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Διπλωματική Εργασία

***The Prospects of Renewable Energy Sources - RES -
in view of the 2050 Energy Transition: A Case Study
based on USA, Europe, Russia and China***

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Executive Summary

The present thesis refers to the prospects of RES, in view of the 2050 Energy Transition, based on USA, Europe, Russia and China. The analysis is based on the geopolitical aspect of the subject and the methodology followed was that of the case study approach. According to the analysis results, the prospects of RES for the EU are positive but it seems that the transition period will be prolonged. The EU will need fossil fuels and minerals so as to produce and maintain renewable energy generators. As for China, the country will be able to gain the majority of advantages by the transition. It will lead the technological evolution and the production of renewable energy generators, while it invests on electricity grids. The USA has a large domestic market for natural gas and it is a pioneer in R&D concerning electricity. On the other hand, there is still a lack of a clear national energy policy. As far as Russia is concerned, even if the country is rich in rare earths and hydrogen, it is probable that it will remain just a supplier of these materials and will not be able to compete in the innovation sector. The country does not have the required infrastructure and R&D. A cleaner energy system will not ease the geopolitics aspect. Instead, new geopolitical realities will be created and energy will be, once again, the leading force of international alliances and competition.

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1. Introduction

Energy represents an issue that is widely discussed during the last decades. Sustainable development is a demand and energy policymakers need to find ways to meet the official requirements set for the first time by the United Nations Framework Convention on Climate Change in 1992 and further specified with the Paris agreement in 2016. But, even though the need is more than urgent, the energy sector is characterized by volatility and uncertainty and each country will face different challenges, as far as decarbonization and the transition to a new era, where renewable energy will dominate are concerned. It is important to realize that the energy market is one that shapes policies and affects the global economy, so, stakeholders need to understand that there are some key factors that affect energy and these include technology, investment and geopolitics.

First, as far as technology is concerned, it has a significant role in the development of the use of renewable energy resources. Of course, not all technologies have a long-term prospect, like nuclear energy, which seems to be cost-effective only in the case of large scale programs. On the other hand, solar or wind energy seem more price competitive. In addition, the geography of energy production will change. Electricity will dominate the globe and investments will be required so as to create smart grids and distribute the energy. Also, energy storage alternative will become an issue of concern. It is also important to refer to the gas, which seems to have a role in the transition period. This role depends on factors like the pace of development of alternative sources and the politics of each country.

The next factor is investment on energy. First, energy will be distributed in a different way and investment on traditional transportation means will no longer be the case. So, the shipping industry and global trade will need to face this issue. Smart electrical Grids will be the new reality and this will create important implications. In addition, economies begin to decouple from carbon use and eventually they will be decoupled from any form of energy. Then, policies and regulations need to be established and policymakers try shape the energy future, by collaborating and investing on R&D.

Last but not least, energy geopolitics is an issue with several parameters and implications. First, nations that had to depend on other nations for the supply of energy will be less leveraged, at least in terms of politics. It is true that the most dominants suppliers will continue to dominate the market, by offering diverse energy types, but, they will not be able to exercise political leverage because the dependence of the buyer

will be reduced. Then, renewable energy trends include the focus in the energy needs of citizens, something that is not the case with fossil fuels. Furthermore, the transition to the use of renewable energy sources entails the co-operation of countries and economies around the world. The Paris Agreement is indicative of this trend, since it set the foundations of co-operation through the development of common goals and principles regarding energy. Countries around the world have developed initiatives so as to achieve these goals by 2050.

The present thesis refers to the prospects of Renewable Energy Sources (RES) in view of the 2050 Energy Transition (Based on USA, Europe, Russia, China). The research aim is to reveal the prospects of the use of Renewable Energy Sources in view of the 2050 Energy Transition, by geopolitical point of view. More precisely, the following questions were developed:

- Which are the prospects of the use of Renewable Energy Sources for the EU, in view of the 2050 Energy Transition, in terms of geopolitics?
- Which are the prospects of the use of Renewable Energy Sources for China, in view of the 2050 Energy Transition, in terms of geopolitics?
- Which are the prospects of the use of Renewable Energy Sources for the US, in view of the 2050 Energy Transition, in terms of geopolitics?
- Which are the prospects of the use of Renewable Energy Sources for Russia, in view of the 2050 Energy Transition, in terms of geopolitics?

The thesis is structured as follows. First, the theoretical background is presented, focusing on the following topics: The Geopolitics of Energy & energy security, The global energy transformation and the Geopolitics of Renewable Energy. Then research methodology follows. The fourth chapter contains research analysis. Then, discussion on the analysis follows, as well as the relevant conclusions.

2. Theoretical Background

2.1 The importance of energy

Access to energy is fundamental for the well-being and quality of life of people around the world. It is also argued that energy represents a basic prerequisite for sustainable development, meaning the economic, financial and social prosperity. Energy, when used for transportation and lightning helps connect people and societies. When it is used for heating or cooling, it contributes to human health and comfort. And of course, when energy is used in the industrial, entrepreneurial or consumer activities, then it contributes to the economic activity. It is also important that nowadays energy can be used in order to mitigate environmental problems. It is therefore fundamental to use energy in a way that it can contribute to the social and economic development, by at the same time respecting the environment.

2.2 The Geopolitics of Energy & Energy Security

It could be argued that “energy makes the world go round” and this makes energy a fundamental aspect of development. During the previous decades, oil and gas represented the main energy sources and the geopolitics of energy referred to these products. Nevertheless, things change and the overexploitation of these resources makes the global energy economy change and new renewable sources of energy are emerging, in an attempt to respond to the potential of energy scarcity in the future, but also to respond to the need for sustainable development.

The term “geopolitics” was first used in 1905 and refers to the study of the way geography affects the relations among countries and the powers and vulnerabilities that characterize these relationships. It describes the ways geographical factors define the international presence of a country. It is widely argued that geopolitics is a zero-sum game which involves nations trying to gain power and security, as well as trade and investment advantages over other nations. Nowadays, new terms are also used as complementary to the core one, like geo-economics and geostrategy. Geo-economics refers to resource allocation in and between nations, while geostrategy refers to obtaining physical control of an area, or to the capability to deny others to control a territory.

The geopolitics of energy is an old story, with new content and aspects. It refers to the way countries develop, interact, create alliances or make wars under the framework of energy supply. The geopolitics of energy are highly related to parameters like the amount and location of natural resources, their availability, the state of control, the balance between national, regional and international markets, pricing, political decisions and costs. In addition, the geopolitical role of a state is highly related to factors like the degree of dependence with other states of business factors. Besides, the natural resources of a country represent major elements that impact the domestic economy, the business environment, the relations among different stakeholders. Under the above shaped framework, countries develop geo-strategies in order to ensure energy sufficiency. The global alliances and agreements are widely led by the energy policies (Austvik, 2018). It is worth to mention the term “geoenergia” created by I. Vidakis and G. Baltos in order to describe the implications created by energy on political, financial systems and the global relations. According to this term, decision making at a political, economic or social level is highly influenced by energy resources’ availability and accessibility. There are several examples that demonstrate the role of energy in geopolitics, like the dispute between the USA, the UK and other countries, on the one side, and the Shanghai Cooperation Organization (China included) over the control of “the pipelines, the energy routes and the supply contracts” (Fernades & Ferreira Rodrigues, 2017). The geopolitics of energy were described in a widely accepted way by Conant & Gold who stated that: *“access to raw materials, especially access to energy is a top priority of international political relations. The ability to obtain these essential commodities is no longer subject to the traditional colonial relations or military protection, but depends on geographical factors and the political decision-making of the governments on the basis of different political conditions. The country having control over the resources will control those who rely on the resources, which will lead to a profound transformation of international relations”* (Conant & Gold, 1978: 3). The above mentioned description is indicative of the interdependence between the geopolitics and energy.

The geopolitics of energy became more apparent during the last decades, were energy resources started becoming less and less available, while, at the same time, energy needs around the globe became greater. A recent definition of energy geopolitics refers to “the study of national security and international politics in the context of the global

energy scene” (Pascual, 2015:4). It is the analysis of all the factors related to energy resources treatment, from production to end user. The geographic location of an energy resource and the whole system around the production and distribution of energy refer to the energy geopolitics. The global energy system is characterized, among others, by cartels, oligopolies and monopolies, while, consuming countries need to develop international strategies so as to have access and control over resources that belong to other states. The reasons for importing countries to have control over external resources are multiple and include the energy sufficiency, national security and financial prosperity. Then, it is important to have an uninterrupted supply of energy, so as to ensure global stability. In addition, consuming countries need to ensure – as much as possible – reasonable pricing. On the other hand, producing countries need to ensure long-term demand, so as to take the money invested back, but also in order to develop. Geopolitics of energy can be described as the study of the ways all stakeholders (countries, organizations, businesses, unions etc) interact, as well as the study of the variables included in the energy supply and demand system, like infrastructure, R&D, geographical location, supply chain and all the factors that influence the discovery, exploitation, distribution and consumption of energy (Austvik, 2018).

Geopolitics also define the way relations are built among different countries referring to the satisfaction of energy needs. Two prominent examples are listed below. First, the USA depend only on oil and they co-operate with Middle East counties which are their main suppliers. On the other hand, the EU which has similar needs, relies on gas – at a great extend – and imports it from Russia. This makes Russia a major player of geopolitics in the region (Pascual & Zambetakis, 2016).

It is interesting that energy and geopolitics are interrelated, but the results vary, influenced by several factors. Energy resources may represent a source of power and this can affect geopolitics. On the other hand, energy resources may represent a vulnerability. They can also help a state develop, or they can lead to financial decline. nevertheless, access to such resources is a factor that can contribute to the development of alliances or a reason for starting a war. Nowadays, more than ever before, energy is a fundamental aspect of all human activities. As a consequence, a disruption in supply may have devastating consequences for the receiver. The invasion of Russia in Ukraine represents a major geopolitical issue which is mainly driven by energy resources allocation. Russia controls the gas supply in Europe and the fact that the European

countries support Ukraine may lead Russia to cut off gas deliveries. This is a scenario that could create major issues in Europe and is indicative of the importance of having an adequate energy mix that reduces dependence on just one provider (Popkostova, 2022). As a consequence, it is highly understood that the political nature of energy is fundamental and apparent and in moments of energy crisis.

Energy security is a core concept related to energy geopolitics. It is a concept widely used, but not universally defined. It can be argued that energy security is “the uninterrupted availability of energy sources at an affordable price” (International Energy Agency, 2022). It is a concept with several aspects which refer both to the long-term horizon (timely investments so as to ensure energy supply responds to demand) and the short-term horizon (potential to effectively and promptly respond to energy crisis). Energy security is highly related to the renewable energy sources, because in this way the dependence on few energy resources can be avoided. The EU encourages member states to proceed to initiatives which will increase the proportion of renewable energy in their energy mixes.

