been ahead of the global economy ranking holding the highest nominal GDP and accounting for quarter of the global economic system as lastly reported in 2022 by the International Monetary Fund.

It's only natural to assume that if every aspect of national security in the United States is kept in such high regard that the same pattern should be observed with energy security's role and its safeguard and development. This is why to prove if that is the

case in reality, the following chapter will be examining U.S. energy mix and respectively their primary and secondary resources and in this regard to what extent are they dependent on foreign imports to meet their needs or have they managed to secure inner energy independence. Furthermore, to examine how much they value energy security within their state, the chapter will investigate into United States' strategic incentive behind their use of energy resources and go through the different energy policies they passed throughout the past few decades and their relation to their perspective towards energy security's role.

4.2. Energy Mix in USA

The United States consumes approximately 16% of the world's primary energy sources and is considered to be the second biggest producer of energy today, only behind China, since it began its export in 2019. However, that wasn't always the case for the U.S. as only in the past few decades they managed to diversify their energy sources and expand their technological innovations to allow them to start production of their own. On the one hand, up until the 20s they mainly relied on biomass and coal as affordable but arguably environmentally non-friendly energy resources to meet their needs. At the time renewable energy, petrol and natural gas were non-existent as the main incentive behind energy source choice was the economic point of view.

Naturally, as observed by three researchers at the Princeton Environmental Institute, at the time between 1850 and 1917 while the U.S. mainly relied on coal and biomass, the country's emission intensity or the levels of air pollutants were drastically higher than the ones post 1920s, (EIA, 2011). During that time, via the shift to different energy sources like petrol and natural gas and via the adoption of new technological and industrial changes aiding the generation of renewable energy specifically within the manufacturing and transportation industries and households, the report shows that the emissions dropped and is positive the USA could work towards a decarbonized future, (Richard, Pacala and Socolow, 2016).

Contrary to times before the 50s where USA primarily rely on biomass and coal, today the United States energy mix looks much different. The country mainly depends on primary resources such as petroleum and natural gas which each taking up a third of

its overall consumption and 12% comes from renewable energy, a third of which is generated through wind power, while coal and nuclear power on the other hand make up just a tenth of the general use, as per the information taken from the 2022 EIA research.

U.S. primary energy consumption by energy source, 2021

total = 97.33 quadrillion British thermal units (Btu)

total = 12.16 quadrillion Btu

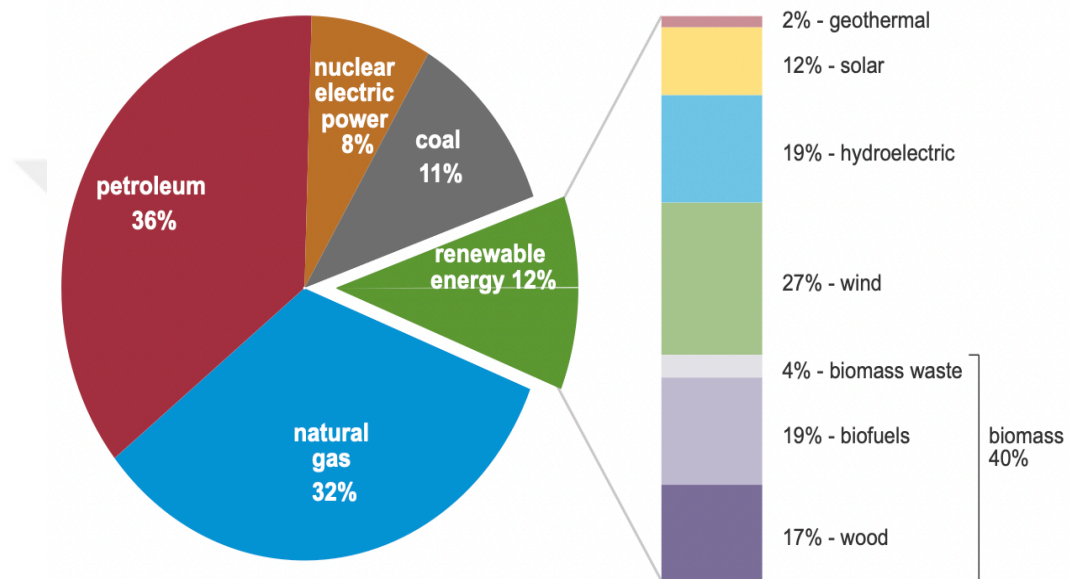


Figure 4. U.S. Primary Energy Consumption by Energy Source in 2021 (Source: EIA, 2022)

Over time many energy patterns the United States followed took a sharp turn towards the increase and stability of their energy security. As mentioned earlier to decrease harmful emission via the implementation of technology it made switch towards more environmentally friendly resources. Furthermore, during the 70s, as explained previously, America relied heavily on petrol imports from the Middle East to a point they reached approximately 30% of their consumption to count on imports and became the world’s largest energy dependent state (Stern, 1993).

However, by implementing certain policies and methods in 2019 it officially became an exporter country taking the second top ranking behind China. In order to do so and try to avoid supply instability, the U.S. turned to domestic production of oil and natural

gas and rapid increase within the renewable energy use and participation. When it comes to natural gas extraction it accounts today alone for more than a third of the country's overall production rate and serves as its largest electricity generation source. Furthermore, it managed to make the USA the world's biggest natural gas producer surpassing Russia in 2009. Since then it has been annually attaining higher levels of production while at the same time it provided the state with the opportunity to supply its citizens with much more competitive consumer prices in comparison to other regions like Europe and Asia, (Wang, Chen, 2014).

A source, highly regarded today in the USA, but one which previously used to be considered as uneconomic, difficult to extract and which use would be unjustified, is shale gas. Natural gas extraction from shale rocks via the use of hydraulic fracturing has served to provide the United States with the unique opportunity to enhance their energy security policy by implementing the use of innovative technology and providing a stable domestic supply, it has brought energy prices lower than any state in Europe and Asia and an abundance of new job opportunities at the sector. Not to forget the ability to turn the United States into a gas export country which adds on the additional financial benefits and provided them with steadiness and secure energy supply during the past one year throughout which the rest of Europe had to suffer from disruption of energy supply, lack of security and higher prices, (Stevens, 2012).

4.3. Highly influential energy policies passed within the United States since the 70:

The following part of this thesis will aim to present some of the main energy policy passed within the United States since 1973 in order to influence the improvement and strengthening of their energy portfolio and provide stability in times of conflicts or the above-mentioned issues that recently rose regarding energy security. The latest article published by Oxford University Press defines energy policy as a term which focuses on matters regarding sources, efficiency, prices, production and the environmental issues surrounding energy and its production, transportation and usage. Often these policies are shaped by governments and their priorities and include matters of legislation, taxation and efficient methods of energy use and conservation, (Tosun, 2022). Within the United States, decision regarding the shaping and direction of new energy policies is decided on behalf of the federal, state and local entities as they have

an influence on a certain group and can apply changes and initiatives in accordance to their area of jurisdiction. For the purpose of this thesis, energy statues enacted only after 1973 will be reviewed as they have a certain effect on the events that took place little after and during the development of shale gas extraction industry and could be of use to determine the future role and extend of participation of the natural gas as part of U.S.' energy security.

1975 Energy Policy and Conservation Act – passed by President Gerald Ford/Republican Party

As previously discussed, the 1973 oil crisis had a severely negative effect on the global but in this specific case also on the Unites States' economy as they were heavily reliant on import from the Middle East and as supply abruptly ceased oil prices quadrupled and caused for detrimental financial consequences. Following this event, the U.S. had to urgently imply better and much more stable energy security environment for its citizens. In order to do so, they passed the Energy Policy and Conservation Act of 1975, commonly known as EPCA. The Act had a multipurpose role which was as stated “to increase domestic energy supplies and availability; to restrain energy demand; to prepare for energy emergencies; and for other purposes” (EPCA, 1975). As it can be seen the newly adopted policy advocates for development and reliability on domestic energy resources which serves to provide a stable supply. A strategy the U.S. later successfully managed to implement as previously seen within the energy mix discission where we followed the historical evolution of energy sources employed by the country. In the aftermath of the 1973 crisis, the natural gas and petroleum domestic production doubled, whereas today the surplus of extracted shale gas allowed for the U.S. to become a net energy exporter. On the other hand, reliance of foreign imports dropped from record high of 30% to a nearly as half that amount today, as it can be followed by the graph and date from EIA's latest data on USA energy production, consumption, imports and exports throughout the past couple of decades.

