Czech University of Life Sciences Prague

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Bachelor Thesis

Energy Development in the EU and Factors Affecting it.

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CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE

Faculty of Economics and Management

BACHELOR THESIS ASSIGNMENT

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Business Administration

Thesis title

Energy development in the EU and factors affecting it

Objectives of thesis

The purpose of this thesis is to analyze the development of energy in the European Union. Its past, present and future.
1) To study the types of energy: which ones are more reliable, sustainable and inexpensive, as well as their impact on the environment.
2) Analyze energy consumption in the European Union and selected countries (Germany, France, Czech Republic, Sweden, Spain). Conduct a statistical analysis of energy consumption in the EU by type of energy as well as by member state.
3) Explore the prospects for further development of electric power based on the influence of external political, economic and environmental factors.

Methodology

The theoretical part includes general basic concepts of what electricity is, what kinds of energy it is, how it is produced, and what it takes to produce, what it is used for.

In the practical part I will rely on official statistics data from Eurostat for the time period from 2007 till 2021, and by using basic statisctical methods for time series analyses. It will be research how much and what kind of energy is consumed in the EU and selected EU countries, what is the difference, what the price is, where supplies come from, and how the geographical location of the country affects the pricing policy.

The proposed extent of the thesis

40 – 50 pages

Keywords

energy, consumption, suply, demand, economy, development, production, electricity

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Recommended information sources

Hasanuzzaman, M., & Abd Rahim, N. (Eds.). (2019). Energy for sustainable development: demand, supply, conversion and management. Academic Press.

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Expected date of thesis defence

2022/23 SS – FEM

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Declaration

I declare that I have worked on my bachelor thesis titled " Energy Development in the EU and Factors Affecting it." by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break any copyrights.

In Prague on 14.03.2023 ____________________________

Acknowledgement

I would like to thank Ing. Pavel Kotyza, Ph.D. and all other persons, for their advice and support during my work on this thesis.

Energy Development in the EU and Factors Affecting it.

Abstract

The purpose of the thesis is to study the current state of energy development in the European Union (EU) and the factors affecting its consumption using the example of selected countries. The main objectives of the study are to identify the key factors affecting energy consumption in the EU, analyze trends in energy consumption, and discuss the future of energy in the region based on the results of the tendency observations.

To achieve these objectives, the study uses qualitative and quantitative data analysis to gain a comprehensive understanding of the energy sector in the EU. The study analyzes data on energy consumption in 5 selected EU countries, focusing on factors such as economic growth and population size.

The analysis shows that the EU has made significant progress in reducing dependence on fossil fuels and increasing the use of renewable energy sources. The study also highlights the need for further efforts to promote energy efficiency and sustainability in the region. In addition, the thesis shows that the trend toward renewable energy is expected to continue in the future, and that technological advances in renewable energy production and energy storage are likely to play a significant role in the future of the EU energy sector.

Based on these results, the thesis concludes with a discourse on the future of energy in the EU. The results of the study contribute to a better understanding of the future of energy in the regions and provide introductory information for stakeholders in the energy sector.

Keywords: energy, consumption, suply, demand, economy, development, production, electricity

Vývoj energetiky v EU a faktory, které jej ovlivňují.

Abstrakt

Cílem práce je na příkladu vybraných zemí prostudovat současný stav vývoje energetiky v Evropské unii (EU) a faktory ovlivňující její spotřebu. Hlavním cílem studie je identifikovat klíčové faktory ovlivňující spotřebu energie v EU, analyzovat trendy ve spotřebě energie a na základě výsledků pozorování trendů diskutovat o budoucnosti energetiky v regionu.

K dosažení těchto cílů studie využívá kvalitativní a kvantitativní analýzu dat, aby získala komplexní představu o energetickém sektoru v EU. Studie analyzuje údaje o spotřebě energie v 5 vybraných zemích EU se zaměřením na faktory, jako je hospodářský růst a počet obyvatel.

Analýza ukazuje, že EU dosáhla významného pokroku při snižování závislosti na fosilních palivech a zvyšování využívání obnovitelných zdrojů energie. Studie rovněž zdůrazňuje potřebu dalšího úsilí o podporu energetické účinnosti a udržitelnosti v regionu. Práce dále ukazuje, že trend směřující k obnovitelným zdrojům energie bude v budoucnu pokračovat a že technologický pokrok v oblasti výroby energie z obnovitelných zdrojů a skladování energie bude pravděpodobně hrát významnou roli v budoucím energetickém sektoru EU.

Na základě těchto výsledků práce v závěru pojednává o budoucnosti energetiky v EU. Výsledky studie přispívají k lepšímu pochopení budoucnosti energetiky v regionech a poskytují úvodní informace pro zúčastněné strany v energetickém sektoru.

Klíčová slova: energie, spotřeba, dodávka, poptávka, ekonomika, vývoj, výroba, elektřina

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ktoe... kilotonnes of oil equivalent

1 Introduction

Energy is directly related to the economy, and the availability of an accessible and stable energy supply has always been of fundamental importance to the development of society. In the modern world, energy is the basis for the development of basic industries, determining the progress of social production. However, the connection between energy and the economy is not one-sided. Energy is not only a tool for economic development, but also a driver of economic growth. A stable and sustainable energy supply can contribute to the creation of new industries, the development of new technologies, and the improvement of living standards.