2.3 The global energy transition

Energy is a power that is highly related to human life and prosperity. People, since the dawn of civilization try to find energy resources so as to fulfill their needs for food, warmth, cooling, transportation and a lot more. During the years, people change the energy patterns they use. There are multiple energy resources available in nature, like fossil fuels (natural gas, oil, coal) and renewable sources like the sun or the wind. Then, these resources are subject to a process that offers the energy carriers, like electricity or gasoline. Then, energy carriers are used in order to provide energy to energy converters, like cars or lightbulbs. When energy transition is the case, it is important to state that it can involve “a particularly significant set of changes to the patterns of energy use in a society” (O'Connor, 2010: 8). Also, energy transitions are made up of small changes and energy sources change the areas of their applicability. For example, oil was replaced by electricity and gas in the daily life (it was widely used for lighting), but now it is widely used in the transportation market. Coal may not be used for home heating but is used in the electricity market instead.

Energy use changes over the years and, during the last two hundred years, countries around the world use different sources of energy, according to availability and other

factors. Innovation is a main driver of change and, in the case of energy, constant research and technology development lead to innovative solutions as well as to improvements in the quality and quantity of the energy services provided. It is interesting to refer to the factors that lead to energy transformation during the years and the market conditions that are related to this transformation (Solomon & Krishna, 2011).

It is indicative that energy consumption shifted from wood, which was the main source of energy on 1870s, to coal (in 1900s) and oil and gas in 1960s. It is also interesting to refer to the patterns of energy used in different countries, throughout the years. More precisely, it is evident that, in many cases, the energy sources that were in developed countries during the earlier eras, are those that are now used in developing countries. Another element that needs to be taken under consideration is the fact that the demand for energy is more or less similar across countries. People of all countries need heat for cooking, heating or cooling devices in order to cope with weather, mechanical power for agricultural and mechanical activities. People also need energy to communicate, to entertain themselves, to participate in social and educative activities. The demand for energy is related to the climate of a country, the existing infrastructure, even the cultural and economic status. Besides, the availability of resources also influences the way the economy is developed (Pascual, 2015).

The USA, for instance, developed an energy pattern which was mainly based on low-cost energy sources, which could be found in abundance, like coal (since wood was the first energy source widely used), oil and natural gas. It is indicative that the country is the one with the largest per capita consumption in energy, among the developed countries, as well as the one with the most energy per unit of gross domestic product. But, the energy pattern of the country did not take under consideration the side effects and adverse consequences of the overexploitation of energy resources. Fortunately, the country has the chance to use other, more environmental friendly sources, like the wind, the sun or biomass and effectively and successfully transform its energy pattern in the future.

It is well understood that change in energy patterns is a reality and this is evident in the way people use energy throughout the years. The drivers of energy transition are multiple but the demand for energy services is the core factor of the transition. Also, it is important to understand the factors affecting the choice of an energy option over

others that are available (Takacs-Santa, 2004). First, it is the factor of supply constraints. Not all resources are renewable and there are those that cannot respond to the demand for ever. These supply constraints are further boosted by demand growth, like in the case of oil. Second, the choice of an energy option depends on cost advantages. Even in cases when a resource is abundant, cost constraints (throughout the supply chain) may lead to the transition to another energy resource. This was the case with home heating, where natural gas replaced coal. Third, there are performance advantages. These advantages include speed, safety, cleanliness and are always evaluated in terms of the price of the energy resource. For example, the early adoption of electricity, the use of oil-driven steam turbines in vessels, the use of refrigerators instead of iceboxes, the use of high-power engines for cars, all represent examples where the transition was made thanks to the better performance of the chosen resource. The fourth factor that affects transition is policy decisions. The geopolitics of energy where discussed above and reveal that the decisions of governments can affect energy supply and the source of energy preferred. It is indicative that OPEC members can control supply and create price shocks or artificial shortage in the market.

The last factor is probably the most important one, at least during the present time, and refers to the environmental benefits of an energy transition. It is argued that the use of an energy resource by individuals or groups, for personal or commercial reasons, causes negative externalities to the community. So, it is vital that the choice of a fuel over another needs to take this aspect under consideration. The Greenhouse Effect represents such an “externality” of the use of fossils. In these cases, policies are developed so as to protect the society from the negative consequences of the emissions. The transition to a low- carbon energy use is a decision that is part of policies that are applied on a global extend. International Conventions and Agreements are in place and drive the transition. The table below, describes some of the major energy transitions that were realized by 2000 and reveals the drivers for change, as well as the enabling developments (O'Connor, 2010).

Transition	Year	Driver	Enabling Developments
Charcoal to coal for smelting iron	1850	Local wood cost increases	Coking used to remove sulfur
Wood to coal for railroads	1870	Coal cost decreases	Bituminous coal or improved fireboxes used to overcome anthracite difficulties
Waterwheels to steam engines	1870	Performance advantages (power, reliability, location)	Extent of coal distribution expanded
Sailing ships to steam vessels	1810-1880	Cost, performance (safety, odor)	Improved refining practices for most fuels
Wood fireplaces to coal stoves in UK	17 th century	Rising cost of wood	Urbanization leading to easier distribution of stoves and coal
Oil lamps to electricity (rural)	1930	Performance (brightness, safety), cost	Expanding electricity grid
Gas light to electric (urban)	1910	Performance (safety), cost	Tungsten filament allowed lower overall cost
Wood to anthracite for domestic heating	1900	Urbanization, local wood cost increases	Coal distribution network (railroads, canals, roads)
Anthracite to oil / gas for domestic heating	1950	Cost (including associated labor cost)	Oil and gas distribution networks
Coal to oil for UK naval vessels	1913	Performance (speed), labor costs	Securing supplies of oil from Anglo-Persian Oil Company
Steam engines to electric motors for manufacturing	1915	Performance	Infrastructure
Coal to gas for UK electricity generation	1990-2000	Costs, policy	Deregulation of electricity industry

Table 1: Examples of energy transition, source: O'Connor (2010, p. 21)

2.3.1 The first major energy transition: from wood to fossil fuels

As already discussed above, energy transition is realized for several reasons, like cost, supply shortages, innovation systems, convenience, performance and a lot more. At a global extent, the first major energy transition was the one that involved the abandonment of wood, in favor of fossil fuels. The transition period lasted for about two centuries and by the end of the 19th century, fossil fuels became the first energy source that was in use at a global level. The transition period differed, according to the country and the sector involved. In the UK, for instance, it was the high labor costs and the scarcity of wood supplies, combined with the difficulties related to shipping wood, that led to the transition. Besides, urbanization led to excessive supply of cheap British coal, while, on the other hand, the prices of wood were increased. In fact, the UK was the first place in the world that, in the light of the first industrial revolution, replaced wood with coal (Fourquet, 2010).

Energy transformation is affected by the economy. In the UK, during the first industrial revolution, the agricultural as well as the industrial production have increased in

productivity and businesses were willing to use more efficient energy sources. Then, the technological development led to the use of new machinery, like the steam engine, which could work with coal or wood. The innovations that refer to the steam engine led to a revolution to the transportation sector. Then, during the 20th century, steam engines were replaced by internal combustion engines. These engines were much smaller in size and easy to transfer. besides, modern automobiles are based on this technology.

Petroleum fueled engines dominate the early 20th century, the century where the USA became a leading worldwide economy. When the diesel engine was developed, in 1882, the era of steam dominance ended. Nevertheless, steam-turbine generators that produce electricity use coal as their fuel and coal still represented a main energy source. Petroleum dominated several sectors, like the transportation and it was considered the ideal solution until geopolitical issues, as well as environmental issues arose. It is indicative that during the 1970s the member of OPEC decided to impose embargo in the shipments to the western countries. The Arab members of OPEC decided to set the embargo as a response to the support of Western countries to Israel. The embargo was imposed on the Western European countries, the USA and Japan and lasted for about five months. Oil prices were increased by 70%, with negative effects in production and in the global macroeconomic variables, leading to a global recession. It is evident that the lack of energy sources with a country makes it rely on other countries and this creates unfavorable dependencies. Thus, countries around the world have started developing programs, so as to become more energy independent (Solomon & Krishna, 2011).

2.3.2 The international conventions that drive the energy transformation

The United Nations Framework Convention on Climate Change (UNFCCC), Rio Summit, 1992

The need to change the energy patterns was realized decades ago, and during the Rio Summit, in 1992, the “United Nations Framework Convention on Climate Change” was agreed among participants, so as to protect the climate system for present and future generations (United Nations, 1992). The main purpose of the Convention was to stabilize the greenhouse gas concentrations, so as to ensure that the climate system does not end up to be dangerous for the humanity, but also the general global ecosystem. It was also argued that the acceptable levels of gas concentrations needed to be achieved

within a specific timeframe, something that is indicative of the urgent nature of the energy transformation. Climate change was a reality and it was well understood that economic development needed to follow sustainable principles, so as not to jeopardize food production and ecosystem viability.

The UN Convention is based on the following principles (United Nations, 1992). First, all participants, and more precisely developed countries, should take the lead and implement initiatives in order to combat the adverse effects of climate change, as well as in order to stop climate change. Second, the needs and special circumstances referring to the developing countries had to be considered, so as these countries do not have to bear a disproportionate burden. Third, all parties involved should ensure that precautionary measures are taken, always by bearing in mind the different socio-economic contexts but also by considering the development of co-operation among the parties. It is also of high importance that any initiatives should be cost – effective, meaning that global benefits should be achieved at the lowest cost. Fourth, sustainability is the key concept and practice that needs to be considered among interested Parties. Last, an open international economic system should be promoted, a system that ensures sustainable development but also allows for international trade to be realized in the best way.

The Convention also included some commitments, referring to the Parties involved. First, all Parties would remove by sinks all greenhouse gases that were not controlled by the Montreal Protocol. Second, all Parties were committed to take measures that will mitigate climate change, at national and regional level. Third, Parties involved agreed to co-operate at all required levels and sectors (like industry, energy, forestry, waste management), so as to reduce emissions of greenhouse gases. Co-operation was also established at the prevention level. Fourth, all stakeholders decided to promote sustainable management of sinks and reservoirs of greenhouse gases that are not controlled by the Montreal protocol. Fifth, all parties committed to develop strategies so as to deal with the consequences of the climate change. Such consequences include drought and desertification but also floods, like in the case of Africa. Sixth, all Parties were committed to ensure that they would implement practices so as to mitigate the adverse effects on economy and well-being by the measures taken to adapt to climate change. Then, all Parties were committed to co-operate in research, to develop data archives concerning the climate and the environment, so as to gain in depth

understanding of the causes and effects of the climate change. It is also important that developed countries undertook more commitments, since these are the ones more responsible for the climate change.