Few more initiatives that were introduced on behalf of EPCA include the foundation of the Strategic Petroleum Reserve, the Energy Conservation Program for Consumer Products and the Corporate Average Fuel Economy regulations. The Petroleum Reserve's aim is to guarantee stable supply of energy at all times of disruptions and

further, eliminate price fluctuations, it is the world's largest available energy security reserve, (Pirog, 2012).

1992 Energy Policy Act – George Bush/Republican Party

The energy act was passed with purpose of incentivizing alternative energy resource development for the purpose of energy security improvement. The act was aimed toward the aid of renewable energy programs establishment through the use of tax inducement programs and government finance for their initiation, what is more it shed a focus on the need to generate and consume clean energy in the most efficient way. The main purpose of the act was to encourage the generation of energy through domestic resources and decrease reliance on foreign imports. The policy also aimed to promote a decrease regarding the use of petrol as a source in general through establishment of programs for hydrogen generation (Beneke, 1993).

CHAPTER 5: THE IMPORTANCE OF SHALE GAS GAINED IN THE U.S. SINCE THE 2000S

5.1. The Interaction between shale gas and other sectors

Apart from new energy policies over the past few decades and the use of shale gas being incentivized through tax and government financial aid, there are multiple additional reasons for shale gas to gain such enormous attention and importance for the country. What is more, it is important to evaluate its connection and contribution to other internal sectors like the economy and the effect on other industries.

On the other hand, there is a wide variety of criticism that has been aimed towards its generation surrounding the methods of extraction and how they affect the environment and in return the surrounding areas, population and agricultural and stock condition. What is more, there is an array of evidence and motive for local residents and environmental groups to firmly stand against shale gas extraction and use and even advocate for its permanent termination of cultivation. The following chapter will aim to examine the additional aspects that brought for the natural gas importance for the U.S. today and will also address the above-mentioned criticism and take it into account when trying to evaluate the future role of shale gas as part of the state's energy resources and security.

While this thesis covered the events that took place starting from 1973 and led to the initiation of a wide range of energy policies aimed towards the improvement of nation's energy security and it is undoubtedly an important factor in the making of shale gas and its abundance as part of U.S.' energy mix today, instability of imported energy and unreliability of external factors is not the only reason for its successful development and growth as a resources nowadays. Wang and Krupnick, maintain in their research on the natural gas' worth and evolution that its foremost the innovation within the technology sector regarding the methods of hydraulic fracturing that played the biggest role in its formation and value today, (Wang, Krupnick, 2013). They claim these technological break throughs mainly came as a result of the hard work carried out on behalf of privately owned companies and entrepreneurs within the oil sector for

the development of oil exploration and development within the industry but also as part of research and development programs on behalf of the government.

Although, similar to this thesis' assumption regarding the initial stages of the shale gas' development being as a result of the 70s international energy instability and the following governmental program aiding domestic resource development to individual companies which were otherwise lacking the financial capita, the researchers maintain that it was for the private entity of Mitchel Energy& Development which contributed for the success behind the Barnett Shale Gas project in Texas – an area and entity considered to be also the pioneer behind the natural gas commercialization. The beginning of the drilling era for the Texas based Mitchell Energy company was back in 1981 when they found and extracted their first well from the BARNET Shale. At the time, there was no governmental financial aid programs and information on the natural gas was scarce, nevertheless,

5.2. The effect of shale gas and hydraulic fracturing on the environment

Until this point, this thesis hasn't provided in-depth research into the disadvantages or obstacles surrounding shale gas extraction and in specific the method used for its generation – hydraulic fracturing. What is more, all evidence was narrow sided, as it mainly focused on the benefits and derivatives that came as a result of the natural gas industry in the United State. However, there is dark side behind shale gas extraction that has prompted million on citizens within the U.S. to boycott its generation and use for the environmental damages that follow behind hydraulic fracturing.

In order to examine, all relevant criticism and take it into account when trying to determine whether shale gas will remain an important part of USA's energy portfolio, this thesis will also thoroughly investigate into detail the process of hydraulic fracturing and the different stages its comprised of and then offer an objective representation of the negative effects that follow as a result of its extraction, which areas within the country are mostly affected and how does it the livestock and agricultural industries.

The method used to extract shale gas is most commonly referred to as hydraulic fracturing, but it is also recognized under the terms fracking and hydraulic fracture stimulation. According to the U.S. Environmental Protection Agency (EPA), hydraulic fracturing includes the following steps - “acquisition of source water, well construction, well stimulation, and waste disposal”, (EPA, 2010). A more in-depth look into the shale gas extraction will be presented to give an understanding of how the process works, as well.

Overall, on average it takes 3-5 months of on-site work at a single location for the drilling of a well and extraction of shale gas to be completed. It consists of several steps as described above, the initial one being the need to find water as a resource which is later used as highly pressurized liquid and is injected through the horizontal wells to reach the shale rock and fracture it, (Speight, 2020). According to a study carried out by Duke University researchers, between 2005 and 2014 shale gas companies used approximately 250 billion gallons of water to carry out hydraulic fracturing, and 210 billion of that number ended up as contaminated water, (Vengosh, 2015) or as per the American Petroleum Institute 4 million gallons of water per well, considering there are nearly one million natural gas wells in the USA, according to the latest information released in 2023 on behalf of the U.S. Energy Information Administration.

Horizontal wells are drilled deep into the ground, approximately 3km vertically and then additionally they continue a few hundred meters horizontally in order to reach the shale gas trapped within shale rock which has a very thick surface and thus needs the highly pressurized liquid to break them. The water used for the process is not used in its pure substance and form, it is actually mixed with sand or other proppants and chemical additives such as methanol, ethylene glycol, acids, chloride and propargyl alcohol, and together they form a liquid known as “fracking fluid”. The water mixture is used to increase the rate of the fracking performance and make the extraction of the natural gas flow more effortlessly as they keep the fractures open.

Once the shale gas rock has been fractured and the companies proceed to the collection of the resources step, initially the fracking fluid is extracted and then through the wells the natural gas stored within the underground gas reserves is released and it is later

being collected for distribution to the final consumer, (Speight, 2020). Only an estimated 10-25% of the “flowback” or water used for the hydraulic fracturing process can be purified and then recovered for later utilization, only available to be used for fracking and no other industry or human consumption.

The rest of the liquid ends up being disposed as a waste product in accordance to government regulations, some amounts of the flowback liquid remain also within the extracted natural gas formations, (Ferrer, Thurman, 2015). On average, a shale gas well’s lifespan can last between 20 to 30 years and the time usually depends on the active years of its use. A well can be determined “inactive” once it has been 12 months since there has not been any natural gas extracted from the sight (Guo, 2007).

The method, unfortunately, uses a wide range of additional clean resources to extract natural gas from shale rock formations. Some of the fundamental issues that come up as a result of the process have to do with air pollution, land contamination affecting the nearby population, agricultural development and stock and huge bodies of clean water being intoxicated and then damaged to a no reversal point causing in places shortages, as well. While naturally one may think why a would resource that affects and damages three of the four universal elements – water, air, earth – would still be regarded of the high importance that is today, governments around the globe and in specific the United States still maintain its extraction and spread unbothered. The following paragraph will examine in detail what are the specific ways in which shale gas and the process of hydraulic fracturing damage the environment and harm the habitants of the locations they use to generate its extraction.

The investigation on the negative impact commence with the detrimental effects hydraulic fracturing has on the air quality. Research carried out and published by the National Resources Defense Council in the U.S. points out they found how there are 15 different stages part of the fracking process, including the well drilling, mixing the water with contaminants and extraction of the gas, that release pollutants into the air, (Srebotnjak, Rotkin-Ellman, 2015). If we were to look at air pollution as a result of hydraulic fracturing, then there would be impacts on several different levels – local, regional and global effect. The consequences at local areas are immediate and direct. As machinery is brought for the horizontal drilling of the wells and the immense

amounts of outsourced water is transported, diesel exhaust emissions are released from the engines of the trucks used for the delivery of the above. Hydrocarbons are released from the wells, condensate tanks, the impoundment pits filled with the contaminated water and the pipelines. As the natural gas extraction begins, several toxic air pollutants get released from the shale gas formations, such as hydrogen sulfate, heavy metals and radioactive materials, a mixture of chemical called BTEX (benzene, toluene, ethylbenzene, xylene) and in addition, formaldehyde.