Energy is the most important resource that determines economic development and social progress. Without access to affordable, reliable and sustainable energy, industry cannot function, businesses cannot work and households cannot meet their basic needs

Currently, an energy crisis is developing in Europe. Europe suffers from shortages of natural gas and, to a lesser extent, coal. The energy crisis has created economic and social problems, including rising energy prices and supply disruptions. Shortages of natural gas and coal have led to higher prices, which have a significant impact on households, businesses, and industry. This situation has its reasons, and in my dissertation I will discuss these reasons in order to understand what path the EU should take in developing energy.

Moreover, energy is one of the sources of negative impact on the environment and human beings. Energy is defined as any field of human activity related to the production and consumption of energy. Most of the energy industry operates from the energy released by burning fossil fuels (oil, coal, and gas), which in turn releases a huge amount of pollutants into the atmosphere. The impact of energy production and consumption on the environment is a critical issue that has attracted worldwide attention. The EU has set ambitious goals to reduce greenhouse gas emissions, increase energy efficiency and encourage the use of renewable energy sources. Achieving these goals requires an in-depth understanding of the factors affecting energy development in the EU.

Technological innovation and digitalization are transforming the energy sector, creating new opportunities and challenges for energy development in Europe. The emergence of new technologies, such as renewables, smart grids and energy storage systems, is changing the energy landscape, and Europe needs to adapt to these changes to remain competitive in the global energy market.

Overall, energy development in Europe is critical for economic, social and environmental reasons. Understanding the factors affecting energy development in Europe will allow policymakers, industrialists, and other stakeholders to work together to ensure a safe, sustainable, and prosperous energy future for Europe and the world.

In this thesis, I will examine the various economic, social, and political factors affecting energy development in the EU, such as energy policy, technological innovation, energy demand, and consumer behavior. By analyzing these factors, this dissertation seeks to provide insight into the challenges and opportunities for energy development in the EU, as well as potential solutions for achieving a sustainable and secure energy future. The dissertation will contribute to the ongoing debate on energy development and environmental protection by providing recommendations for policy makers, industry participants and other stakeholders.

2 Objectives and Methodology

2.1 Objectives

The purpose of this thesis is to analyze the development of energy in the European Union. Its past, present and future.

1) One of the main objectives of this thesis is to explore the different types of energy and their sustainability, reliability, and environmental impact. Fossil fuels, which have been the primary source of energy in the EU, are finite and their extraction and consumption lead to significant environmental damage. In contrast, renewable energy sources are sustainable and have a lower environmental impact. However, they may not be as reliable and inexpensive as fossil fuels, which are widely available and can provide energy on-demand.

2) To analyze the energy consumption in the EU, this thesis will focus on selected countries such as Germany, France, Czech Republic, Sweden, and Spain. The statistical analysis of energy consumption in the EU will be conducted by type of energy and member state. This analysis will provide insights into the energy consumption patterns of different countries in the EU and their impact on the overall energy mix.

3) The thesis will also explore the prospects for further development of electric power in the EU. The EU has set ambitious targets to reduce greenhouse gas emissions and increase the share of renewable energy in its energy mix. However, the development of electric power is influenced by external factors such as political, economic, and environmental factors.

In his paper, the author answers the following questions:

- What is the trend of electricity consumption in the european Union?
- What role, if any, do renewable sources of consumption play in the environmental and economic issue?
- Is the goal of reducing the overall intensity of the EU energy sector achievable?

2.2 Methodology

The theoretical part includes general basic concepts of what electricity is, what kinds of energy it is, how it is produced, and what it takes to produce, what it is used for.

In the practical part the author will rely on official statistical data from Eurostat for the period from 2000 till 2021, and by using basic statistical methods for time series analyses. It will research how much and what kind of energy is consumed in the EU and selected EU countries, what is the difference, what the price is.

The main approach the author will use is quantitative approach with numerous techniques that will help me to answer the main research question. To answer the questions set in the thesis the author will make trend analysis, and correlation analysis as the main techniques.

To perform correlation analysis the author will use the Pearson correlation coefficient. This coefficient measures the strength of the relationship between two variables, ranging from -1 (indicating strong negative correlation) to 1 (indicating strong positive correlation).

The formula to calculate the coefficient is:

$$\boldsymbol{r} = \frac{\sum(Xi - X\ mean)(Yi - Y\ mean)}{\sqrt{\sum(Xi - X\ mean)^2 (Yi - y\ mean)^2}}$$

Then, the author determines the statistical significance of the correlation coefficient by computing the t-value, using the formula:

$$\boldsymbol{t\ value} = \frac{Rxy\sqrt{n-2}}{\sqrt{1 - Rxy^2}}$$

To test the hypothesis, a traditional significance level of 5% is employed.

The data chosen for the practical part of the thesis is relevant for two reasons. Firstly, the analysis of the types of energy is critical to understanding the sustainability, reliability, and environmental impact of different energy sources. And secondly, the statistical analysis of energy consumption patterns in the countries provides valuable insights into the energy consumption patterns of different countries and their impact on the overall energy mix.