The Convention was signed by 154 countries and it did not involve legal obligations, but it set the framework for further action in the future. Besides, it is indicative that during those years, even though the signs were more than evident, there were a lot of doubts concerning the need to take action. Thus some years later, in 1997, the Kyoto Protocol came to boost the effectiveness of the Convention.

The Kyoto Protocol

The Kyoto protocol was developed in order to set specific, measurable goals concerning the environmental protection against dangerous gas emissions. The Kyoto Protocol was signed in 1997 and its main goal was the total reduction of emissions, at least by 5%, during the years 2008-2012, compared with those referring to the 1990s. According to the Kyoto Protocol, the parties involved agreed to retain emissions of six gasses up to specific levels. The protocol started being valid since 2005.

More precisely, the main issues included in the protocol are the following (United Nations, 2022).

- Developed economies committed to reduce the total emissions by 5%. This goal refers to the following gasses: carbon dioxide, methane, hydrofluorocarbons (HFCs), fluoride hydrocarbons and Sulphur hexafluoride.
- All Parties had to accomplish the above mentioned goal during the period 2008 – 2012.
- The Parties involved had the option to co-operate and co-accomplish their obligations. They could develop synergies and agreements where each country would have to have the permitted levels of emissions.
- The parties also had the choice to fulfill part of their requirements, through third party flexible mechanisms, like the mechanism of “clean” development and the trade of emissions.
- The States – Parties had to adopt policies and measures towards the fulfillment of the Protocol goals.

- All Parties need to comply with their obligations and a strict framework was developed so as to ensure this compliance.

As mentioned above, the Kyoto protocol referred to a commitment period of five years (2008 – 2012). Then, the second commitment period started in 2013 (until 2020) and was decided during the Conference of the Parties, in Doha, on 8 December, 2012 and it is known as the Doha Amendment. The Amendment entered into force on 31 December, 2020. According to the Amendment, new commitments were undertaken by existing parties, while new Parties entered the Convention. It is indicative that during the years 2008-2012, there were 37 developed countries (and economies, like the EU), that committed to reduce emissions of GHG by 5%, while during the second period, that was determined with the amendment, countries and Parties (different from those in the first period) committed to reduce GHG emissions by 18% (compared to those during the 1990s).

The Kyoto Protocol represents the starting point of changes concerning the use of energy. The establishment of flexible market mechanisms was something new but really effective, since they encourage the reduction of GHG emissions, first where it is cost-effective. In fact, developing countries represent an example of where GHG emissions can be reduced, while new, green investments can be encouraged. Then, another important element of the Kyoto Protocol is the fact that it established a robust monitoring system. All countries' emissions are registered in records, while transactions among the Parties are also monitored through the development of a registry system (United Nations, 2022).

The Paris Agreement

The Paris Agreement represents a landmark, concerning the climate change, and it is, in fact, the agreement that further strengthens the UN Convention and the following agreements (like the Kyoto Protocol). According to “Article 2” of the agreement, it is fundamental to “strengthen the global response to the threat of climate change, in the context of sustainable development and efforts to eradicate poverty” (United Nations, 2015). Specific goals include the holding of the global average temperature at acceptable levels (2⁰C above the pre-industrial levels and gradually 1.5⁰C above the pre-industrial levels). Then, countries around the world have to adapt to the adverse effects of the climate change, while, at the same time, trying not to jeopardize food

production. Also, it was clear that funding would involve only low greenhouse gas emission initiatives and sustainable development initiatives (United Nations, 2015).

The core values of the Agreement include long-term goal setting, contribution of all Parties through the development of specific National Action Plans, ambition, transparency and solidarity of developed countries towards the developing ones. The Agreement started being valid on 4 November, 2016, after it was validated by at least 55 countries, which are responsible for the 55% of the global GHG emissions. All EU member states have validated the Paris Agreement.

Since the Rio Summit, there are a lot that have been done, especially as far as research is concerned, but, not really effective measures were undertaken, regarding the climate change. The United Nations Framework Convention on Climate Change was the first official step, followed by the Kyoto protocol, which established legal binding goals concerning the climate change. The Paris Agreement was a chance to renew the commitment of all Parties. It is also important to state that, under the Paris Agreement, the EU developed its long-term strategy referring to the climate change and decided to reduce gas emissions by 55%, compared to the levels of 1990 – 2030 and to achieve climate neutrality by 2050 (European Council, 2022).

The following infographic is indicative of the EU's road to climate neutrality.

Paris Agreement: the EU's road to climate neutrality

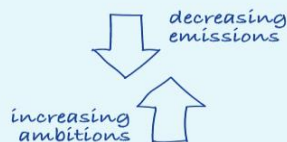
In December 2015, for the first time **all countries worldwide** agreed on a collective effort to:



keep global warming well below **2°C**



tackle climate change effects



The agreement requires parties to submit national plans to reduce emissions and to review these commitments **every 5 years**



What the EU pledged

The EU has agreed to cut emissions by **at least 55% by 2030**, up from its 40% commitment in 2014.



The EU's end goal is to reach **climate neutrality by 2050**. This will entail a transition which should:



require action from **all sectors of the economy**



be **socially balanced and fair**



preserve the EU's **competitiveness**



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General Secretariat

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Image 1: Infographic - Paris Agreement: the EU's road to climate neutrality, source: (European Council, 2022)

Developed countries can be used as a reference point, so as to study the energy transformation patterns. The present study focuses on advanced economies, like the USA, Europe, Russia and China. In the analysis chapter, there is extended reference on the prospects of RES, as well as the policies developed by the above mentioned countries and economies.

2.3.3 The Global Energy Transition parameters

The Conventions and Agreements referred above indicate the need to proceed to the transition to a new era, conserving energy consumption. Renewable Energy Sources, (and conventional ones), need to be implemented in an efficient and effective way. Up to now, in order for the globe to reach the goals of the Paris Agreement mentioned above, it is necessary to intensify the use of renewable energy. According to scientists, it is technically feasible to limit average global temperature to below 2⁰C above the pre-industrial levels and gradually 1.5⁰C above the pre-industrial levels. It is also more beneficial for all aspects of sustainable development. But, the transformation – or Energy Transition - to a world that is based on Renewable Energy Sources is really difficult, since the global society and economy is based on fossil fuels.

Renewable Energy Sources, along with energy efficiency, represent the most adequate way to reach the desired goals, within the desired timeframe, as far as gas emissions are concerned. It is estimated that RES and energy efficiency can contribute to the reduction of 90% of carbon dioxide emissions that are energy related. Also, RES involve the use of safe, reliable and affordable technologies that are readily available. Besides, technology is developing day – by – day and innovations are added to the existing systems and practices. According to existing research, developed countries and economies around the world can use RES in order to replace traditional sources of energy. More precisely, it is estimated that for the majority of countries, RES can represent the 60% of the total energy consumption, while for China this percentage can reach 67% by 2050 (it was 7% in 2015), while for the EU this percentage could reach 67% by 2050 (IRENA, 2018).

If energy efficiency is constantly improving, then, it is feasible to use RES as the primary energy supply (accounting for two thirds of the total energy supply). Also, energy intensity needs to be reduced by about two thirds, so as to reach the 2050 targets. It is important that RES need to be used in all sectors of the economy. First, the power sector is one of the most important ones, referring to the energy transition. The decarbonization of the sector is fundamental and it is estimated that by 2050, renewable energy needs to represent 85% of the total energy used in the sector. This can be realized mainly through solar and wind energy, while low-carbon electricity needs to represent the 40% of end-use consumption by 2050. Even though the power sector makes progress, year-by-year, in relation to the use of renewable energy, but this progress is not adequate and needs to be accelerated. Then, the building sector, as well as the transportations and industry are based on energy and renewable electricity supply, bioenergy, solar energy and geothermal energy represent RES that are widely used. In these sectors, biomass seems to represent a main source of energy, by offering around the two –thirds of the renewable energy used (IRENA, 2018).

It is important to also refer to the economic aspect of the energy transformation. It is estimated that the annual cost of the transition will be around 1.7 trillion US dollars. Nevertheless, the benefits are far more important. Cost savings that refer to better health and reduced damage to the environment are far larger than the costs and are estimated to reach 6 trillion US dollars by 2050. Besides, the energy transformation will lead to a reduced footprint, and consequently the global prosperity and welfare will be improved in terms of GDP and employment. It is estimated that the cumulative gain by the increase of GDP will be 52 trillion US dollars by 2050. Of course, in order to reach these goals (or estimations) it is necessary to invest in low-carbon technologies. In order for the energy transition to become a reality, it is fundamental to increase investment by 30% by 2050 (something that refers to 120 trillion of cumulative investment by 2050). In terms of GDP, it is estimated that about 2% of the global GDP needs to be invested each year so as to implement the decarbonization projects.

It can be argued that the energy transition, apart from the carbon footprint, it will improve the socioeconomic footprint as well. Welfare will be increased, GDP will be improved and employment will be increased as well. In fact, the increase of the welfare will be the most prominent ones, while GDP and employment increase will depend on the special characteristics and the project of each separate region. Another positive

aspect of the energy transition is that it will boost employment in the energy sector. According to researchers, the amount of people employed in the energy sector will be greater than that of those working in the fossil fuel industry. About 19 million people will be employed in the energy sector by 2050, 11.6 million more than the job losses due to the transition. In order to ensure employability, it is necessary to develop training and education policies and practices. New skills and competencies are required and the transition is expected to bring a fair and just socioeconomic change (IRENA, 2018).

2.4 The Geopolitics of Renewable Energy

Nowadays, globalization and technology create new challenges, like climate change, while issues like power conflict are rising again. Oil and gas resources, which represent the traditional sources of energy become scarce, while their environmental footprint is major. On the other hand, the cost of solar and wind power becomes lower, thanks to the technology advancement and renewable energy, as shown above, represents the new alternative which is intended to dominate the energy mix. The trade of renewable energy between countries has already caused tensions, especially in the case of solar trade disputes between the EU and China, as well as the USA and India. It is also indicative that investments in renewable energy sources becomes an international trend and multinationals, like Google invest across the globe. This is why it is interesting to focus on the geopolitics of renewable energy, which in fact has not yet received the attention required. Besides, the geopolitics of renewable energy significantly differs from those of traditional energy and all stakeholders need to start exploring the consequences of a rapid expansion of renewable energy on geopolitics (Austvik, 2018).

2.4.1 The definition of renewable energy

Renewable energy is a term that is used in order to distinguish between the conventional sources of energy which are not renewable, like coal, natural gas or oil. These conventional sources of energy are characterized by the fact that when the energy is extracted, the source cannot be re-used. Fossil fuels are formed during millions of years and the supplies of oil, natural gas and coal are limited, in the sense that they cannot be used for multiple times. On the other hand, there is renewable energy, which can be described as “all natural energy flows that are inexhaustible (i.e., renewable) from an

anthropogenic point of view: solar radiation; hydropower; wind; geothermal; wave, and tidal energy; and biomass” (Criekemans, 2011: 6).