According to a research on the potential health effect on humans, 75% of the released chemical have detrimental impact on the respiratory system and other sensory organs, 50% of them can be hurtful the nervous and cardiovascular system, and 25% of them could lead to cancer, (Colborn, 2011). While workers at the drilling facilities wear at all times protection equipment, that is definitely not the case for the nearby inhabitants who are exposed to all the above chemicals and consequently to their damaging outcome, for that reason it is safe to conclude use of hydraulic fracturing at inhabited areas should be prohibited.

According to the research on the regional effects regarding air pollution from fracking, carried out by Tanja Srebotnjak, Miriam Rotkin-Ellman, nitrogen and additional volatile organic compounds get released too and in return form ozone smog which is associated with having caused respiratory and cardiovascular impact on humans when inhaled and may lead to asthma inflammation and premature death, (Srebotnjak, Rotkin-Ellman, 2015). They mention that in some shale gas extraction central locations such as Wyoming, Colorado, Utah, Pennsylvania, Texas and Oklahoma the levels of ozone have risen 13 times since initiation of fracking related activities and reported the amounts to be twice as higher than the accepted federal requirements.

The impact on a global level is just a concerning, as the process of fracking shale wells release methane which has the ability to exhaust much more energy in comparison to carbon dioxide and in return warm the environment an estimated 80 times more, (Howarth, 2023). The next element negatively impacted from the shale gas industry that will be explored in detail is the land at which hydraulic fraction is performed and consequently, the effects it has on the soil, agricultural and stock development. The lands used for hydraulic fracturing and the surrounding areas had brought for some

deep and serious analysis regarding the concerns arising from the impact it has on the areas in which its performed. It is found hydraulic fracturing causes damages to stock and agriculture developed in the surrounding properties due to air pollution and toxic spills within the soil which directly affects plant species and causes water contamination to groundwater used otherwise for consumption, noise scarring away flocks, all causing permanent damages and lead to fewer resources for development and financial damages, as well, (Anna Lin-Schweitzer, 2022). Hydraulic fracturing is, furthermore, linked with general water pollution. The reason for that is that crack formation form during fracking at time when the structure is not strong and well built, after that the toxic chemicals used to reach shale gas penetrate into the healthy and clean soil which also stored underground water used for drinking. What is more, water for consumption can also be contaminated if the liquid toxic chemical spill on the way to the drilling station while being transported via trucks or while they distribute the left-over fluid from the hydraulic fracturing process to store it for the aftermath purification process or just temporary containment, (Ellafi, Jabbari, Tang, 2020).

The below image, created by Robert Howarth and his colleagues, serves to provide a visual idea of the different ways in which the hydraulic fracturing process of shale gas extraction can contaminate the environment – air, water, land, (Howarth, 2011).

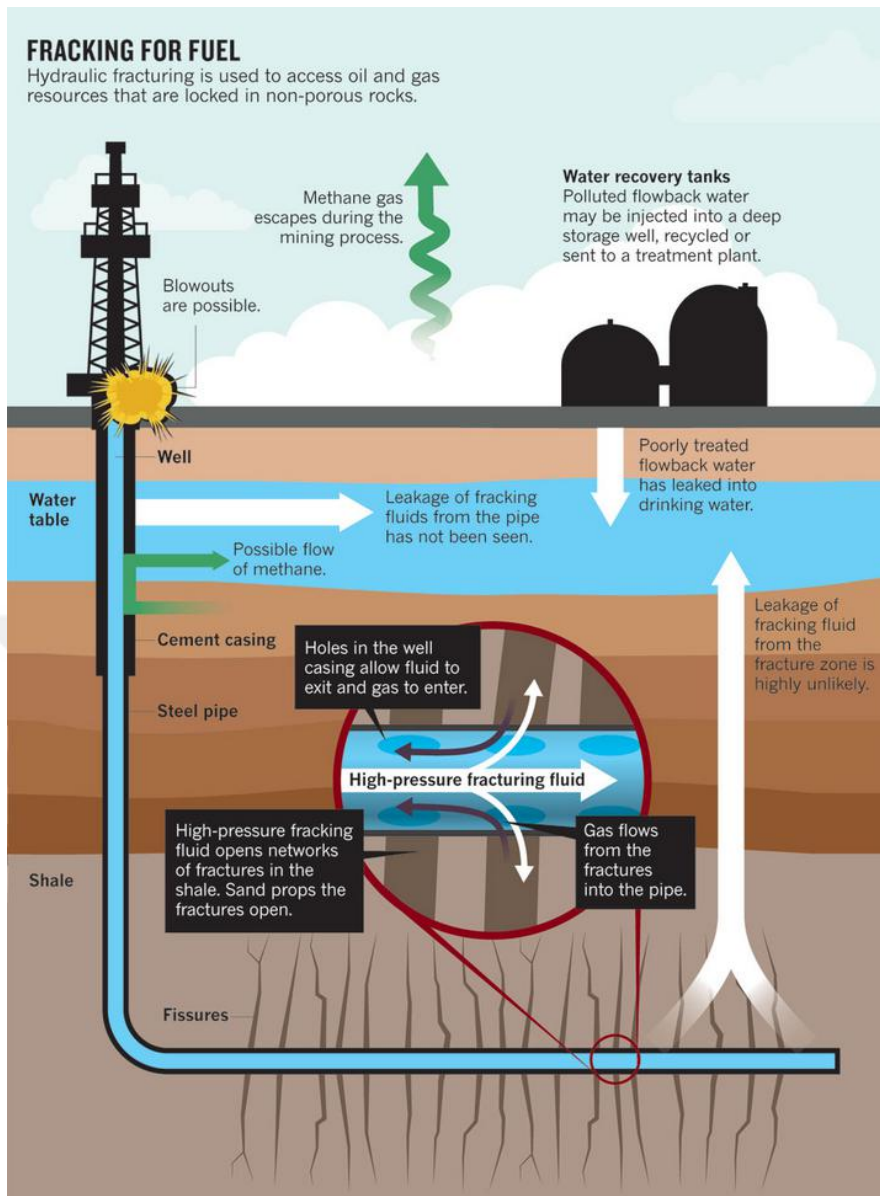


Figure 5. Hydraulic Fracturing Process of Shale Gas (Source: Howarth, 2011)

CHAPTER 6: THE RELATIONSHIP BETWEEN CLIMATE CHANGE MITIGATION AND ENERGY RELATED DECISION-MAKING

This chapter will aim to evaluate whether the United States has the ability to maintain their energy security policy while at the same time achieve an environmentally friendly energy portfolio. It will try to examine if that is realistically possible and if so, in what ways can it be achieved and to what extent can we expect that such transition will in fact take place.

This chapter also aims to discover whether shale gas and hydraulic fracturing are here to stay or does the USA's strict policies on adopting a climate friendly initiative and fully transforming the energy mix from the current office under Joe Biden will overrule. Is shale gas pass its prime time or is its valuable role and contribution to the country's energy security policy irreplaceable? All questions and discussions will be addressed in the following chapter with the aim to aid this thesis purpose and to find an answer as to what shale gas' future role within the United States will be.

6.1. US Presidents' Energy Policies Over the Years and Their Reflection on the Energy Portfolio

While in Chapter 3, this thesis covered some of the latest energy related policy that were passed, now there will be a deeper discussion on whether they actually influenced the energy portfolio of the U.S. and what impact they had or will have on climate change mitigation. Through this process, the thesis aims to provide an understanding of how different presidents and they outlook on energy and climate have evolved overtime, as well as the reflection they had on the energy portfolio with the state. Were presidents in the United States always prioritizing the conservation of the environment or were they often inclined to emphasize first and foremost the importance of energy security? Via this study the thesis will provide a better understanding of how the future of energy resources and climate change will be shaped within the North American state through the past.

6.1.1. Discourses of US Presidents

Richard Nixon

President Nixon's policy might be perceived as a foundation for USA's path toward energy independence. As explored by this thesis, the 70s were a difficult time for the U.S. as ongoing oil embargo brought upon them was economically devastating and not mention the high prices which came as result of it, there was a shortage of energy resources, as well. As a result, Nixon introduced a plan called "Project Independence" in November 1973.