3 Literature Review

3.1 Where does energy come from?

Power plants produce electricity, which is what humanity uses to meet its energy needs. They use various fuel types and heat water to turn it into steam. Steam is then turned into steam through heating. Turbines rotate steam turbines and generators are connected to these turbines to generate electricity. You can get heat from any source: coal, wood, oil, natural gas or biogas. Even a complex nuclear reactor can convert water into steam and produce electricity.

It is essential that electricity be produced as much as possible. However, there are no ways to store large quantities of electricity. Nowadays, electricity production can be spread over large distances. It is preferable to build power plants right where electricity most needs. Wind and solar power are producing more electricity.

Importing electricity is an option when local energy production is insufficient to supply the country. If it is less expensive than the energy available, imported energy can also be used.

In the 21st century, humanity has found quite a few sources of energy. These sources are classified into two types: renewable and non-renewable. Non-renewable sources have limited resources that people can use. This type of source recovers their reserves for a long time. They include minerals such as coal, oil, natural gas, and nuclear energy.

In turn, renewable sources replenish their reserves in a short period of time. They include solar energy, wind, water, geothermal energy, and others. There are some unconventional sources such as waste-to-energy, carbon capture, and storage, etc., which have been emerging as energy sources in recent years. Nowadays, energy storage and energy efficiency are also considered as energy source. (Hasanuzzaman & Rahim, 2020)

3.2 Fossil Fuels

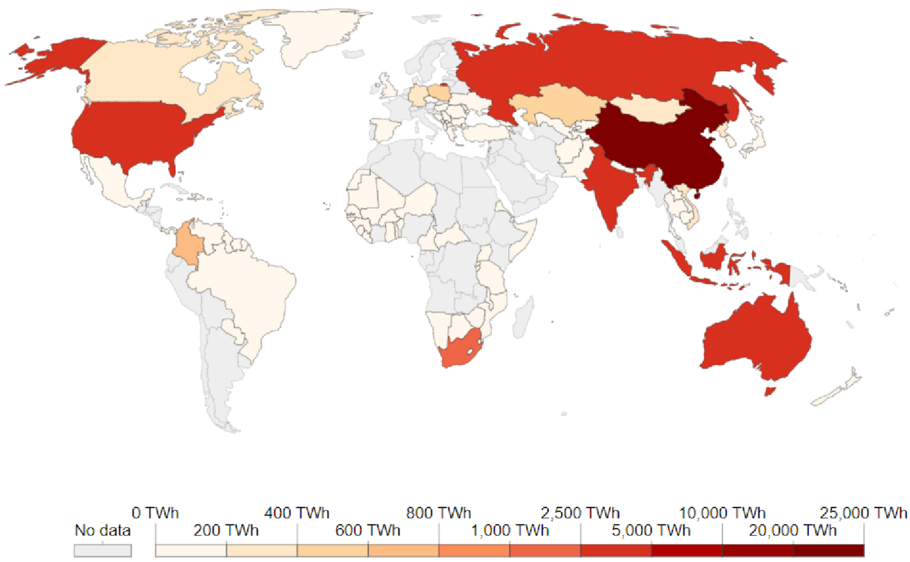
Fossil fuels: coal, oil, and natural gas are hydrocarbons formed from the pressed fossilized remains of prehistoric organic material. Peat and coals arose from the slow alteration of dead plants (phyto mass), hydrocarbons from more complex transformations of marine and lacustrine single-celled phytoplankton (mostly cyanobacteria and diatoms), zooplankton (mostly foraminifera), and some algae, invertebrates, and fish (Smil, 2017). During combustion, these hydrocarbons interact with oxygen and release the chemical energy hidden in them in the form of heat.

Because this type of fuel is a ready source of energy, it has become the main type of fuel used today.

3.2.1 Coal

Coal is a sedimentary rock formed from ancient plant matter. Coal is the largest energy source at this moment and one of the first to play an important role in the global energy industry. It Is a fossil fuel and is primarily used as a source of energy for electricity generation and industrial processes. Like all fossil fuels, coal is made up of elements such as hydrogen, sulfur, nitrogen, and oxygen. The energy value is given to it by its carbon content, respectively, the higher the carbon content and the lower the percentage of moisture in the coal, the more energy it can give off. Coal production refers to the process of extracting coal from the ground, processing it, and delivering it to the market for use as an energy source. The world's largest coal producers are China, the United States, India, Australia, and Russia.

Figure 1: Coal Production Worldwide (2019)



Source: BP Statistical Review of World Energy and Shift Data Portal

By 2020, coal-fired power plants accounted for 40% of the world's energy consumption. From 2000 to 2014, global coal consumption rose by 64%, which portrays its dominating role in the world economy. Coal is easily flammable and its burning produces smoke with harmful gases, which makes it hazardous to the environment. But as of 2020, coal mining has developed carbon storage technology and reduced carbon emissions. (Seredin & Dai, 2012)

Coal is the largest energy source at this moment and one of the first to play an important role in the global energy industry. Its main feature is the ability to store fuel directly at power plants. The energy value is given to it by its carbon content, respectively, the higher the carbon content and the lower the percentage of moisture in the coal, the more energy it can give off. By 2020, coal-fired power plants accounted for 40% of the world's energy consumption. From 2000 to 2014, global coal consumption rose by 64%, which portrays its dominating role in the world economy. Coal is easily flammable and its burning produces smoke with harmful gases, which makes it hazardous to the environment. But as of 2020, coal mining has developed carbon storage technology and reduced carbon emissions (Hasanuzzaman & Rahim, 2020).