Renewable resources have the advantage of being able to replenish themselves, but, on the other hand, they are flow limited, in the sense that, for example, in the case of wind energy, wind doesn't blow constantly. Also, it is important to distinguish between renewable and sustainable energy, since sustainability represent a major policy issue for countries, organizations and institutions around the world. According to the Brundtland report, sustainable development is the “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (Brundtland Report, 1987). Under this framework, set by the report, sustainable energy sources are “renewable energy sources which are less burdening the environment in terms of climate, acidification, waste, disruption, drying out, etc. as compared to conventional energy sources” (Criekemans, 2011: 7). As a consequence, not all renewable resources are sustainable. For instance, hydropower may cause severe problems to the local communities and the local biodiversity and environment.

2.4.2 The areas that renewable energy can affect geopolitics

Energy transition and the use of renewable sources of energy can have consequences, both from an internal and an external geopolitical perspective. As far as the internal-geopolitical perspective is concerned, the energy transition will have economic and social effects. It can be compared to the industrial revolution and can question social structures, economic systems, as well as politics among nations. It is evident that national states in Europe were created during energy transition periods. This is the consequence of the need for central power supply, since huge amounts of capital, as well as central political decisions making are required. Besides, this is the reason why energy is highly related to geopolitics. Countries with high levels of demand for energy, like the USA or China, are also prepared to secure their access to energy resources by even developing military apparatus. The transition to renewable energy will bring substantial changes, since the energy supply will be decentralized and consequently the political balances will also be affected. There will be “more players” in the energy domain, since the governments that decide to invest a great deal on renewable energy, will gain an advantage over their traditional energy suppliers. On the other hand, the

countries that hold the monopoly of conventional energy supply will probably try to continue dominate the energy field. So, it is vital for governments and policy makers to try to develop strategies and framework that will ensure diversity, equality and transparency among energy suppliers, both renewable and conventional energy suppliers. last, the external geopolitical perspective includes the change in the dominance of geopolitical players. It is probable that, instead of the dominance of the USA or USA and China, a multipolar scheme is created and power is equally distributed (Criekemans, 2011).

The augmenting use of renewable energy can affect geopolitics, related to five distinct areas. First, the critical materials supply chain (O'Sullivan, et al., 2017). The use of renewable energy sources requires materials which are rare (like dysprosium, neodymium, terbium, europium and yttrium) are found in countries like China and Russia. Even though rare earths are also found in other countries, China represents the global processing center. This could enhance the development of cartels. In order to avoid geopolitical issues, it is advisable to reduce the need of such elements in the development of renewable energy systems and to start developing supplies in countries other than China and Russia, since rare earths are not in fact rare, but they are found in smaller percentage in several countries.

Another material that can affect geopolitics is lithium, which is used in several renewable energy technologies, especially in batteries for EVs. It is mainly found in Australia, Chile, China and Argentina. Also, indium, which is mainly provided by China and cobalt, which is mainly provided by DR Congo are also two important geological reserves used in solar panels and batteries. of course, it is worth to mention that global reserves of minerals are not exploited in the same intensity, since their extraction depends on technology, demand, infrastructure, research and a lot other factors. Supply shortages can, therefore, create geopolitical conflict.

The second area that is related to renewable resources geopolitics is technology and finance. Renewable energy is based – at a great extent – on technology and infrastructure and countries which wish to dominate the sector need to invest on intellectual property. Thus, it is possible that the countries with high levels of innovation and R&D investment will be those that will distinguish. It is possible that the need for constant technology development may create synergies but also lead to geopolitical rivalry (Criekemans, 2011). For instance, developed countries, which are

able to invest on R&D and renewable resources may further enhance their geopolitical power. This, in turns, may create a new aspect for geopolitics, where R&D expenditure will represent a leading factor. Another area of potential geopolitical issues is the development of rivalry concerning renewable energy infrastructure. It is indicative that China, which is the leader in renewable energy investment, followed by the USA, envisions to develop a global wind and solar power grid, known as the “Global Energy Interconnection” and this may lead to geopolitical leverage (World Economic Forum, 2016).

Super grids represent a third factor which can affect the geopolitics of renewable energy. They are multinational grids ate are used for resource sharing and economies of scale. Through these systems, countries that have no adequate resources, they import energy, while resource rich countries export energy. Even though this situation could be a reason for developing regional peace, it is probable that it can also create geopolitical issues, like regional conflicts. For instance, a country can take advantage of its energy and use it as an element of power over the countries that depend from the energy. Also, the interdependencies within the super grid arrangements are related to the geopolitical power of participants. On the other hand, if countries decide to develop decentralized, micro-grid solutions, then the reduced interdependency may lead to reduced incentives to avoid conflict among states. The case of the Russian and western countries conflict over Ukraine is an example of energy geopolitics, where the EU, which depends on Russian natural gas had to exclude it from sanctions against Russia (Fjaertoft & Overland, 2015).

Then, the reduction of the usage of oil and gas demand will change current status and will lead to several geopolitical consequences. First, oil and gas producers will face important fiscal challenges, especially those that base their economy on oil or gas production. Unemployment in those areas will increase, political and economic reforms will be realized, leading to social reforms, while the decline in revenues can cause political instability. On the other hand, the scarcity of oil may lead Middle East countries to acquire more geopolitical power. Second, the use of renewable sources may reduce the energy security shocks, will create new jobs, will enhance innovation and R&D investment. These factors may lead countries will high penetration to renewables, like Morocco, Chile and Jordan, to gain political power in the global arena (O'Sullivan, et al., 2017).

Another factor that relates renewable energy and geopolitics is the climate change. More precisely, stakeholders around the world were worried about the geopolitical consequences of the climate change. The danger of sudden natural disasters and resources' scarcity could lead to global migration phenomena and, as a result, to political instability and tension, both inside a country, but also between countries. Thus, the use of renewable energy can be considered as a conflict prevention factor (Hogarth, et al., 2015).

It is important to refer to the issue of the access to sustainable energy which also creates geopolitical implications. First, energy poverty is a major factor that enhance conflict and political instability. It is indicative that Africa and developing Asia represent areas where energy poverty is apparent. On the other hand, access to renewable energy sources can minimize internal instability and enhance people's prosperity (Behrens, et al., 2012).

2.4.3 The geopolitical benefits of renewable energy

As already discussed above, renewable energy may lead to a better, more just energy distribution and this will probably affect geopolitics in a positive way. It can also strengthen energy security and create new interdependencies among nations. Also, since renewable energy will be available and a lot of countries will be able to own such resources, the geopolitical tensions that are developed due to energy issues will be reduced. In addition, the development of global partnership could lead to the reduction of the financial differences between the North and the South and the creation of a new global market which will not be characterized by conflicts over scarce resources (Hoggett, 2014).

The renewable energy may positively affect geopolitics since it can reverse the "resource curse" created due to the fact that oil and gas production countries demonstrated distortions in their economies (high rents led to overvalued exchange rate, corruption, violent conflicts, uneven development among the sectors of the economy). Renewable energy, on the other hand, can become a factor which will held countries to develop diversified, sustainable economies (Humphreys, et al., 2007).

Other researchers argue that when renewable sources of energy will dominate the world, then, countries will be able to have self-sufficiency and this will make them

concentrate on the management of the internal supply of the energy, rather than on the securitization of external supply, as it was the case with conventional energy sources. This is due to the fact that renewable energy sources are not geographically concentrated, so it will be difficult for a country to control market prices or to use political power (O'Sullivan, et al., 2017).

2.4.4 The geopolitical drawbacks of renewable energy

Researchers also refer to the drawbacks of energy transition. Unlike those who argue that the use of renewable energy will contribute to the minimization of geopolitical tension, these researchers argue that new types of conflicts may arise. They state that renewable energy can be used in order to create new geopolitical tensions, like those referring to conventional energy sources. For example, if energy is transported across borders, then it is probable that the same issues as before arise (Laird, 2013).

Researchers also state that the transition period may entail geopolitical risks. The change in the global energy mix may lead to reduced security levels. More precisely, some existing risks will be reduced, while new risks will appear. Furthermore, new types of conflicts and controversies will be created, something that makes the transition period uncertain and with complex consequences (Westphal & Droege, 2015). It is also worth to mention that the new era will still have some vulnerable states that will be the “losers” concerning the geopolitical status that renewable energy dominance will create. Countries with limited financial resources will not be able to compete the other countries in terms of technological development and R&D (Johansson, 2013).

The following table includes the short-term and long-term impact of the adoption of renewable energy sources on security issues.

Drivers	Security implications	Examples	Short- and medium-term impact	Long-term impact
Structural inequalities reduced by EU renewables policy	More fossil fuels resources available for rest of the world	More fuels to burgeoning economies in Asia and Africa	EU: gradually less need to be involved in international disputes, but international tensions over energy could still increase	Positive impact on overall energy-related conflict worldwide if rest of world also makes transition to renewable energy
Developing and accessing new resources	Less pressure to secure new resources off- or onshore	Less tensions in South China Sea, Arctic Sea	Tensions concerning access to new resources could increase if demand goes up	Tensions could decrease if supply outstrips demand
Energy as a coercive instrument	Energy will be less useful as stick or carrot	Russia, Gulf States, Venezuela	No price decreases expected now, energy as coercive element remains useful	Should prices decrease, energy less useful to coerce other countries

Table 2: Short-term and long-term impact of the adoption of renewable energy sources on security issues, source: O'Sullivan, et al. (2017: 43)

Researchers further argue that uncertainty represents another element that will characterize the future of geopolitics of renewable energy. This is due to the fact that a lot of countries which are not technologically competent, may have to take decisions which will have geopolitical consequences. Besides, uncertainty refers to the supply and demand of energy, since the transition period is not well-defined. It is also supported that the Paris agreement is characterized by multiple geopolitical implications which need to be clarified. In addition, it is argued that the geopolitics of renewable energy could resemble to those of fossil fuels. In fact, renewable energy is related to a lot of issues and has several dimension, like technical, economic, legal and sociological and this creates complexity (Liano-Paz, et al., 2016).

3 Research Methodology

The research methodology describes the way the researcher has chosen so as to offer the required answers to the research aim and question. In the present case, the research aim is to reveal the prospects of the use of Renewable Energy Sources in view of the 2050 Energy Transition, by geopolitical point of view. More precisely, the following questions were developed:

- Which are the prospects of the use of Renewable Energy Sources for the EU, in view of the 2050 Energy Transition, in terms of geopolitics?
- Which are the prospects of the use of Renewable Energy Sources for China, in view of the 2050 Energy Transition, in terms of geopolitics?
- Which are the prospects of the use of Renewable Energy Sources for the US, in view of the 2050 Energy Transition, in terms of geopolitics?
- Which are the prospects of the use of Renewable Energy Sources for Russia, in view of the 2050 Energy Transition, in terms of geopolitics?