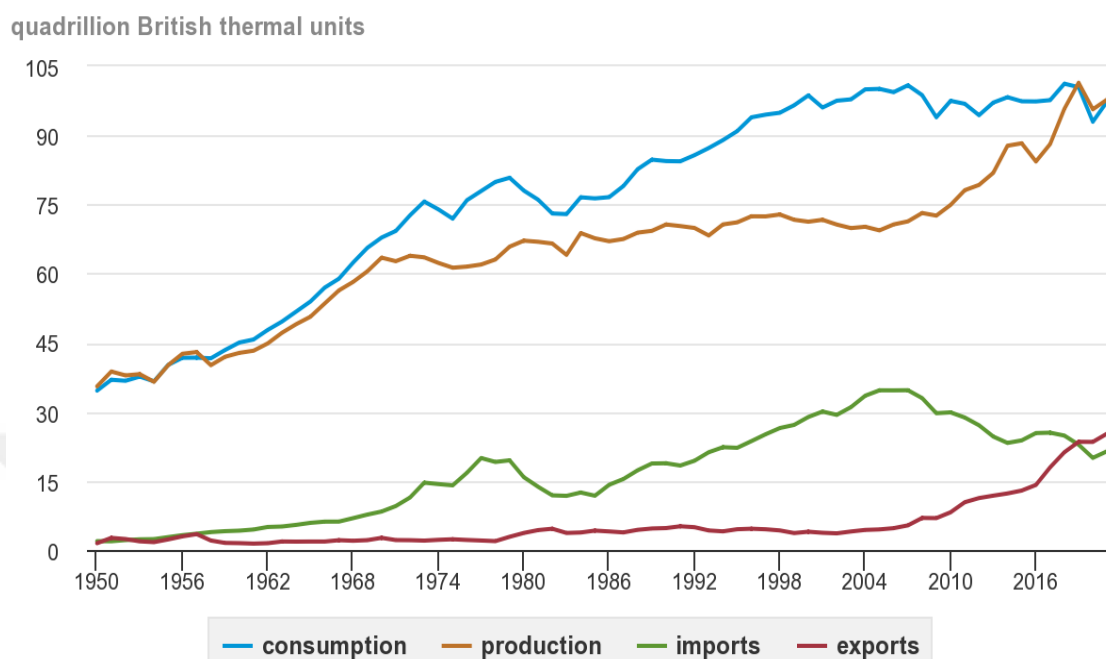
His idea was to reverse the ongoing energy resource dependence on energy imports and initiate reliance on domestic production and supply, defining the main goal of the project through his words as "the strength of self-sufficiency", (Keefer, 2011).

The two main goals of his initiative were to impose energy conservation strategies and to aim towards alternatives sources of energy in order to weaken the reliance on one source or a single region of distribution. Nixon's initiative was primarily based on his plan to focus on use of domestic resource, technology and labor and he advocated for construction of nuclear power reactors across the country.

However, as reliance on nuclear power was a concern for American citizens due to the numerous accidents involving radioactive spillages, contrary to President Nixon's predications during his time in office energy import and dependence on foreign supply only increased, as it can be traced from the table below exhibiting the reliance on imports, (EIA, 2022).

While Nixon might not have successfully achieved his goal of energy independence at the time, undoubtedly his policy and the events that took place during his time had such a detrimental impact on the U.S.' economy that they served as foundation for the energy policy we can see today – one based on self-reliance.

U.S. primary energy overview, 1950-2021



 Data source: U.S. Energy Information Administration, *Monthly Energy Review*, Table 1.1, April 2022, preliminary data for 2021

Figure 6. U.S. Primary Energy Overview, 1950-2021. (Source EIA, 2021)

Gerald Ford:

The next head of state that succeeded Nixon was Gerald Ford. During his time, several very important energy related policies were established that serve up until today as USA's pillars of energy stability. Amongst them there is the 1975 Energy Policy and Conservation Act (EPCA).

Fundamentally, the aim behind EPCS was to provide the state with better readiness and ability to act in times of energy supply instability. In order to do so, the act initiated the Strategic Petroleum Reserve, the Energy Conservation Program for Consumer Products and the Average Fuel Economy policies. The first one serves as the world's largest available petroleum storage and was established as a way to control price fluctuation and avoid shortages, and minimize long-term challenges related with supply by maintaining a storage worth of 90 days that could meet USA's citizens' needs at all times. The Strategic Petroleum Reserve has been used on multiple occasion to help stabilize energy supply in times of international military conflicts like the

ongoing Ukraine-Russia war, during natural disasters, or in times of oil spill and ship-channel closures like the Houston Canal closure that lasted three days, (Berman, 2023). On the other hand, the other two acts that were introduced both have to do with energy conservation application through the use of appliances and automobiles which perform in a more efficient way, in addition to electricity use control over residential, commercial and industrial facilities.

Both the Energy Conservation Program and the Average Fuel Economy one serve on an economic incentive model. They don't imply the use of energy efficiency in a forceful way but rather promote the use of goods with improved energy functioning as financially beneficial, (Department of Energy, 1996).

Jimmy Carter:

The following President in office was Jimmy Carter. Similar to his predecessors he followed the path towards United States' achievement of energy independence as during his years of Presidency the country was still as negatively economically affected from the 1977 oil crisis as from its onset. President Carter founded the Department of Energy at the time with the purpose of working on domestic resource development including renewables and coal, and also installed a ban on power plants to run on petrol or gas, (Hikes, 2023).

While not all of the adopted energy policies had a long-lasting effect in the USA, the ones regarding the development and use of renewable energy was a first and is perhaps the most valuable one today. Unlike previous President which we have explored until this point, Jimmy Carter had both a focus on maintaining the stable functioning of the country's energy policy but also adapt towards environmentally friendly resources and the mentality of climate change mitigation. Interestingly in his 1979 State of the Union speech he shared that his vision for the upcoming 20 years is to achieve a total of 20% of the consumed nation's energy to be generated through renewables such as wind, solar power and geothermal energy, (Brown, 2022). In the following years he passed the National Energy Act which shifted focus on the increase of renewables as part of USA's energy portfolio and efforts towards energy conservation.

Furthermore, in 1980 President Carter introduced the Energy Security Act of 1980 which financially incentivized individual companies and entrepreneurs to pursue development of renewable energy. The Energy Security Act serves as tax incentive and a loan of money to help developers focus on renewable energy, (Miller, 1995).

President Jimmy Carter's energy interest and following policies regarding development of renewable energy resemble those of Joe Biden, which will be address in the following paragraphs, they can be described as persuasive and aggressive, (Martinez, Brady, 2023). Solar energy generation and its progress and ability to be stored was a specific focus of President Jimmy Carter. He created in 1977 the Solar Energy Research Institute and even proclaimed May 3rd as a day of the Sun to be celebrated, he even was the first President to install solar panels to aid energy generation at the White House – these same panels were later removed by his successor Ronald Reagan, (Brown, 2022). At the end of his mandate, President Carter finished off by publishing one last report regarding climate change which was to aim towards maintaining global temperatures at just 2 degrees higher than the preindustrial ones, (Alter, 2023).

Ronald Reagan:

President Ronald Reagan's legacy and imprint on energy security drastically contrasts his predecessors as he had to face the need to provide a significant price decrease at times where the prices excelled inflation rated. In order to do so, unlike past measurement that were taken towards the increase of domestic production and reliance of national resources, he maintains the country needs to switch back to counting on increased resource imports to decrease energy shortages and also expand the capacity of the Petroleum Storage to further strengthen the state's vulnerability in case of upcoming embargos, (Minsk, 2017). He opposes following the "Project Independence Plan" as suggested by Nixon's office.

What is more, President Reagan presents a plan for oil imports and suggests that price range and allocation management on domestic oil generation should be removed, (Macavoy, 1981). Reagan's time in office and the changes he applied in regard with the U.S.'s energy policy was met with great opposition on behalf of environmental groups, the citizens and congress members, which led in 1983 to the resignation of his

main team in charge of environmental policies, (Kraft, Vig, 1984). As a President Reagan managed to apply full scale of changes to the domestic and in return energy policy of the USA, he reversed the adoption of policies on behalf of the government and tried to create free market by granting this role to the private sectors. His policies are known to have demeaned the role of the climate change mitigation and completely left out the importance of developing renewables as viable energy resources – a direction he publicly accepts as unharmed due to the “optimistic expectations of the extend of untapped resources worldwide and the resilience of the free market”, (Katz, 1984).