3.2.2 Oil

Oil is a liquid fossil fuel that is composed primarily of hydrocarbons, molecules made of hydrogen and carbon atoms. It is formed from the remains of ancient marine plants and animals that were subjected to heat and pressure over millions of years. Oil is extracted from the ground through a process called petroleum production and is refined into various oil products such as gasoline, diesel, and others. It is widely used as a fuel for transportation and as a raw material in the production of chemicals, plastics, and other products. The global oil industry plays a significant role in the world economy and is influenced by political and economic factors, as well as global events such as natural disasters and conflicts. The largest oil producing countries in the world are the United States, Russia, and Saudi Arabia. (Masnadi et al., 2018)

Crude oil is a mixture of hydrocarbons and other organic compounds that are extracted from the earth and then transported to refineries for processing. Refined oil is the processed form of crude oil and includes various products such as gasoline, diesel fuel, jet fuel, heating oil, lubricating oils, and other specialty products. Conventional oil is liquid at atmospheric temperature and pressure, so it flows easily through a well core or a pipeline. Is the most popular type of oil and is extracted from underground reservoirs using traditional drilling and pumping techniques usually easier and cheaper to extract. (Ollivier & Magot, 2005)

Unconventional oil refers to sources of petroleum that cannot be extracted using traditional methods, such as drilling from conventional oil wells. It includes heavy oil, oil sands, and oil shale. These types of oil are typically found in deposits that are more difficult and expensive to extract, process, and refine compared to conventional oil.

Figure 2: Crude Oil Reserves Worldwide (2019)

Source: VisualCapitalist

The biggest crude oil producers nowadays are USA, Saudi Arabia, Russia, Canada, China and others.

3.2.3 Natural gas

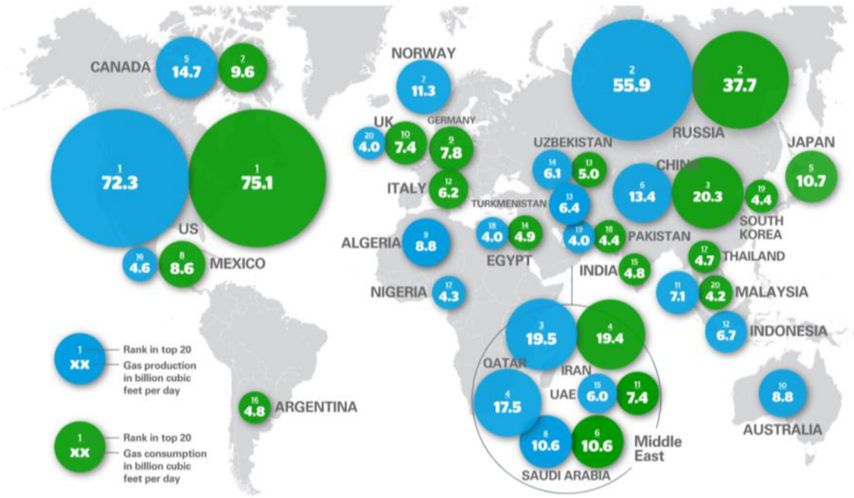
Natural gas is one of the most important commodities in terms its contribution to industrial progress and human survival. Natural gas is a reliable and efficient heat source in cold climates.

Natural gas consists of methane and the ethane principal components. It also contains various amounts of other hydrocarbons like propane, butane and pentane.

Methane is the main component of natural gaz. It is simply a mixture of carbon and hydrogen atoms. Natural gas is the most clean fossil fuel. Natural gas is primarily combusted to produce carbon dioxide and water vapor. Natural gas produces very little sulfur dioxide or nitrogen oxide, unlike other fossil fuels like oil and coal. There is also virtually no ash and particulate matter when it is combusted. Natural gas is widely used around the globe due to its high heating value and clean burning properties. Natural gas is used in residential homes for heating, cooking, as well as fueling appliances like dryers and water heaters. Natural gas is used in commercial settings for water heating, space heating, air conditioning, refrigeration, lighting, air conditioning, and cooking. (Meira et al., 2022)

Natural gas is used for industrial purposes. The largest industrial users of natural gas are power generating companies. They use natural gas to generate electricity. Natural gas-fired power stations emit a lower level of carbon dioxide and nitrogen than those that are powered by coal or oil.

Figure 3: Natural Gas Production and Consumption (2016)



Source: BP Statistical Review of World Energy; and Shift Data Portal

3.3 Nuclear Energy

Nuclear energy is released in the form of heat during nuclear fusion reactions or nuclear fission. Uranium isotopes are mainly used as fissile material. In several developing countries of the world, nuclear power is the main source of energy. It contributes to almost 11% of the global energy demand. This type of energy helps reduce oil consumption in the energy industry. Then it can be assumed that this type of energy production can completely replace fossil sources. However, during the development of nuclear power, several significant problems have come to light. The heat generation in a reactor core cannot be stopped.. Accordingly, the reactors must be constantly cooled, otherwise their temperature will constantly rise. As a result, this can lead to an explosion of the reactor and the release of radioactive substances into the atmosphere. (Rutledge, 2019) We know the consequences of such an outcome from the Chernobyl nuclear power plant.