In order to provide robust answers to the above mentioned questions, so as to fulfill the aim of the study, the qualitative research approach was selected. While quantitative research refers to the collection of measurable, quantitative data, qualitative research focuses more on the actual phenomena, instead of the frequency of their appearance. Qualitative research focuses more on “how” and “why” some things happen (Saunders, et al., 2015). In other words, qualitative research carefully describes the phenomena and tries to develop a theoretical framework. In the present case, the effort is to develop a framework about the prospects of the use of RES for major economies around the world, in relation to geopolitics. Through the use of qualitative research, the author was able to proceed to an in depth investigation of the secondary data, by analyzing and interpreting them (Crowe, et al., 2011).

The research methodology selected is the case study and the cases that are studied include four different countries and economies, the EU, the USA, China and Russia. Through the case study, the researcher focuses on a specific subject, that of the transformation of the energy mix and the replacement of conventional sources of energy with renewable ones. The subject is analyzed through the geopolitical aspect and the researcher tries to reveal interconnections among different variables.

There are several types of case study approaches (Yin, 2003). For example, there are case studies that contribute to the completion of other studies. There are also case studies that seek to reveal the causal relationships between theory and practice. Furthermore, there are case studies that entail narration. The present case study is an intrinsic one since it tries to investigate a specific phenomenon, that on the prospects of the use of RES, under the geopolitical perspective.

The case study approach is not an easy one and requires the careful and strategic organizing of all the processes and procedures and the effective use of time and resources that are available to the researcher. First, it is necessary to set the boundaries of the study, the limitations and the ethical considerations. Also, it is necessary to conduct a thorough literature review, so as to have an in depth understanding of the existing theoretical background. Then, the research design follows, so as to specify what will be investigated, for what reason and which are the success criteria (Saunders, et al., 2015).

3.1 Data collection

Data collection represents the basic element of the case study approach. The sources of data are closely related to the subject under investigation. In the present case, where the prospects of the use of RES are discussed, in relation to geopolitics, relative articles and official publications were used in order to find reliable data. First, the author tries to find information by official institutions and organizations, like the EU Council, the International Energy Agency and IRENA. Also, journal articles were searched, though well recognized internet websites, like Google Scholar. Then, internet sources, like newspapers' websites were used.

All data were written down and double checked for their suitability to be included in the research. Also, the use of multiple sources further assured the data relevance and credibility (Bryman & Bell, 2011). The key-words that were used include the following:

- energy security
- geopolitics of energy
- energy transition
- renewable energy geopolitics
- the prospects of RES for China

- the prospects of RES for EU
- the prospects of RES for USA
- the prospects of RES for Russia

Then, the researcher read the data gathered and chose those that were included in the study.

3.2 Data analysis

data analysis in the case of qualitative research is different than that in the case of quantitative research. Quantitative research analysis is realized using scientific tools and is considered to be more objective, since it is not subject to interpretations. On the other hand, qualitative research analysis requires the researcher to have critical thinking, as well as an objective (as much as possible) treatment and interpretation of data. In other words, in the case of the qualitative analysis, the researcher's skills and experience are of great importance.

In the present case, the analysis of the data was realized as follows. First, data gathered were evaluated for their relevance and usability in the research. Then, all data and their sources were written down, while, throughout the research, the researcher constantly evaluated data and tried to specify those that would be included in the analysis. The analysis was realized by country of interest.

3.3 Ethical considerations

During the research, it is possible that ethical issues arise. These issues may refer to the collection of data, the analysis or the interpretation of data (Crowe, et al., 2011). As far as the present research is concerned, ethical issues were managed as follows. First, during the collection of data, the sources that were used were valid and widely accepted, while these sources were characterized by open access. So, no need for approval appeared. Then, during the analysis stage, data were cross-checked, so as to ensure their credibility. Also, in the case that the researcher had some doubts about the credibility of the data, then, these data were not included in the study. Furthermore, during the interpretation of the data, the researcher tried to offer an objective view, according to the resources used and not according to personal beliefs. Last, the research aim and

questions were used, so as to avoid conclusions that were different from the research aim.

4 Data analysis

4.1 The prospects of Renewable Energy Sources – EU

Energy in Europe is highly related to geopolitics. The European Energy market is widely dependent on the Russian Gas and even market driven decisions made by businesses so as to change their commercial relationship with Gazprom, the organization that has the monopoly on the provision of Russian Gas, may lead to geopolitical issues. The contracts with the Russian Gazprom are long-term and the attempt to change them could make Russia turn to China, something that, according to researchers, could affect the general political conditions between Russia and the EU (Abdelal, 2015). As a consequence, the prospect of using RES in order to mitigate the negative effects on climate change, could raise important geopolitical issues.

In fact, the EU depends on the Russian Gas since the 1960s. But, during the last decades, this dependent became an issue of concern with geopolitical parameters. The entrance in the EU of East European countries that were part of the Soviet bloc made the dependent on Gas really important, since these countries received almost all of their gas from Russia, so EU members had a different degree of dependence on Russia. In addition, these countries did not have the best political relationships with Russia and dependence on Russia for energy was an issue of worry. Furthermore, given the fact that Russia moved its transit infrastructure to Ukraine, the EU was (and is) in the middle of the dispute between the two countries. The EU Commission realized that the dependence on Russian gas is not beneficial and creates insecurity, so it began building an internal market for natural gas, in order to stop Gazprom's monopoly (Salzman, 2016). It is evident that the transition to an era where the energy mix includes less natural gas and more renewable energy sources is in favor of the EU, but can cause geopolitical changes.

It is true that the EU represents the economy that was among the first to declare, during the Paris Agreement and before, that the transition is important and necessary and that it will proceed to the implementation of all the required policies and measures so as to reach specific goals by 2050. It is also true that the energy policy of the EU is based on the following factors: the security of energy supply, competitiveness and sustainability. As a consequence, the EU needs to increase its commitment to energy efficiency and the use of renewable energy represents a way to fulfill this commitment. On the other hand, and by taking under consideration the geopolitical aspects of the sudden reduction

of natural gas usage, the transition period can include the use of natural gas (Salzman, 2016). Indeed, natural gas is far less pollutant than oil or coal and it could be used to replace other, dirtier energy sources, so as to achieve the Energy Roadmap 2050 goal of reducing gas emission by 80% below the levels of 1990, as shown below.

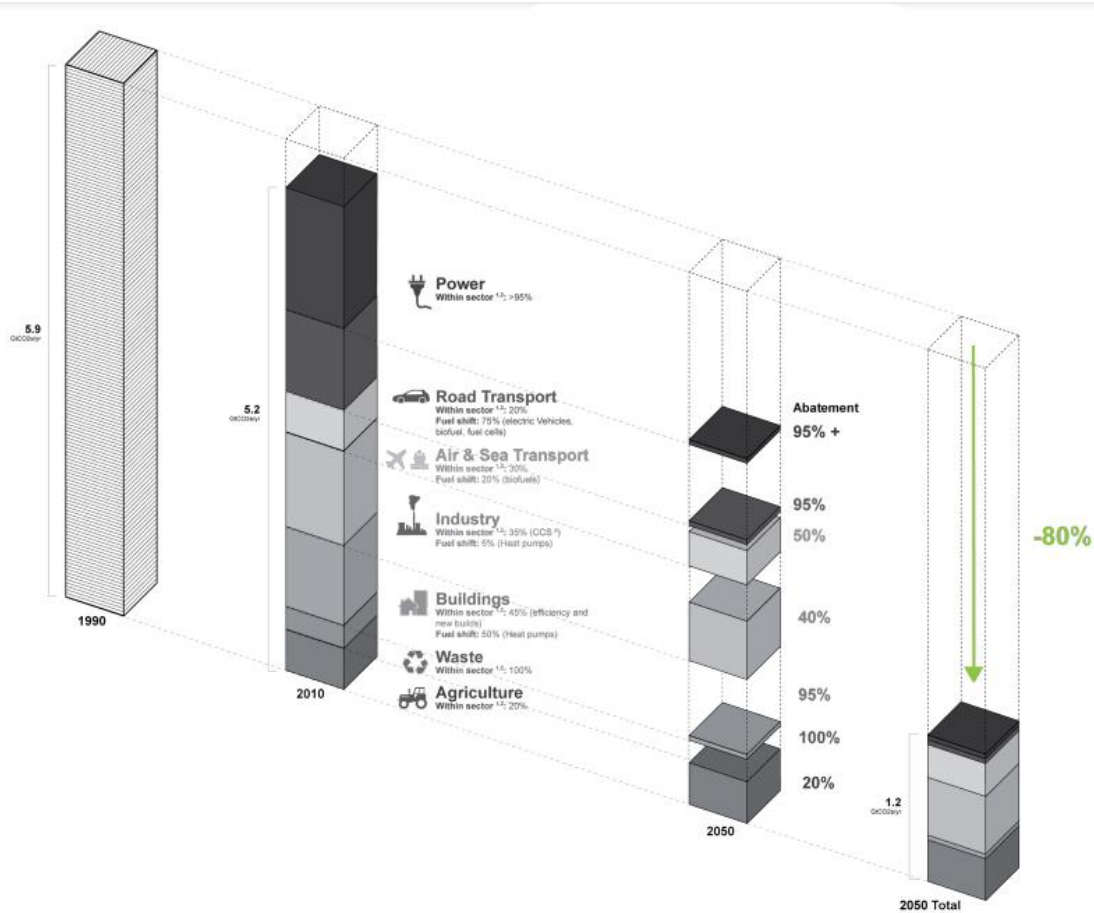


Figure 1: The 2050 energy roadmap for the EU, source: (RoadMap2050, 2022)

The EU has established an aggressive “Roadmap” with specific targets for the years to come. The aim is to reduce greenhouse gas emissions, to improve energy efficiency and to use renewable energy sources at a great extent, by reducing the use of conventional sources of energy. In fact, during the last decades, there is substantial progress, as far as the reduction of greenhouse gas emissions and energy efficiency is concerned, but, in the case of RES, not all member-states make the same progress. Also, there are differences concerning national and EU energy policies, while fossil fuels still represent the dominant source of energy.

Under the above mentioned framework, the energy transition is a reality and a necessity but it is important to realize the prospects of the use of RES in the case of EU. First, in

order to proceed to the transition, the EU needs to decide between an evolutionary or a transformations transition. The first type of transition refers to a long-term transition period which combines old and new sources and providers of energy. The second type of transition refers to a complete, short-term transition and to the use of 100% renewable sources of energy. More precisely, according to the evolutionary transition, the EU will continue relying on fossil fuels and nuclear energy and will – at the same time – start using renewable sources of energy. Technology and innovation will be used so as to make a more efficient use of conventional energy sources. Also, this type of transition is, in fact, characterized by multiple transitions, some long-term and some short-term ones. Furthermore, this evolutionary transition is driven by the need for energy security. So, there will be special care so as to ensure availability of fossil fuels and – at the same time – create a “low” carbon economy, while it will be necessary to reduce reliance on suppliers like Russia, which is one that the EU is highly dependent on. It is evident, though, that this type of transition is preferable for the countries that represent energy suppliers (RoadMap 2050, 2022).