Goerge H. W. Bush:

Up next as a successor this thesis will explore the energy legislations proposed by at the time the acting President George H. W. Bush. Unlike the country’s previous head of state Ronal Reagan, President Bush followed the philosophy and path the Nixon, Ford and Carter and reversed once again the direction of USA’s energy policy when he passed the Clean Air Act Amendments of 1990 and the Energy Policy Act of 1992.

The documents were aimed to decrease energy imports and improve domestic energy production reliance, while at the same time, shed a focus on the renewable energy generation, climate change, air pollution and efficiency use, (Energy.gov, 2018). He initiated the Energy Department Office of Environmental Restoration and Waste Management which was to serve to meets the needs of environmental protection and furthermore, with the mission to clean up the land polluted from nuclear weapons construction and use during the Cold War and get rid of the particles forming acidic rain fall which was a rising climate discussion and matter to be solved in 1980s.

The enacted policies show a direct reflection and improvement on the quality of air as Bush applied heavy taxation on and government requirements on coal production facilities, (Vizcarra, Goffman, 2018). Some industrial facilities were realistically unable to face the severe demand and new limitations that is why President Bush came up with the “cap and trade” bill. The policy basically allowed for companies to buy out each other’s carbon and sulphur dioxide emissions caps and trade where necessary meaning some more environmentally friendly ones could sell their unused capacity of emitted pollution to the more heavily contaminating companies which were over the

limit at times, (LLI, 2022). The energy policies which President George W. H. Bush adopted and also revived from his predecessors, laid the future foundation of the energy policy which can be observed in office today in the USA and were followed as pillar of energy security decision making by his successors from the Clinton, Bush, Obama and Biden administration, as it will be explored in the following paragraphs.

Bill Clinton:

The next head of state in line is President Bill Clinton. At his time in office, the environmental protection movements around the globe and climate change mitigation had already gained focus and importance, and for President Clinton – they were a fundamental part of his energy policy. His administration started a series of programs aimed to drive the preservation of the environment and decrease of the harmful polluting greenhouse gas emissions, amongst one of his enterprises was the Clinton Change Technology Initiatives which provided over 6 billion dollars of financial aid and tax incentives for business owners and entrepreneurs to develop energy efficient technologies that would improve the use in factories, vehicles and in power accumulation in general, (Royden, 2002).

Clinton's administration additionally presented the British Thermal Unit (BTU) tax which was aimed at reducing emission by applying higher taxed amounts for resources based on their heat content. The BTU tax, naturally, was not applied for when renewable energy was generated and used, (Erlandson, 1994). In 1993 President Clinton, furthermore, presented his Climate Change Action Plan (CCAP) which sole purpose was to establish carbon emission and pollution level to the one 1990 within the next 7 years by providing additional 2 billion dollars investment into renewables research and development, (Royden, 2002).

George W. Bush:

President George W. Bush similar to his father H. W. Bush and his predecessor Bill Clinton was on a path of implementing energy policies which would improve at the worsening climate change situation, however, perhaps in a little more controversial manner, here are some reasons is why. As he stepped in as head of state in 2001 one of his first moves in a seemingly environmentally way was to announce the USA won't be party to the Kyoto Protocol anymore as implementing would result in economic

damages and ineffective climate mitigation efforts, (Reardon, 2004). Nevertheless, President George W. Bush did not deny greenhouse gas pollution and the need for climate change policies, he insisted that the U.S. would carry on decreasing their emissions to the possible minimum which doesn't also harm them financially.

As in a matter of fact, since he stepped in as head of state, his office has allocated over 60 billion dollars towards the improvement of energy security and in return climate change, as well as for the development of renewable energy technologies, (Roberts, Downey, 2016). President Bush' energy policy was highly focused on the need for the U.S. cease dependency on foreign oil imports and he implicated several plans into action in order to achieve so.

He adopted the well-known today Energy Policy Act of 2005 which have numerous statues but is most famously remembered for maintaining that biofuel and in specific ethanol to be blended with gasoline, provide loans and tax incentives for technologies which do not emit pollution or do so in as decreased quantity as possible such as nuclear powerplants improvement and renewables, and also to increase the use of coal but this time through the use of less pollutant methods of extraction from the coal plants, (Rapier, 2021). A very important energy-related note with President Bush in office, is his decision to lift off bans on hydraulic fracturing and pursue shale gas extraction domestically for the improvement of energy supply and thus energy security, (Mouawad, 2008).

Barack Obama:

President Barack Obama's energy policy can be described as one focused both on the development of renewable energy and on the domestic production of natural gas.

President Obama's energy policy was defined as an "all-of-the-above" method of functioning as it included reliance on domestic sources of energy, as mentioned earlier, both natural gas and renewable energy. While previous democrat head of states, as per the pattern this thesis built on their tendency to lean towards clean energy development, Obama was a true example of a Democrat party leader who manages to simultaneously build reliance on domestic production of oil, natural gas and immense investment and development of renewable energy. Amongst his campaign promises,

one was that 10% of sources used for electricity generation will be coming from renewables by 2012 and he managed to full it. Another one, maintained that oil imports were to decrease two times during his time in office until 2020 and that was indeed the case – he managed to achieve that number by 2014, (Soffen, 2017).

During his presidential election campaign, during his second round, he faced republican candidate Romney who opposed fully the existence of climate change based on his belief for there to be a lack of enough scientific evidence proof. Romney, similar to pattern this thesis has built, like his previous republican colleagues followed a narrow path towards the sole support of fossil fuels extraction and reliance and full lack of clean energy involvement.

Obama, on the other hand, clearly recognized the importance of the need to continue relying on fossil fuel energy generation but also shed a focus on the importance of climate change and the need to imply renewable energy and regulation such as the Environmental Protection Agency's rules on greenhouse gas emissions regulations – an agency's functioning Romney fully opposed, (Koch, 2012). While, both candidate's strategy was involving continuous reliance on oil and natural gas generation, Romney's struggle to recognize the existence of climate change and the lack of even intention to pursue clean energy development resulted in Obama second election.

As part of his contribution towards clean energy, the American Recovery and Reinvestment Act of 2009 was placed in order which in return yielded nearly three and a half billion dollar of investment on Smart Grid development out of staggering 80 billion of total funding for the contribution towards environmentally friendly energy resources, (White House Archives, 2009).

In 2013, President Obama announced an additional climate change mitigation plan with the following three main goals – “reduce domestic emissions, respond to the impact of climate change and lead the international community to deal with change”, (Qian, 2020). In 2016, even though congress disapproved of the Paris Agreement, President Obama nevertheless signed it in a manner expressing his deep concerns and willingness to globally work united towards climate change improvement, (Durney, 2017). As head of state, Barack Obama maintains what the USA needs is an energy

strategy which can handle all aspects of the energy industry and provide stability for the future, he named his policy “All-if-the-Above” and presented its three goals – to enhance economic growth and provide jobs, to improve energy security and lastly to adopt the use of low-carbon emitting technologies, (Furman, Stock, 2014). While Obama supports the investment and development in cleaner energy, during his time in office it was clear that he regarded shale gas as a highly valuable asset which was not only contributing to the state’s resource supply and pricing stability but was also an alternative to the environmentally damaging coal.

It is of no surprise, that during President Obama’s time the shale gas industry entered into its revolution stage and managed to surpass by domestic generation other major state producers like Russia and Saudi Arabia, (Clemente, 2019). Barack Obama’s energy policy indeed was a successful one from an entirely national energy policy point of view while it also maintained a heavy focus on development of renewable energy. However, whether his approach and perception of shale gas as a cleaner alternative to coal is an additional discussion that will be addressed during the climate change wave evolution in the following paragraphs.

Donald Trump:

The successor of President Barack Obama was the infamous Donald Trump. Since day one in his time at office, he publicly declared environmental policies and climate change programs to be of no use to U.S. economy and declared his energy policy would be to focus on the safeguard of resources to the consumers via the use of fossils.

He announced the name of his policy as “America First Energy Plan”, which has three main goals: “lower energy costs for Americans; maximize the use of American energy resources; freeing America from dependence on foreign oil”, (Tagliapietra, 2017). In 2017, President Trump used his ability to unilaterally withdraw from Paris Agreement which anyways an agreement promoting climate change actions and environmentally friendly policies, not one binding signatory states to any limitations. Nevertheless, Trump’s justification of his notorious move on anti-climate change and withdrawal from the non-binding agreement was that he didn’t want the USA to financially contribute as it had promised to provide 3 billion dollars during Obama’s presidency, (Durney, 2017).