Nuclear power plants produce a huge amount of radioactive waste. First, they are fueled by uranium, and its extraction is dangerous for both people and the environment. Secondly, the reprocessing of spent radioactive fuel is very problematic. But despite these details, nuclear power is quite widespread and accepted around the world.

3.4 Renewable Sources

Renewable energy sources are those that can be generated almost as quickly as we use them. The major sources of renewable energy are those that occur naturally on Earth. These include solar power, wind power, and hydropower. Such sources use local resources, so it is logical to assume that this type of energy is typical for territories without rich fossil resources. Hydropower is based on moving water. Geothermal power uses heat from the Earth deep below. We have had plenty of sun for many billions of years, so none of these energy sources will run out. Renewable energy releases less harmful byproducts like carbon dioxide into the environment. Hydropower converts the kinetic energy of running water into electricity. A run-of-river power station diverts a portion of the river's flow through tunnels to turn turbines of a generator. This works in certain places, but it is difficult to control the amount of energy generated to meet the demand. You can control how much fuel is burned and the power produced with fossil fuels. This is what runs-of-river power plant struggle with because the amount they produce depends on the flow and temperature of the river. Both of these factors are not controlled. (Ellabban et al., 2014)

Renewable sources have great potential because they can meet the global demand for energy and are replenished at a higher rate than they are consumed. One of the advantages of renewable energy can be seen as the fact that the production of such energy has less negative impact on the environment than fossil fuels, and its production is cheaper.

3.4.1 Hydropower

Hydroelectric power involves the process of converting the energy of flowing water into electric current. It is considered a renewable resource because the sun keeps the water cycle going. Today, hydroelectric power plants produce about 70% of all renewable energy in the world. Hydropower is one of the oldest sources of energy on the planet.

The mechanical energy of the moving water rotates the turbine blades, which are connected to an electromagnetic generator, which in turn generates electricity. In order to generate electricity with water, a head must be created. There are two main types of production - dams (flow is created by a reservoir) and either hydro-storage plants (pumps move water between reservoirs at different heights) or river flow (uses the natural flow of the river). The generally accepted classification of hydroelectric power plants divides all plants into three groups: large (over 30 megawatts), small (100 kilowatts to 30 megawatts) and micro plants (less than 100 kilowatts). (Bartle, 2002)

Of all renewable sources of clean electricity, hydropower has the largest share. The industry has several advantages. First, an economically competitive form of electricity, although the initial capital investment can be high. Second, hydropower is fairly reliable compared to other renewable energy options. Third, it combines well with them because it can take on a major role in the energy mix. In some cases, reservoirs and dams can help with flood control and supply water to nearby communities. (Ellabban et al., 2014)

However, there are also problems, especially when it comes to large dams. Impacts on the natural course of the river have a tangible effect on the local environment, altering wildlife habitats, blocking paths for fish and often forcing people living in coastal areas to leave their homes. In addition, malfunctions at dams can become catastrophic, flooding areas downstream. Another disadvantage of hydropower is the output of one unit with a gigawatt capacity is at best 500 megawatts, which also affects the development prospects of hydropower. (Munoz-Hernandez et al., 2013)

Most of the economically viable hydro potential has already been tapped in the developed countries, particularly in Europe - 75 percent, in North America - about 70 percent, and possibilities for construction of large hydro power plants have been almost exhausted. At the same time, Africa (21 percent of the world's hydroelectric resources) and Asia (39 percent) contribute only 5 and 18 percent, respectively, to the world's hydroelectric power production. South America and Australia combined, with about 15 percent of resources, provide only 11 percent of the world's hydroelectric power.

3.4.2 Solar Energy

Solar energy is the main and richest possible source of energy on Earth. The sun is an inexhaustible source of energy. Countries around the world have different sunlight supplies at different latitudes, but despite this, the energy system of countries with little sunlight can be well balanced by solar energy, because this resource is independent of imports.

Solar energy refers to the process of converting sunlight into electricity. And there are two ways to convert light into electricity: the first way is to concentrate light in a high concentration, for example, on water or another liquid, to convert the water into steam, and then the steam spins a generator, usually a turbine, just like the almost similar process in a conventional power plant, which was described above. The second way is the direct conversion of light into electricity, where nothing is heated and nothing spins, there are no mechanical generators, but there is a semiconductor converter that absorbs photons, the absorption of photons generates current, voltage, electrical power, the production of which is the task of solar energy. The efficiency of solar cells is quite high and can be more and more. (Ellabban et al., 2014)

Solar technology is versatile: it can produce heat, electricity, cooling, and fuel for a variety of applications. For example, solar photovoltaic modules (PV) for electricity, solar thermal collector (STC) for heat, and photovoltaic thermal for both heat and electricity. PV modules directly convert sunlight into electricity by means of photoelectric effect using semiconductor materials, mostly silicon. (Hasanuzzaman & Rahim, 2020). Solar panels are very affordable and have a long lifespan of about 30 years. this makes solar energy the most affordable, cheapest, and safe for the environment. (Nations, 2022.)