The second type of transition is the transformational one and it is about a rapid and sudden switch to the use of renewables. This 100% RES use vision entails the setting of targets that are measurable and requires official authorities to effectively manage the transition, perhaps by implementing a state-centric perspective. This type of transition is mainly based on the realization of the need for environmental protection, the need to stop the use of health damaging fossil fuels and the need for developing a sustainable world. In addition, the scarcity of conventional resources in many EU member states may motivate this type of transition (Szarka, 2016). The following table summarized the main elements of the two types of transition.

Evolutionary transition (“type 1”)	Transformational transition (“type 2”)
Multiple energy transitions	Singular transition to renewable energy
Fossil fuels (with or without CCS)	100% renewables
Continued/expanded use of nuclear power	
Partial recourse to renewables	
Energy efficiency understood as greater energy intensity	Energy efficiency understood as major energy savings
A “low carbon” economy	A “zero carbon” economy
A slow- and long-term set of transitions	A rapid and near-term transition
An open-ended perspective	A deterministic perspective
A process-oriented frame	A product-oriented frame
Little or no belief in transition management	Strong belief in transition management
Modest policy prescriptions, mainly by incumbent energy majors and established policy communities	Ambitious policy prescriptions, mainly by renewables lobby and environmental NGOs

Table 3: The alternative types for energy transition in the EU, source: (Szarka, 2016: 8)

In order to refer to the prospects of RES within the EU, as well as the type of transition that is most appropriate – and is followed – it is necessary to refer to the present energy mix. As already mentioned, the EU is heavily depended on Russia for the supply of natural gas. Also, the EU imports oil from politically unstable nations, and this is a matter of concern. Nevertheless, the official policy is to pass to a new era of low carbon energy usage and of safe, secure, sustainable and affordable energy. Besides, this policy is not only in favor of the climate protection, but, at the same time, it can ensure energy security. But, it is not at all easy for the EU to process to the transition. A major obstacle is the difference among the member-states’ policies. The EU tries to reinforce its institutional capacity related to the energy policy development and implementation with the Lisbon Treaty, where it is stated that: “a spirit of solidarity between member states” directed to four aims: “(a) ensure the functioning of the energy market; (b) ensure security of energy supply in the Union; (c) promote energy efficiency and energy saving and the development of new and renewable forms of energy; and (d) promote the interconnection of energy networks” (European Union, 2012). But, unlike the above mentioned statement, member states continued following diverse policies.

The Energy Roadmap 2050 represents an effort to proceed to the use of RES in do-ordination and with specific targets. The Roadmap refers to the following ten changes that need to be done, so as to protect the climate (Szarka, 2016).

Structural changes required for the energy transition in the EU

- (1) decarbonization is possible – and can be less costly than current policies in the long run;
- (2) higher capital expenditure and lower fuel costs;
- (3) electricity plays an increasing role;
- (4) electricity prices rise until 2030 and then decline;
- (5) household expenditure will increase;
- (6) energy savings throughout the system are crucial;
- (7) renewables rise substantially;
- (8) CCS has to play a pivotal role in system transformation;
- (9) nuclear energy provides an important contribution; and
- (10) decentralization and centralized systems increasingly interact

Table 4: Structural changes required for the energy transition in the EU, source: Szarka, 2016: 13)

The above mentioned changes are clear and refer to a transition model that resembles to the first type of transition described above. More precisely, the EU “Energy Roadmap 2050” does not refer to the use of 100% RES, it promotes centralized systems for the generation and transmission of energy and is also based at a substantial extent on the nuclear energy, which is not always acceptable when referring to the renewable sources. Also, the decarbonization process is not precisely states and it is rather ambiguous how this will happen and which are the priorities. Last, as already mentioned above, the EU is dependent on natural gas and it seems that his fossil fuel will be used as the bridging energy source (Commission of the European Communities, 2013). As a result, the transition will be realized, but, it will not be a transition to 100% use of RES, but to an energy mix that will include several fuels, as shown below.

	2005 (%)	Reference/CPI		Decarbonization scenarios	
		2030 (%)	2050 (%)	2030 (%)	2050 (%)
RES	6.8	18.4–19.3	19.9–23.3	21.9–25.6	40.8–59.6
Nuclear	14.1	12.1–14.3	13.5–16.7	8.4–13.2	2.6–17.5
Gas	24.4	22.2–22.7	20.4–21.9	23.4–25.2	18.6–25.9
Oil	37.1	32.8–34.1	31.8–32.0	33.4–34.4	14.1–15.5
Solid fuels	17.5	12.0–12.4	9.4–11.4	7.2–9.1	2.1–10.2

Table 5: Decarbonization scenarios for the EU by 2050, source: Szarka (2016: 14)

But, whichever the energy mix, it is interesting to refer to the impact of the transition and the accomplishment of the 80% target. If this is the case, then, severe security and geopolitical implications would occur. First, the distribution of political power at a global level can change, since the EU represents one of the major energy conventional energy consumers. As a result, the total demand will be decreased, prices will also fall and security risks may arise. In the medium term, the results of the use of RES are not necessarily predictable. For instance, it is possible that the EU establishes a policy so as to develop a renewable source and, at the same time, the prices of conventional energy sources fall. Then, the dilemma will exist and the EU will need to take decisions over the benefits of the use of a cheap fossil in the short-term or those involved in the use of RES, which requires time. On the other hand, in the long term, the shift to the RES will reduce that power of global suppliers, and, in the case of the EU, the dependence of Russia will stop, along with Russia's interference in the affairs of East and Central European countries.

Another aspect of the use of RES is that of security. If the EU becomes energy independent by 2050, then, the geopolitics will change and the EU will not have to secure its energy interests abroad, neither will it have to pursue new resources. In other words, the EU will strengthen its geopolitical position (The Hague Center for Strategic Studies, 2014).

4.2 The prospects of Renewable Energy Sources – China

China represents a country that faces an important challenge concerning both the energy supply and demand. It is indicative that in China the energy production, as well as the energy consumption followed for the last decades a continuous increase. It is the country that in 2014 accounted for the 24% of the global energy consumption. This

makes it also the country with the greatest emissions in carbon dioxide at a global level. The economy of the country is based on coal by about 70% and China needs to change this situation due to the shortage of resources and the need to minimize environmental damage (Zhang, et al., 2017). In order to do so, China has to prospects of using renewable resources, since it is a country with abundant such sources, but it has not managed yet to exploit its potential. The country’s energy structure is depicted on the following figure and reveals the increasing use of renewable sources of energy, but also the small percentage of these sources in the energy mix.

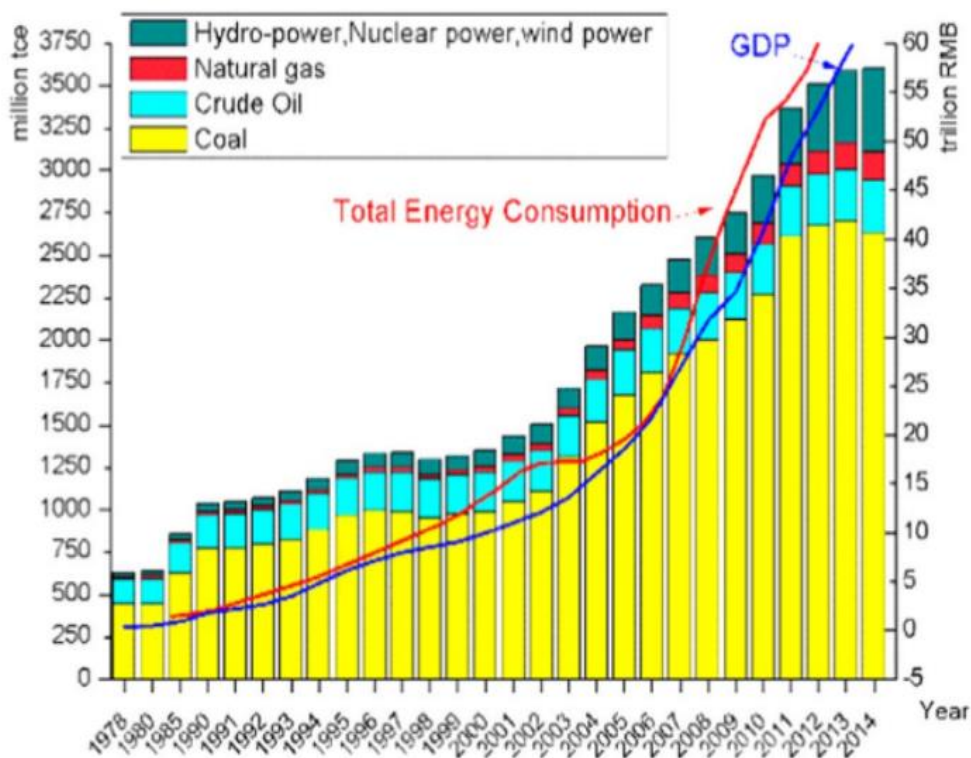


Figure 2: The energy mix of China, in terms of production, 1976-2014, source: Zhang, et al. (2017: 866)

The main renewable energy sources that are used in China are wind power, solar power, biomass power and hydropower. Especially in the case of hydropower, the country has the richest resources globally, while wind power is also promising. By 2050, the energy demand structure in China involves the use of coal, but on a steady rate, since coal will continue being used thanks to the clean coal technologies. On the other hand, RES and nuclear energy will be used on an increasing rate, as shown on the following figure.