Trump's decision was highly criticized on behalf of Democrats, environmentalist organizations, businessmen and widely across citizens within the USA, apart from Republican who mainly stood by him (Hayden, 2017). Towards the end of 2020, Trump enacted another groundbreaking anti-environmental decision to remove official government protection from the protected National Tongass Forest in Alaska so that it can be used for tree harvesting across over 9 million acres of forest land (Tagliapietra, 2017).

Donald Trump and his time at office, and out of office, have always been highly criticized, his contradictory changes of the USA's energy policy are aligned with his conservative nationalistic political views. Nevertheless, he served as head of state for only four years, and his successor, current President Joe Biden is in full compliance with the climate change movement and the needed regulatory policies to achieve a net-zero climate, as this thesis will explore in the following paragraph. Perhaps, for himself and a portion of the citizens in the U.S, Trump's views are correct and needed, but if we were to investigate them from a broader perspective in reality, they are egocentric, narrow minded and unable to grasp the reality of the devastating consequences of their actions.

Joe Biden:

As President Joe Biden came into power in 2021, he brought back all the environmental pursuits of his predecessors, including the official participation and contribution of the U.S. in the Paris Agreement as of his first day in office, (Cartwright, 2020). It was his mission to restore back USA's participation into the world arena of climate change, especially since it wasn't present in the matter for past four years. As Biden stepped into power, he presented his energy policy whereas he created the National Climate Task Force which is to invest 2 trillion dollars in order to achieve an environment and economy which will be net-zero greenhouse gases by the year 2050, and before that by 2035 fully carbon emissions free generation and consumption of electricity, and by 2030 pollution emissions should be half the levels of 2005, (Loris, 2020).

When researching Biden's policy on shale gas, results come off a little ambiguous for several reasons. On the one hand, Biden presents his impressive and ambitious policy to tackle climate change in a very assertive manner by stating that via financial aid solar and wind energy will power homes, by releasing millions of electric vehicles, by approving offshore wind project and sustainable aviation fuel, creating clean energy jobs in the sector and introduction of higher taxes for the oil and gas producing companies, (Moran, 2022). On the other hand, Biden hasn't taken measures to begin demolition of hydraulic fracturing, in matter of fact he claimed he will not be putting a ban or planning on removing it from the energy mix for the moment but instead use it as a transition fuel. Presently, Biden is reported to have paused fracking taking place at several new lands, however, this pause is not permanent, and it hasn't been applied to existing drilling locations (Rott, Detrow, Wise, 2021).

It is a little difficult to conclude whether shale gas is here to stay and for how long would that period be if Biden's policy was the only one to be taken into consideration. Although much hope for a positive turn out for the future of climate-change can be expected judging from his overall energy policy regulations and a promise for a net zero future, it is still important to take into consideration the importance of shale gas for USA's energy policy and that it is undoubtedly not going to be easy for them to suddenly remove the resource that provided them with energy independency.

6.1.2. Climate Change Mitigation Policies in the USA

The next part of this chapter will focus on the evolution of the climate change mitigation. The reason for it is to be able to track whether the above-mentioned government energy policies were adopted in correspondence to the climate change wave development or did they follow their own separate path in accordance with the political views of the head of state at the time. If the newly adopted energy policies happen to be in direct relation with the climate change mitigation movement that this dependency might be of use to this thesis to serve in a helpful way to establish to what extend will shale gas, be present in the future energy policy of the United States.

The table below was individually created, and it aims to provide the reader with the ability to view in perspective the information previously explained above. Now,

summarized into a table format with specific determined data on each president's political inclination towards energy production and legislative reforms and whether they pursued methods for renewable energy generation and implication, or were more focused on energy security provision from a national security point of view, or had a combined approach which focused both on clean energy generation but also safeguard of national and energy security with the current available resources.



Table 1. Presidents Table

Richard Nixon / 1969-1974	Republican	foundation of energy independence post 1973 oil crisis, rely on domestic resources and nuclear power which was an environmental concern for the public	Not pursuing renewable energy (RE) / focus on energy security
Gerald Ford / 1974-1977	Republican	Improve readiness at times of instability. Created the Petroleum Reserve, energy efficiency legislation	Not pursuing renewable energy (RE) / focus on energy security
Jimmy Carter / 1977-1981	Democrat	Founded Department of Energy to pursue development of domestic resources like renewables and coal, first one to introduce renewable energy generation	Renewable Energy Inclined and focus on energy security
Ronald Reagan / 1981-1989	Republican	Increased energy resources imports, his policies are known to have demeaned the role of the climate change mitigation	Not pursuing renewable energy (RE) / focus on energy security
George H. W. Bush / 1989-1993	Republican	decrease energy imports and improve domestic energy production reliance, focus on the renewable energy generation, climate change, air pollution and efficiency use	Renewable Energy Inclined and focus on energy security
Bill Clinton / 1993-2001	Democrat	Initiated Clinton Change Technology Initiatives financial aid for development of efficient technologies and renewables	Renewable Energy Inclined and focus on energy security
George W. Bush / 2001 - 2009	Republican	Took USA out of the Kyoto Protocol, pursue hydraulic fracturing	focus on energy security
Barack Obama / 2009-2017	Democrat	“reduce domestic emissions, respond to the impact of climate change and lead the international community to deal with change”	Renewable Energy Inclined and focus on energy security
Donald Trump / 2017-2021	Republican	publicly declared environmental policies and climate change programs to be of no use to U.S. economy	Not pursuing renewable energy (RE) / focus on energy security
Joe Biden / 2021-incumbent	Democrat	He brought back all the environmental pursuits of his predecessors / net-zero greenhouse gases by the year 2050	Renewable Energy Inclined and focus on energy security

The following part of this thesis will aim to provide an understanding of the evolution of the climate change movement and activism as a result of rising global warming temperatures as of direct connection with human activities and the scientific research that brought forth its evidence. It will point out the main events that led to its initiation

and how it developed overtime and to what extend was it reflected within the recently political energy policies that were applied.

Author of the “Global Climate Change” piece on understanding the importance of environmental preservation, Andrew Dessler and Edward Parson, claim that climate change is the most detrimental and harmful thing that has happened to humans of all natural disasters due to high damages that will be inflicted upon us as a result of the actives we have undertaken to cause for it. The two Cambridge science researchers maintain all human societies, their homes, lands, the air they breathe, the activates they are involved in, our economies all depend on a relatively stable and predictable weather conditions which given the current circumstances are no longer able to be anticipated in the foreseeable future of the 21st century which is on its own turn is a rather dreadful future to look forward to, (Dessler, Parson, 2005).

This is why it is important to study to what extend has the climate change movement influence policy making in order for this thesis to have a more predictable idea about the future of environment’s condition, shale gas participation and energy policy making in the USA. Ever since the Industrial Revolution and at the time heavy reliance on highly pollutant fossil fuels and their harm on the environment, the need for climate protection activities and regulations has been raised as a question.

The concept of climate change was introduced in 1896 by Nobel prize winner Svante Arrhenius. The Swedish scientist was focused on determining the causes of the ice ages and also the rising post-Industrial Revolution pollution levels, during his research he concluded that the greenhouse effect is the result of increased carbon dioxide levels which in return result in rise of temperature on Earth. His results on the double increase of carbon dioxide at the time and the reflection it would have temperature rise would be between 5.5 - 9 Fahrenheit, not far from the 0.5-8.6 F expectations that scientist have concluded to occur by the year 2100, (Baum, 2016).

Contrary to what the reader might conclude, not all climate change events throughout the recent history of the past few decades were related with global warming. Between 1940s until 1970s, as a result of the aerosol contaminants causing smog from the World War II sunlight was reflected off earth and in return caused a wave of cooling effect.

However, while these aerosol pieces lasted just for a few weeks and only caused a short-term cooling effect, carbon dioxide influence remains for several centuries before it can get cleaned off from the atmosphere (Rasool, Schneider, 1971).

A U.S President whose policies haven't been overlooked in detail in this thesis is Lyndon B. Johnson, the predecessor of Nixon, he was the first one to actually not specifically take actions against ongoing climate change but officially warn his citizens of CO₂ effects in his precedent, at the time, report called "Restoring the Quality of Our Environment" (Report, White House, 1965). President Johnson used his position to express his concern about the rising levels of carbon dioxide and the dangers it holds as it is invisible to the eye and people might not feel the direct hazard it poses; however, it is a long-term cause of increase in temperatures.