But, as mentioned above, there is a problem in storing electricity. Converting solar energy is only possible during clear weather, whereas electricity is always needed. As of today, there are no good, stable and cheap batteries capable of storing the converted solar energy. This is one of the reasons why at this point in time it is not possible to replace all sources of energy with solar energy. If we compare the consumption of electricity produced by power plants and solar panels at different times of day, we can see that when only solar energy is produced during the day and non-renewable at night, the demand for conventional energy increases dramatically when the sun goes down. However, traditional power plants cannot ramp up their power production so dramatically, meaning they must maintain a certain amount of power throughout the day. If you produce energy in two ways at the same time, it can happen that more energy may be produced during the day than will be used, which can lead to overloading. (Brumana et al., 2022)

3.4.3 Wind Energy

Wind is like the sun in its energy source properties. It is just as variable and accessible in all parts of the globe. Its speed is not constant, it depends on the season and the terrain. according to maps, the strongest winds blow in sea waters. The energy comes from the kinetic energy of the wind, caused by the uneven heating of the atmosphere, differences in topography and the rotation of the earth. To produce as much energy as possible, it was decided to install taller turbines with larger blades. (Hasanuzzaman & Rahim, 2020).

Wind power is divided into large onshore wind turbines, small onshore wind turbines, and offshore turbines. The wind turbine generator converts the kinetic energy into mechanical energy and then to electrical energy. A wind turbine generator's power can range from 5 KW up to 4500KW. Modern turbines can generate energy even with very weak winds - up to 4 m/sec. The "green tariff" allows wind turbines to be used as part of an independent private power plant. These facilities can provide energy for both local and island facilities as they solve their own energy supply issues. Wind streams turn the blades of a turbine generator. They pass through the turbine and drive it, which then begins to spin. The turbine's shaft generates energy. This will be proportional with the wind flow. The more wind generated energy, the stronger it is. The shaft then transmits the energy to the multiplier, if one exists. Devices that do not have a multiplier, which speeds up the rotation of an axis, are more efficient. This is because there is no wasted energy and the wind speed is sufficient to ensure the generator is running at its best. The generator converts mechanical energy into electric energy. If the turbine is small, the wind flow must be strong for power to be high. Vice versa, a large turbine can produce the exact same power with a weaker wind. It is important to accurately calculate all parameters at the design stage in order to ensure that the wind turbine operates correctly and produces the correct amount of energy. (Hannele Holttinen et al., 2011)

3.4.4 Other Renewable Sources

Geothermal energy is energy derived from the natural heat of the earth. This heat can be achieved by means of wells. This heat is delivered to the surface in the form of steam or hot water. This heat can be used both directly to heat homes and buildings and to generate electricity. The most promising geothermal resources are in areas of volcanic activity. Such "hot spots" are on the borders of tectonic plates or in places where the crust is so thin that it lets the heat of magma through. Many hotspots are in the Pacific Rim, also called the "ring of fire" because of the large number of volcanoes.

Currently, there are three hydrothermal power generation schemes: direct with dry steam, indirect with water steam, and a mixed production scheme (binary cycle). The type of conversion depends on the state of the medium (steam or water) and its temperature. Power plants using dry steam were the first to be developed. To produce electricity, steam from the well is passed directly through the turbine/generator. Power plants with indirect type of power generation are the most common today. They use hot underground water (up to 182 degrees Celsius). Geothermal power plants with a mixed production scheme differ from the previous two types of geothermal power plants in that the steam and water never come into direct contact with the turbine/generator. (El Bassam et al., 2013)

Marine energy (or ***ocean*** energy) and hydropower are different types of energy, although both are produced on water. But ocean energy is based on the energy of waves, tides, ocean currents and even water salinity. This type of energy production is considered relatively new and is poorly developed, even though, like solar and wind energy, ocean energy has great potential in the industry. Technology requires more development and costs are very high. It can be declared that this type of energy is only available to countries with coastlines.(Zhou, 2022)

The energy of the world's oceans waves can meet up to 20% of humanity's energy needs. The appeal of using waves lies primarily in their high power density, which exceeds that of solar and wind energy. Regions most potentially suitable for the launch of wave power plants are areas with a long coastline and the presence of stable strong winds. Such areas include the European west coast, the British north, the Pacific coast of North and South America, New Zealand and Australia, as well as South Africa.

Bioenergy is extracted from biomass. Biomass is the byproducts and waste products of organic materials (other than minerals). People have been using bioenergy since ancient times by burning dung or firewood, thereby creating heat to heat rooms or to cook food and provide light. In poor areas of the earth people still use this method of energy production. In today's world, agricultural and forestry residues and organic waste can be used as biomass. But despite the recycling of organic waste, bioenergy is still harmful to the environment. Burning biomass produces greenhouse gases, albeit in small quantities; cutting down forests for charcoal extraction leads to de-greening and changes in natural landscapes. Bioenergy includes many products besides charcoal and agricultural waste. For example, biofuels, biogases, pellets - solid biofuels produced from wood dust and straw. Europe is the leader in the production of pellets (60%) (Hasanuzzaman & Rahim, 2020)

In addition to the above-mentioned types of renewable energy, which are currently the main ones, there are relatively new sources. These include waste-to-energy. This type of energy extraction can be called environmentally friendly, because it helps to solve the problems of waste disposal and its impact on the environment by using them rationally to generate energy. For example, energy can be extracted by burning garbage and thereby reducing the size and number of landfills.