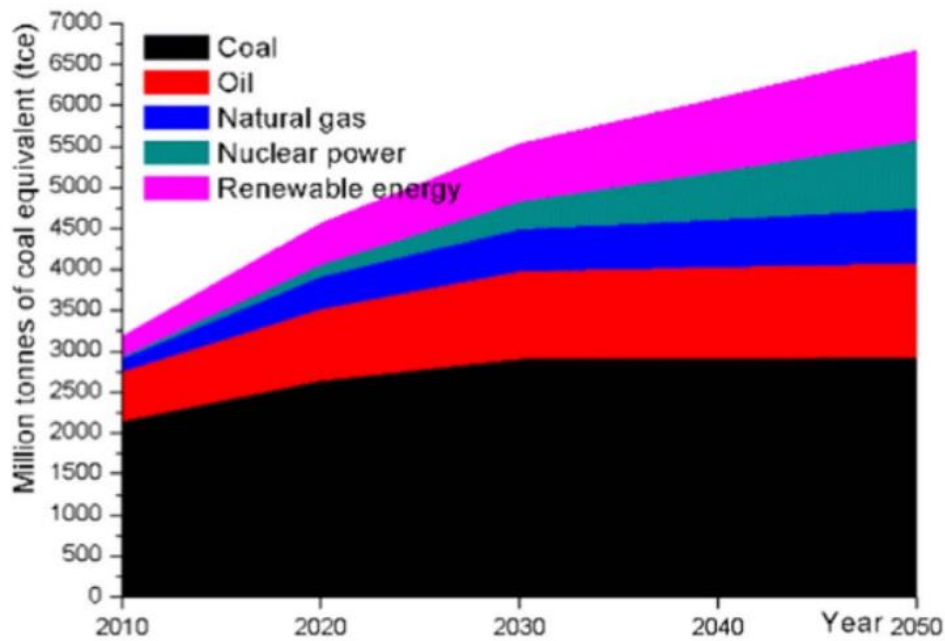


Figure 3: The expected energy demand structure in China by 2050, source: Zhang, et al. (2017: 870)

For China, the transition to a low carbon energy system, which will respect the environment and will allow the financial growth entails the use of the development of renewable energy usage. The country has the required resources, with hydropower and wind energy being the most prominent ones. Of course, it is important to overcome challenges, like the lack of adequate technology and innovation. It is indicative that a lot of technologies that are required for the development of renewable energy are imported and the domestic market does not have the ability to conduct independent research and develop innovations. Another issue that needs to be tackled is the fact that there is a substantial amount of renewable generation capacity that is lost, due to the fact that this energy is not fed to the electricity grid. This is a major issue and it requires the adequate infrastructure, but also the resolving of important quality problems that are related to the electricity that is generated by renewable sources. Last, but equally important is the fact that China is a highly bureaucratic country and it is difficult to manage the transition in an effective way. All stakeholders need to be activated and the government needs to set priorities and specific goals (Zhang, et al., 2017).

After having presented the prospects of RES use in China, the geopolitical implications are discussed below. It is argued that China will be among the winners of the energy transition. It is the country that, even though it did not have the required infrastructure and R&D, managed to be among the pioneers in the manufacturing of batteries, while it is also a country with abundant mineral resources that are required for renewables

energy generators. Besides, China will maintain its role in the conventional energy market, as far as the geopolitics of energy are concerned, since, as shown above, it will continue being a consumer of coal, oil and natural gas during the transition period.

In fact, China is the world's larger importer of oil, while it is the country with the largest needs for oil and gas. As a consequence, it is largely dependent on imported fossil fuels, something that poses energy security issues. These issues have long been tackled in a central way by the Chinese government, through investments around the world, through the use of natural resources as a repayment for loans, through the existence of multiple suppliers around the globe and through the development of reserves concerning crude oil (Meidan, 2021).

The energy transition is an opportunity for China to mitigate energy security risks and the country has already started investments so as to promote the electrification of all vehicles inside the country. Also, the country is a pioneer in the global market as far as the production of materials like solar modules (the country has a share of 70% of the global production) and wind turbines (the country has a share of nearly 50% of the global production), while it is the leader in the lithium-ion batteries supply chain. On the other hand, the energy transition and the reduction of demand on behalf of the country, will cause revenue losses to its traditional providers, something that may cause other problems, like the inability of these countries to repay their loans to China.

Another aspect of the transition in terms of geopolitics is the following. China in order to proceed to the use of renewable energy sources, has proceeded to developments, as far as the electric transport industry is concerned, while it constantly invests on green manufacturing. Also, as stated above, the country tries to ensure its adequacy in raw materials that are basic in the manufacturing of renewable energy generators. So, geopolitically speaking, China has an advantage over its "competitors" in the energy market, since Chinese companies invest in mines in countries where the required minerals, like copper, lithium or cobalt are found. Furthermore, China has an advantage concerning lithium refineries, since it has low labor costs, the required infrastructure and the willingness to accept the consequence on the environment (Overland, et al., 2019).

The emergence of China as a global manufacturer concerning the RES will decrease costs, but, at the same time, it will create geopolitical issues, like commercial disputes.

It is probable that the USA and the EU will want to reduce the dominance of China in the renewables' supply chain. This, in turns, makes China try to rely on its domestic potential and to secure its dominance in the global energy transition. As a consequence, it is evident that a new geopolitical game will begin, that of the leading role on renewables (Meidan, 2021).

4.3 The prospects of Renewable Energy Sources – USA

The USA in terms of energy dependency is a country that is highly dependent on oil imports. This dependence makes the need to secure energy as a major driver of the foreign politics of the country, as well as a driver of strategic alliances, lie those developed with the countries of the Middle East. Besides, the country is willing to proceed to military actions and wars, like the Gulf War, so as to ensure that no enemies dominate the global market of oil. Also, diplomacy develops substantial role in energy security issues.

The USA is also among the largest producers of oil and natural gas. In fact, during the Trump presidency, the country used its energy exports in order to cover its trade deficit. Also, the country is the third largest exporter of LNG in the world and uses this advantage in order to make Europe become less dependent on the Russian natural gas. The recent war in Ukraine reveals this intention since the USA starts selling LNG in Europe (European Parliament, 2022).

The energy transition will be challenging for the USA. The country will probably try to continue attaching a dominant role of energy in the foreign affairs. First, oil and gas, as already discussed above, will continue representing important energy sources during the transition. So, at the extend at which oil demand continues, the USA will focus its foreign policy on it. But, since the energy transition will lead to the use of less oil, it is probable that the country will be able to cover its needs domestically, so oil will stop being a part of geopolitics. On the other hand, the role of natural gas during the transition is more ambiguous, but, in the end, when the transition is completed, the country will not be able to use any conventional energy source as a “weapon” in the geopolitical arena (Meidan, 2021).

The transition to renewable sources will make the USA, like China, to try to secure energy by ensuring its access to the markets that have the required resources for the transition. Furthermore, the country tries to gain a leading role in the international discussions referring to climate change and, in fact, uses this topic as part of its foreign policy, something that was not the case some years ago. As a result, the willingness to promote decarbonization will become an issue of discussion with other nations in Asia and Europe and the results will not always be positive. Of course, all countries around the world support decarbonization, but it possible that this goal may run up against other priorities of the country.

Furthermore, the transition period will be an opportunity for the USA to reach goals like the development and commercial offering of high-end infrastructure related to the global energy transition. These technologies may be shared, in order to support decarbonization, but, it is also probable that these technologies will become a political tool, especially against China. The USA may offer technological or financial assistance to other countries, so as to confront the Chinese competition. Under this framework, the climate co-operation with Europe can be interpreted as an effort – on behalf of the USA – to be the global leader.

4.4 The prospects of Renewable Energy Sources – Russia

Russia represents a particular case in the energy transition project. It is a country with long and disputable history in geopolitics and still tries to define its position in the international scene. Russia is the world's largest fossil fuel exporter and this makes it a major participant and regulator in the geopolitical aspect of the transition. Besides, it is the largest gas exporter and this makes the situation even more complicated. It is also the country with the second-largest nuclear arsenal and the third-largest coal exporter. Its economy, apparently, is highly dependent on energy sources and the way the Russia will be affected by the energy transition will have a major impact to the rest of the world (in fact it will have the largest impact) (Fernades & Ferreira Rodrigues, 2017).

Russia is the country that seems the least prepared for the transition. Its oil industry is very old and the infrastructure is not at all up-to-date. Also, the dependency on hydrocarbons is so high that it seems difficult for the country to effectively participate

in the transition. Then, the structure of the country is such that it is difficult to manage the change towards the use of RES. Examples of the past, like the use of shale, demonstrate the difficulty of the country to accept and incorporate changes. Furthermore, Russia shows mixed attitudes towards the need for environmental protection. On one hand, the country is very supportive of the policies and agreements that are realized at a global level (unlike China or USA, the country ratified the Kyoto Protocol). Also, it managed to reduce emissions at greater levels than the preset targets. On the other hand, Russia was the last country to ratify the Paris Agreement and according to President Putin “climate change is not due to human activity” (Farand, 2017).

According to researchers, it is estimated that the energy transition towards the use of renewable sources will “cost” Russia about one third of its growth. This reduction will be the result of the difficulties the country may have in changing its technology, its policies and its politics (Makarov, et al., 2020). It is true that Russia was substantially based on natural gas exports (mainly to Europe) and on the potential of this mineral to act as a transition fuel during the decarbonization period. But, EU countries try to use renewable more and more, so as to rely less on natural gas. On the other hand, the recent war with Ukraine reveals that the dependency of the EU still exists and that the lack of natural gas may cause energy security issues. The following figure shows the projected fossil fuel exports for Russia, by 2035 (Overland, 2021).

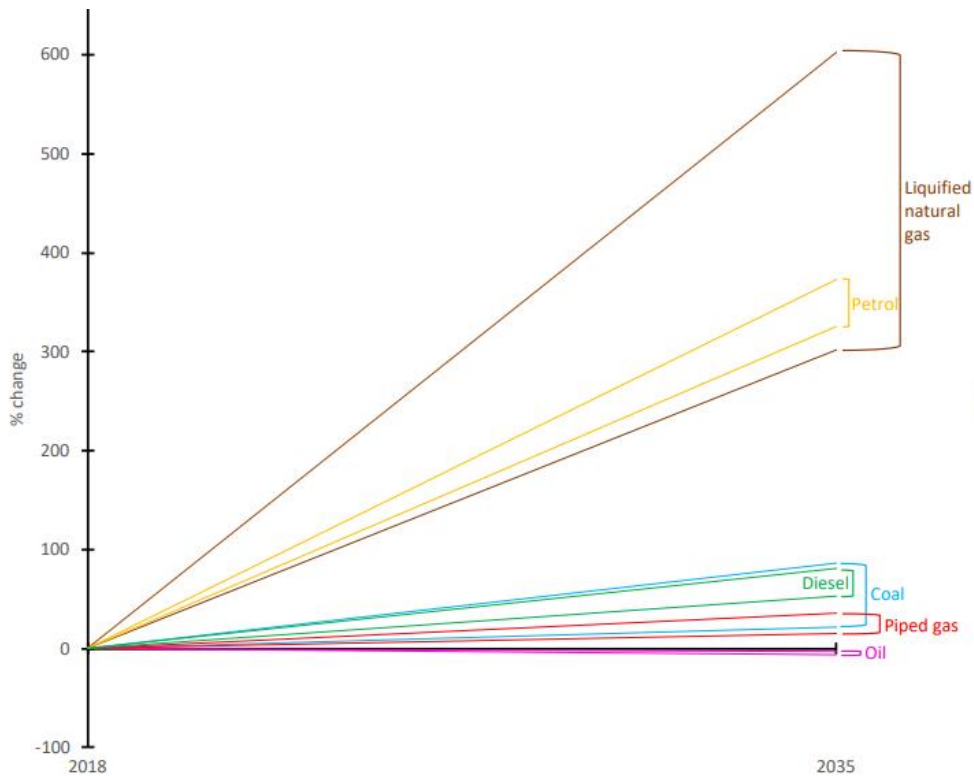


Figure 4: Projected fossil fuel exports through 2035 according to the Russian Energy Strategy, low- and high-growth scenarios, source: (Overland, 2021: 47)

Furthermore, it is important to state that even though Russia has managed to successfully manage the volatility of oil prices, a permanent drop would have severe consequences in all aspects of life. In order for the government to balance losses, it would have to cut back on its social policy, something that would affect internal piece. Especially in the areas where coal mines exist, the problems will be more severe. As a consequence, Russia will be negatively affected by the transition and needs to find out the sources of strength in the new era. Such strengths include the following. First, Russia produces gas and oil at low cost and this offers the country an advantage over its competitors. So, the country can delay the decline in revenues. Then, Russia has renewable energy sources and can take advantage of them. It has the largest solar resources, at a global level, while it is among the first countries in wind power and hydropower resources. So, it could be a leading energy producer if it had the required technology and infrastructure. Third, Russia is the largest country in the world, in terms of surface area, so it has abundant mineral resources. It has nickel, copper, uranium and rare earth reserves, so it can successfully make the energy transition, if the rest factors are fulfilled (Overland, et al., 2019).