Nevertheless, in 1975 the first digital global climate model was created by Princeton University scientists Syukuro Manabe and Richard T. Wetherald. The aim of their research was to provide an estimate of the temperature fluctuation and its correlation with CO₂. Their model illustrated the direct influence that doubling the level of carbon dioxide' quantity have on Earth's temperature increase. In a matter of fact, what they concluded through their breakthrough research using a three-dimensional general circulation model was a number not far away from today's predictions for temperature variation as a result of pollution from carbon dioxide, they claim doubling the CO₂ would lead to a 2 degrees Celsius increase in global temperatures, (Manabe, Wetherald, 1974).

In 1979, the U.S. National Research Council also confirmed that a doubled level of carbon dioxide would in return lead to a temperature rise of anywhere in between two to three and half degrees Celsius, (National Research Council, 1979).

However, it is only in the 1970s that the climate change mitigation efforts were noticeable within USA's politics and had a reflection on the policies and legislation regarding energy related decision-making, and unfortunately, only in post 2000s that real actions are applied and visible.

As mentioned in the earlier paragraphs, Jimmy Carter was the first president that had a motive and interest toward the development and inclusion of renewable energy to the resource portfolio. Motive wise, in the aftermath of the 1973 oil crisis the country still suffered from the economic damages and Carter had to come up with a strategic solution of the detrimental effects dependency on foreign oil had caused and decided to further increase domestic production of energy after Nixon's Project Independence Plan and decided to do so when he created the Department of Energy in 1977.

He claimed introducing the generation of renewable energy would both increase energy stability and decrease negative impact on the environment. Furthermore, envisioning the participation of renewables to be a fifth of the total energy mix and as part of his personal interest towards clean energy he was the first one to introduce it as part of the White House energy generation in the form of solar power. And what is more, his latest report on the need to maintain temperature at a maximum of two degrees above preindustrial levels was visionary enough to be included as part of the Paris Agreement of 2015 – the same one Obama happily joined, Trump recklessly exited but then Biden joined on the first day of his office again.

Below is a study carried out by NASA illustrates at what rate has global temperature increased as a result of human activities polluting the planet and causing the entrapment of greenhouse gases. The chart shows that since the 80s temperatures have increased with over 1 degree Celsius since post-industrial levels and another study published by World Meteorological Organization in May this year predicts that number to reach 1.8 C by 2027, (WMO, 2023). Another Chart created by NGOs Berkley Earth and Climate Central, on the other hand, demonstrate the astonishing ascending levels of CO₂ in the past decade.

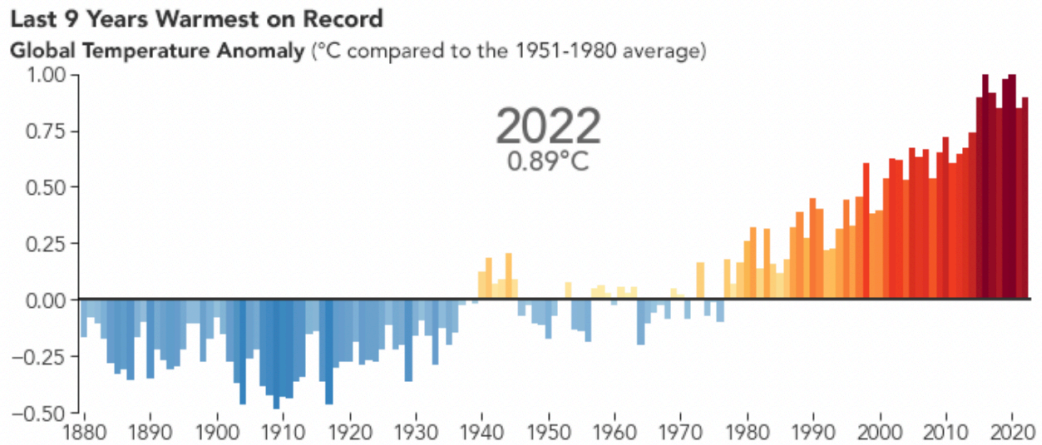


Figure 7. Global Temperature Anomaly (Source: NASA, 2023)

While President Jimmy Carter’s efforts were undoubtedly a sign for change and brought for the attention of current and future policy makers, the 70s are marked with a period of high and increased signs of both global warming and cooling on behalf scientists and at the time caused a chaotic environment due to which people started having doubts about the accuracy of their predications, which until today some people still use to justify their disbelief of the undoubted facts of global warming (Peterson, Connolley, Fleck, 2008).

Nevertheless, scientific research and evidence of global warming and the detrimental effect of human activities emitting astonishing amounts of carbon dioxide persisted with phenomenal strength and from this point onwards, the movement gained a lot more recognition and became part of the daily agenda of every person’s life. As mentioned earlier aerosol pollution is incomparable to the ones from carbon dioxide, as the former can disappear from the atmosphere a lot quicker and as this happened, but CO2 levels were continuously on the rise, the 80s were a time of the need for widely spread awareness on the global warming matter.

In 1988, popular Columbia University professor James Hansen directing the climate change program, carried his speech Congress on the effects of global warming (Shabecoff, 1988). His speech had widely spread influence on the public and governmental organization regarding the importance of climate as he advocated on the importance of preserving our environmental as even though drastic temperature changes had occurred before it essential to understand the consequences, loss of flora

and fauna and the thousands of years it took for the planet to recover as a result. Later that year, Hansen made another statement as part research he had carried out for some time with his colleagues. It stated that temperatures on Earth were at this time higher than measured at any other point before and that this event is a result the greenhouse gasses released from human activities like deforestation and fossil fuels use and lastly, that extreme weather events will follow up, melt down of ice at the Antarctic and a follow up of rise of sea levels, (Hansen, 1981 and Hansen, 1988).

From this point onwards, activities related with environmental preservation and development of renewable energy within the USA politics were on the rise and this time aligned within international developments and measurements taken towards climate change.

In 1988 the World Meteorological Organization part of the United Nations created the Intergovernmental Panel on Climate Change which since than has been following and issuing the latest data on climate change degradation and the risk that will follow as a result of human activities and methods for its prevention (Agrawala, 1998).

With the exception of Reagan and Trump, as already studied in detail previously on this chapter, every other head of state was in full support of renewable energy development and climate change mitigation energy policy and financial investments wise. What is more, both Obama and Biden laid the foundation of not only adopting clean energy but also perceiving as the only future option for generation and consumption as they both implied their carbon free and net zero energy policies that were to be achieved by 2035, and the later in 2050 while relying on the use of shale gas as a transition fuel. It can be seen that from this point onwards, president and in respect U.S.' energy policy was not shedding focus on the need for mitigation but in reality, adapted their policies towards a transition of energy generation and use.

6.2. Republican versus Democrats Debate on Energy Security and Renewables in the USA

Although the discussed aspects within this thesis until this point seem in a way wide enough to make a reasonable conclusion on the future of shale gas within the USA, I

would like to elaborate on one last discourse, and that is the importance of the head of state and his political background – whether that is Republican or Democrat.

The study on the different presidents which took place and time in office reveals a pattern of clear distinguishment between Democrats and Republicans. Whereas the later show a tendency to focus on advocating the strengthening of the USA's energy security policy via the adoption of legislation which undermines the use of clean energy and in return promotes reliance on sources which are currently available, less financially costly to generate and purely focus on the benefit while disregarding the consequences they have on the environment or the rising need for climate mitigation effort. On the other hand, Democrats illustrate an inclination towards meeting both the needs of their citizens via the currently available resources like natural gas and oil but at the same time raising awareness and actual efforts towards the growing need for change in the direction of energy generation and use via their continuous legislative and financial support for renewable energy.

While this pattern exhibits a clear line of behaviour between the attitude Republicans and Democrats have towards clean energy, it does not illustrate though any associated relationship with shale gas consumption or any other domestically produced resources. What is more, it is clearly evident that all presidents tend to show reliance on domestic production of fossil fuels as they have provided the United States with stability and if not fully present, they will at least be used as transition fuel.