3.5 Problems of energy supply of mankind

A crisis in energy supply is when there is an increase in energy demand. The causes of an energy crisis may be in logistics, politics, or physical scarcity. Energy is the foundation for basic industries, which determine social production in the modern world. The rate at which energy is being developed has outpaced that of other industries in all industrially advanced countries. Energy is also a source of negative environmental and human impacts. It has an impact on the atmosphere (consumption and emission of gases, moisture, particulate matter, and humidity), the hydrosphere, which includes water consumption, creation of artificial reservoirs and discharges of polluted or heated water. The lithosphere, which includes fossil fuels, changes to the landscape, and emissions of toxic substances. The public was not particularly concerned about the growing energy consumption despite the negative effects of the energy sector on our environment. This was true until mid-1970s when experts compiled data that showed the strong anthropogenic pressure placed on the climate system. The uncontrolled growth in energy consumption poses a threat to the global ecosystem. Climate change has been the most prominent scientific topic since then. (Ehsanullah et al., 2021)

One of the major causes of this shift is energy. Any human activity that involves the consumption or production of energy is considered to be energy. The majority of energy comes from fossil fuels like oil, coal, or gas. This in turn causes huge amounts of pollution to the atmosphere. The greenhouse effect is partially caused by energy, but there are many other natural factors that influence the planet's climate, including solar activity, volcanic activity and the parameters of the Earth orbit. It is impossible to accurately analyze the problem if all factors are taken into account. However, it is necessary to answer the question of how world energy consumption will change in the near future and whether humanity should set strict self-restrictions on energy consumption to prevent a global warming disaster.

3.5.1 Current trends in energy development

The generally accepted classification divides primary energy sources into commercial and non-commercial. Commercial energy sources include solid (coal, lignite, peat, oil shale, bituminous sand), liquid (oil and gas condensate), gaseous (natural gas) fuels and primary electricity (electricity produced at nuclear, hydro, wind, geothermal, solar, tidal and wave power plants). All other energy sources (firewood, agricultural and industrial waste, the muscle power of working animals and humans themselves) are classified as non-commercial.

The global energy industry as a whole throughout the entire industrial phase of society's development is predominantly based on commercial energy resources (about 90% of total energy consumption). Although it should be noted that there is a whole group of countries (equatorial Africa, Southeast Asia) whose large populations subsist almost exclusively on non-commercial energy sources. (Curtis, 1994)

Various forecasts of energy consumption based on data for the last 50-60 years predict that, until about 2025, the current moderate growth rate of world energy consumption - about 1.5% per year, and the stabilization of world per capita consumption of the last 20 years at 2.3-2.4 t eq. fuel/(person-year) will be maintained. After 2030 according to the forecast a slow decline of average world level of per capita energy consumption by 2100 will begin. At the same time, total energy consumption shows a clear tendency towards stabilization after 2050, and even a slight decrease by the end of the century. (*Energy and Raw Materials Problem. Report on the Topic "Energy Problem of the World and Ways to Solve It*, n.d.)

One of the most important factors considered in this projection is the endowment of the world's fossil fuel-based energy resources. In this projection, which is certainly moderate in absolute terms of energy consumption, the exhaustion of proven recoverable oil and gas reserves will not come before 2050, and with additional recoverable resources after 2100. If we take into account that the explored recoverable reserves of coal significantly exceed the reserves of oil and gas taken together, it can be argued that the development of the world's energy under this scenario is ensured in terms of resources for more than a century.

Reduction of energy consumption in relation to predicted consumption is connected primarily with the transition from extensive ways of its development, from energy euphoria to the energy policy based on improving the efficiency of energy use and all-round energy saving. The energy crises of 1973 and 1979, stabilization of fossil fuel reserves and an increase in the cost of extraction, and the desire to reduce the dependence of the economy on political instability in the world caused by energy exports were the reasons for these changes. At the same time, speaking about energy consumption, it should be noted that in a post-industrial society there is one more fundamental task that must be solved: population stabilization. Thus, per capita energy consumption in the world shows a clear tendency towards stabilization. It should be noted that this trend began about 25 years ago, long before the current speculations about global climate change. This is the first time we have seen such a phenomenon in peacetime since the beginning of the industrial age, and it is associated with the mass transition of countries to a new, post-industrial stage of development in which per capita energy consumption remains constant. This fact is very important, because as a result the total energy consumption in the world is growing at a much slower pace. It can be argued that the serious slowdown in the growth rate of energy consumption has come as a complete surprise to many forecasters. (Xu et al., 2022)

There are many predictions about the development of the energy sector now. Nevertheless, in spite of improved methods of forecasting, specialists who make forecasts are not immune from miscalculations and do not have sufficient grounds to speak about high accuracy of their forecasts for such a time interval as 40-50 years.