As a result, it seems that for Russia the prospects of the energy transition are not favorable, but this can change if the country manages to change its policies and practices and develop its technology and R&D programs and infrastructure.

5 Discussion

As far as the EU is concerned, the prospects of RES are positive but it seems that the transition period will be prolonged. Also, it seems that the target of reducing emissions by 2050 at 80% of those in 1990, is realistic but will be achieved through the use of a mix of energy sources, with renewables leading the mix and natural gas to follow. The EU mainly bases its energy policy on the process, not the product. The statement that the change involved the development of a “low carbon economy”, not an “emission free” economy reveals the strong dependencies of the suppliers and is an element of the geopolitics of energy. In other words, the Commission of European Communities does not have the political will to proceed to an overall transition to RES usage. Instead, the EU member states follow different energy policies and have different dependencies with suppliers. It is also important to state that the EU does not have the means for a quick and thorough transition. In fact, this is unlikely for the whole planet, since it is first, of all, technically impossible (Solomon & Krishna, 2011).

Furthermore, even if the decision is in favor of a radical transition, the EU will need fossil fuels and minerals so as to produce and maintain renewable energy generators. These materials will probably come from China, something that will create greater dependence than the existing one (90% of the minerals used for high-tech products are imported from China) (Popkostova, 2022). It is evident that the geopolitics of energy are really complicated, but, as far as the EU is concerned, it can be argued that the elimination of energy dependence will create a healthier environment concerning the international relations. So, it is worth to try, so as to become an example for other economies.

China, on the other hand, represents a country that faces an important challenge concerning both the energy supply and demand. The country uses coal at a great extent, since its economy is based on coal by about 70%. So, the country will continue using this conventional resource during the transition period. Of course, China is also a country that is rich in renewable energy resources, like wind and hydropower. As for geopolitics, China will maintain its role in the conventional energy market, while the energy transition is an opportunity for China to mitigate energy security risks. Also, China has an advantage over its “competitors” in the energy market, since Chinese companies invest in mines in countries where the required minerals, like copper, lithium or cobalt are found.

The USA is highly dependent on oil imports, while, at the same time it is among the largest producers. The energy transition will be challenging for the USA. The country will probably try to continue attaching a dominant role of energy in the foreign affairs. The transition to renewable sources will make the USA, like China, to try to secure energy by ensuring its access to the markets that have the required resources for the transition. It is also important that the country hosts universities and institutions and is a leader in R&D. Whichever the case, the USA will remain a great player in the global energy geopolitical game and will continue to influence international relationships.

Last, Russia is a country that will face several challenges. It is indicative that it is the country with the oldest history in production of oil, while it is the world's largest fossil fuels exporter, with natural gas being a major source of geopolitical influence. Nevertheless, the country is not yet ready to proceed to the transition. Even though it has agreed to fulfill the international goals towards the use of RES, it does not have the infrastructure, nor the technology available. It is indicative that the energy transition towards the use of renewable sources will "cost" Russia about one third of its growth.

If someone wishes to talk about winners and losers, then the assessment is difficult. All major players discussed above, the EU, China, Russia and the USA can have both gains and losses. But, it is more likely that China and Europe are the winners. China will be able to gain the majority of advantages by the transition (Meidan, 2021). It is a country that will reduce its dependency on other countries referring to oil and natural gas imports, while it will be able to improve its environmental indicators. Also, it will lead the technological evolution and the production of renewable energy generators, something that will increase its income, will create new jobs and improve the economy. Then, Europe is in the way for the transition and makes reductions on the use of imported fuels, while it tries to become more energy efficient. Besides, a lot of EU countries are leaders in the production of renewable energy technologies and products. On the other hand, the EU may need to import metals so as to support the transition and this is the only drawback.

Then, for the USA the situation will be more complicated (IRENA, 2018). If the country manages to continue selling in the global oil and natural gas market, then, it will be a winner of the transition. Also, the USA has a large domestic market for natural gas, while it is a pioneer in R&D concerning electricity, with some of the best universities of the world being located there. On the other hand, there is still a lack of a clear national

energy policy, while its industry is moving slower than the EU and China's one, in relation to the energy transition.

Last, Russia seems to be the loser, since its economy is widely based on the oil, gas and hydrocarbons' revenues. It may be a low-cost producer, but it also has ageing and outdated infrastructure (Overland, 2021). Also, even if the country is rich in rare earths and hydrogen, it will remain just a supplier of these materials and will not be able to compete in the innovation sector.

The analysis that proceeded reveals that a cleaner energy system will not ease the geopolitics aspect. Instead, new geopolitical realities will be created and energy will be, once again, the leading force of international alliances and competition. It is likely that by 2050 diverse energy patterns will be used, with some countries being more oriented to the transition to the use of RES and others relying more on conventional fossil fuels. For example, countries like Norway are leaders in the transition, while others, like Nigeria, prioritize growth and development and do not reduce their dependence on oil. Besides, the energy demand, at a global level, seems to grow and this is also a factor that will determine the energy mix. The countries that produce energy will try to meet the demand by offering both conventional and renewable energy. The countries of the advanced world are more likely to reduce dependence on oil and coal and increase the use of electricity. But this may increase the demand for natural gas, which is considered a preferable alternative for coal (O'Sullivan, et al., 2017).

The energy transition will create new geopolitical standards. It is true that during the last century, conventional sources of energy dominate geopolitics and represent a key parameter that determines international relations, as well as a factor that creates negative events like wars and embargos but also alliances. So, the question is what new energy supply chain will be created and at what extend they will be able no interrupt the status quo.

The energy transition continuous being characterized by multiple uncertainties (political, social, financial and technological), so there are some variables that will determine the effects on both consumers and producers of energy. For example, fossil fuel producers will try to remain in the market by offering lower prices and ensuring low carbon intensity. On the other hand, lower prices will jeopardize the economies of

countries that depend on their fuels' trade. It is, thus, important that these countries are ready to change and to incorporate change in their financial and political system. Then, in the case of energy consumers, factors like the degree of dependence on fossil fuels and the ability to change to renewables will determine the transition.

6 Conclusions

The present thesis refers to one of the most important issues that concern the global economy and politics, the energy transition. The need for change is urgent and energy policymakers need to find ways to meet goals set for the first time by the United Nations Framework Convention on Climate Change in 1992 and further specified with the Paris agreement in 2016. Renewable Energy Sources represent a promising and viable solution, but the transition is a real challenge, since it is highly related to issues like technology, investment and geopolitics. As far as the energy geopolitics are concerned, they dominate the international diplomacy and politics. Countries develop alliances, proceed to embargos and even war. At the moment, conventional energy sources have created a status quo which will change with the increasing use of renewables. The present thesis refers to the prospects of Renewable Energy Sources (RES) in view of the 2050 Energy Transition (Based on USA, Europe, Russia, China). The research aim is to reveal the prospects of the use of Renewable Energy Sources in view of the 2050 Energy Transition, by geopolitical point of view.

During the previous decades, oil and gas represented the main energy sources and the geopolitics of energy referred to these products. Geopolitics can be described as a zero-sum game which involves nations trying to gain power and security, as well as trade and investment advantages over other nations. The geopolitics of energy is an old story, with new content and aspects. The global alliances and agreements are widely led by the energy policies (Austvik, 2018). The geopolitics of energy became more apparent during the last decades, were energy resources started becoming less and less available, while, at the same time, energy needs around the globe became greater.

Nowadays, conventional sources of energy become scarce and renewable sources start to emerge. Renewable resources have the advantage of being able to replenish themselves. The augmenting use of renewable energy can affect geopolitics, related to the following areas. First, the critical materials supply chain. The second area that is related to renewable resources geopolitics is technology and finance. Then, the reduction of the usage of oil and gas demand will change current status and will lead to several geopolitical consequences. Last, another factor that relates renewable energy and geopolitics is the climate change (O'Sullivan, et al., 2017).

Under the above mentioned framework, the prospects of RES were analyzed, by focusing on four different countries and economies. According to the analysis results, all countries and economies under investigation have a lot of challenges to face. First, as far as the EU is concerned, the prospects of RES are positive but it seems that the transition period will be prolonged. The EU will need fossil fuels and minerals so as to produce and maintain renewable energy generators. Then, China will be able to gain the majority of advantages by the transition (Meidan, 2021). It will lead the technological evolution and the production of renewable energy generators. The USA has a large domestic market for natural gas and it is a pioneer in R&D concerning electricity. On the other hand, there is still a lack of a clear national energy policy. As far as Russia is concerned, even if the country is rich in rare earths and hydrogen, it is probable that it will remain just a supplier of these materials and will not be able to compete in the innovation sector.

As a consequence, a cleaner energy system will not ease the geopolitics aspect. Instead, new geopolitical realities will be created and energy will be, once again, the leading force of international alliances and competition. The energy transition will create new geopolitical standards and developed as well as developing countries will need to implement changes and adapt to the new era.

6.1 Research importance and limitations

The present research represents an effort to enlighten the aspects of energy transition through a geopolitical aspect. Even though existing literature widely discusses this issue, the present thesis refers to specific countries and economies, while it is important to explore interdependencies. Besides, every effort to discuss the geopolitical parameters of energy transition is important and adds to existing literature, since the subject is highly complicated.

On the other hand, the present thesis is characterized by limitations. The most important one refers to the fact that it is a qualitative study that is based on secondary data. It is proposed that further research is conducted, with the use of primary data. For example, researchers could conduct interviews with officials, so as to better discuss geopolitics and get an in depth understanding of the related parameters.

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