The reason for this distinguishment on energy views is that historically the two parties differ significantly on their stances regarding energy policy making and tend to favour their political party viewpoint. According to an investigation carried out by Yale University researchers, while Republicans typically tend to be on the more nationalistic side and prefer to safeguard energy policy at the cost of pollution and would lean towards choosing the generation of energy through fossil fuels. If they were ever to support the development of clean energy it wasn't coming from the same reasons as Democrats, but Republican would rather choose this stance for economic purposes such reducing energy costs and relying on a renewable resource which would not be exhausted. However, generally Republicans were leaner towards building their policy based on reliance on petrol, natural gas and coal. While on the other hand, for

purely environmental protection reasons and global warming action, Democrats tend to adopt an energy policy based on development of clean resources and a transition of the energy portfolio towards one based fully on renewables, (*Gustafson, Goldberg, 2020*). While there is no black and white difference between Republican and Democrats' view on energy policy making, and additionally one thing for sure is that according to earlier research, there have been a few Republicans on the list of adapting towards usage of clean energy, it is important to keep in mind that their party initial motives and views have a direct influence on the choices of the head of state. This is why, this correlation between Republicans VS Democrats and their primary energy stances is vital to keep in mind when making the conclusions on the future of shale gas.



CHAPTER 7: ANALYSIS AND FINDINGS

The purpose of this thesis was to try and analyse the relationship between the rising participation of shale gas as part the Unites State's energy portfolio and its connection with the energy security policy of the state with an aim to predict its future importance taking into consideration the global warming phenomenon and the climate change mitigation influence.

For this reason, throughout the different chapters the reader was provided with in depth analysis of the different aspects and events that form the meaning behind energy security evolution overtime, the reason for shale gas to gain the status with which its regarded today – whether that bring a positive or a negative connotation depending on the motives of each group, the importance of the political views and stances of each president of the United States and the energy policies they adopted which have had or are in present having a direct connection with both shale and environmental activism roles, as well as, the evolution of the concept climate change and the realistic consequences that it poses for our society.

Without thoroughly collecting, studying and analysing each aspect and data a broad methodological framework would not have been able to be created and the conclusions of this thesis would be incomplete. In order, to address the research problem of trying the evaluate the future of shale gas within the U.S., the different aspects which have direct effect on it and their characteristics were described in order to gain more in-depth understanding and to be able through these to be able to create a cause-and-effect relationship. Namely, how the evolution of each aspect over time affected directly or indirectly the evolution of energy security within the USA and importance of shale gas.

Under the influence of international conflicts which had a direct effect on the supply of energy, internal economic growth and technology innovations which allowed for innovative methods of energy generation, and the different presidents who came to term within the United States with their personal perspectives on the country's energy direction, this thesis went through evaluating the various contrasting changes that the

state experienced and provided the reader with a wide variety of angled through which they can gain understanding of the topic. At the beginning of this thesis when examining the incentives behind the country's decision to strengthen their energy security and rely more on available domestic resources, it seemed like the United States might not seem to have a motive to stray away from shale gas and hydraulic fracturing as they were the ones who provided it with the ability gain independence and become an exporter. Therefore, the value of shale gas meets all of fundamental initial energy security pillars – availability of the resource and affordability for its consumption.

What is more, as explored earlier, the natural gas not only stabilized the proper functioning of the energy distribution line but provided for massive economic benefits both for the state and the end consumers' incomes. Undoubtedly, shale gas has brought for a great number of benefits for the United States and it not difficult to understand the sectors that are involved with hydraulic fracturing which experienced a boom of availability of jobs and also producers, policy makers and citizens who support the continuous use of the natural gas and see it only for its contribution. However, while 50 years ago, the United States was in a terribly difficult situation due to their high dependence on foreign oil import, low domestic production due to lack of technology innovation within the sector for development of diverse cleaner energy, today this thesis shows this is not the case anymore.

After exploring, the following detrimental long-term consequences of the hydraulic fracturing industry on the quality of the air, the purity and availability of the drinking water and intoxication of the soil and surrounding land life it is evident the shale gas extracting practice harmful effects outweigh the benefits. What would be the point of having enough supply of energy and follow up profit from it, if agriculture stock and people's life would be in danger and would not be able to rely on or consume the available energy. As explored earlier, there are presidents like Carter who began adopting environmentally friendly actions and made the climate issue a public topic, nevertheless, it is only since the 90s that the climate change mitigation movement started being regarded as a problem due to the controversial contrasting theories it had before.

Furthermore, climate change mitigation activism only began obtaining validity and presence within the political realm as part of energy policies and expressed through the actual development of renewable energy programs in the past recent 10-15 years with Obama in office. While, Biden claims that he plans on using shale gas as a transitional fuel and set some very hopeful and promising environmentally friendly policies that foresee a net zero carbon free future, it is important to keep in mind how each individual president has their own perspective on energy security and it is unclear whether his successor would have the same vision, as notorious as Trump's example was and the opposing views Republicans and Democrats had on renewable energy. On the other hand, research shows staggering carbon dioxide levels and temperature increase never experienced before due to human related activities and on what is more methane contaminations from hydraulic fracturing are not to be left side as although their lifespan is shorter than CO₂ they pose a much greater danger to climate change as it this thesis showed how much more energy is exhausts.

While there can never be a clear answer to the future of climate change and an exact calculation to what percentage and extend would shale gas be participating within USA's energy portfolio, this master thesis result shows a great need for a shift of the energy resources they currently rely on to cleaner options. It is evident renewable energy is on the rise and with the help of financially incentivized programs, government restricting policies and technology innovations clean energy generation and consumption will be having a greater participation by the day and natural gas resources like shale which have aided the United States so greatly at times of instability will not just suddenly disappear but might switch from being primary to secondary energy assets.

CONCLUSION

Natural gas extraction from shale rocks via the use of hydraulic fracturing has served to provide the United States with the unique opportunity to become from highly energy dependent state to one which is fully self-sufficient and can give export resources abroad.

Shale gas has granted them with the chance to enhance their energy security policy by implementing the use of innovative technology and providing a stable domestic supply, it has brought energy prices lower than any state in Europe and Asia and an abundance of new job opportunities at the sector. Not to forget the ability to turn the United States into a gas export country which adds on the additional financial benefits and provided them with steadiness and secure energy supply whereas the rest of Europe had to suffer from disruption of energy supply, lack of security and higher prices every time there was an ongoing conflict or crisis involving distributing countries like OPEC or Russia, (Stevens, 2012).

Energy security has several fundamental grounds which have to do with reliability and affordability of all energy resources, as defined by the International Energy Agency (IEA, 2022).

Furthermore, states have to make sure they address and prepare themselves adequately for the newly rising threats to energy supply and distribution security like cybersecurity, natural disasters which become more and more widely spread and unpredictable and dangers arising from non-state terrorist organizations.

Post Industrial Revolution period the USA's economic growth due to the enhanced use of energy, improved technology and economic growth allowed them to become a powerful state, their population grew and so did their needs which is why naturally they had to establish international dominance and cooperation in order to maintain stable access to energy resources. They had to guarantee the standards of their energy security as part of their national security policy had meet the rest of the aspects and

their high standards they set for the performance of their military, economic and global leadership dominance.

While shale has undoubtedly served and still is providing the United States with the unique opportunity to be self-reliant and achieve energy stability and profitability, this thesis has also traced the occurring need that has risen for the past few decades to urgently switch from environmentally contaminating sources to cleaner options like renewable energy generation.

Although, the different aspect that were covered in this master thesis show ambiguous results whereas some of the environmental climate mitigation statistic and forecast illustrate detrimental consequences and it can be seen that in return they are positively addressed on behalf of some head of states who allocate financial aid for change of the energy generation direction. And on the other hand, other Presidents and their energy polices have shown a pattern of shedding focus entirely on meeting the domestic needs of the society regardless of the long-term cost they might be causing, and mainly relying on the idea that energy security should be limited to affordability of resource and availability of access.

While these pillars served as foundation for the creation of energy security concept, it is important to take into consideration how over time different events and actors had influence on the concept and it had to expand its properties and functions. For that reason, I believe that after thoroughly covering each aspect directly linked with the role of shale gas in the United States, climate change mitigation efforts and the rising levels of greenhouse gases causing temperature fluctuations have already began to have their toll on the energy security policy making with the country and will eventually through the help of financial aid and technology developments manage to make a transition towards the reliance on primarily renewable energy. While the future role of shale gas would stay in the background and might be used for emergency situations or just a reserve to help stabilize price fluctuations and if at times clean energy is unable to fully meet the needs of every American citizen.

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