3.5.2 Fuel Resources Crisis

The rate of formation of new fossil fuels in the Earth's interior is difficult to determine. In this regard, expert estimates vary by more than 50 times. Even if we accept the highest number, the rate of fuel accumulation in the Earth's interior is still a thousand times less than the rate of its consumption. With the current mining methods only about half of the minerals can be extracted from the subsurface. The other half remains in the subsurface. That is why it is often said that the reserves will be enough for 120-160 years. Great anxiety is caused by the impending depletion of oil and gas, which (according to existing estimates) may be enough only for 40-60 years. (Butler & Ambrose, 2021)

Coal has its own problems. First of all, its transportation is very labor-intensive. Secondly, the widespread use of coal is associated with serious atmospheric pollution, contamination of the land surface and soil degradation. All these problems look different in different countries, but the solution has been the same almost everywhere: the introduction of nuclear power. The reserves of uranium raw materials are also limited. However if we speak about modern thermal reactors of improved type, then for them, due to their rather high efficiency, it is possible to consider reserves of uranium almost limitless. The whole question is how much it costs. And it is from this perspective that the energy problem must now be considered. in the bowels of the earth there is still plenty, but their extraction Oil, gas costs more and more, because this energy has to be extracted from poorer and deeper layers, from poor deposits discovered in uninhabited, hard-to-reach areas. Much more has to and will have to be invested in order to minimize the environmental consequences of using fossil fuels. Nuclear power is being introduced now not because it provides fuel for centuries and millennia, but rather because it saves and preserves oil and gas for the future, and because it can reduce the ecological burden on the biosphere. (*World Coal Institute - Coal Mining*, 2009)

The views of experts on the prospects for renewable energy sources are very different. The Committee on Science and Technology in England, having analyzed the prospects for the development of such energy sources, concluded that their use on the basis of modern technology is still at least two to four times more expensive than the construction of nuclear power plants. Other experts in various forecasts of these energy sources in the not-too-distant future. Apparently, renewable energy sources will be used in certain areas of the world that are favorable for their efficient and economic use, but on an extremely limited scale. The main share of the energy needs of mankind should be provided by coal and nuclear power. It is true that so far there is no cheap source that would allow the development of energy at such a fast pace as we would like. (Radmehr et al., 2021)

Now and for the coming decades the most environmentally friendly source of energy appears to be nuclear and then, perhaps, thermonuclear editors. With their help, man will move on the steps of technological progress. It will move until it discovers and masters some other, more convenient source of energy.

3.6 Environmental Problems of Energy

The main forms of energy's impact on the environment are as follows:

- The main amount of energy humanity receives so far through the use of non-renewable resources.

- Pollution of the atmosphere: thermal effect, emission of gases and dust into the atmosphere.
- Pollution of the hydrosphere: thermal pollution of water reservoirs, emission of pollutants.
- Pollution of the lithosphere during transportation of energy carriers and waste disposal, during energy production.
- Pollution of the environment by radioactive and toxic wastes.
- Changing the hydrological regime of rivers by hydroelectric power plants and, as a consequence, pollution in the area of the watercourse.
- Creation of electromagnetic fields around power lines. (*Energy and Climate Change — European Environment Agency*, n.d.)

Reducing the constant growth of energy consumption seems possible in two ways. Energy conservation - the use of resource-saving technologies has provided a significant reduction in the consumption of fuel and materials in developed countries. Development of cleaner forms of energy production - the problem can be solved by developing alternative forms of energy, especially those based on renewable sources. (*Environmental Impact of Energy System - an Overview | ScienceDirect Topics*, n.d.)

Most electricity is currently produced in thermal power plants (TPPs). This is usually followed by hydroelectric power plants (HPPs) and nuclear power plants (NPPs).

Thermal power plants. In most countries of the world, the share of electricity generated by thermal power plants is over 50%. Thermal power plants usually use coal, fuel oil, gas and oil shale as fuel. The average efficiency of thermal power plants is 36-39%. In addition to fuel, thermal power plants consume a significant amount of water. Thermal power plants are characterized by high radiation and toxic pollution of the environment. Of the fossil fuel sources the most promising is coal (its reserves are enormous compared with those of oil and gas). The main world reserves of coal are concentrated in Russia, China and the United States. (Dmitrienko & Strizhak, 2018)

Hydropower plants. The main advantages of hydropower plants are the low cost of generated electricity, fast payback (the cost of production is about 4 times lower, and the payback period is 3-4 times faster than that of thermal power plants), high maneuverability, which is very important during peak loads, and the ability to accumulate energy. But even if we use all the potential of all the rivers of the Earth, it is possible to meet no more than a quarter of today's needs of mankind. However, the construction of hydroelectric power plants (especially on lowland rivers) leads to many environmental problems. Water reservoirs, which are necessary to ensure uniform operation of HPPs, cause climate changes in adjacent territories at a distance of up to hundreds of kilometers, and are natural accumulators of pollution. More promising is the construction of HPPs on mountain rivers. This is due to the higher hydropower potential of mountain rivers compared to flat rivers. Construction of water reservoirs in mountainous areas does not withdraw large areas of fertile land from land use. (Mikulčić et al., 2020)

Nuclear power plants. Nuclear power plants do not produce carbon dioxide, the amount of other air pollution is also small compared to TPPs. The amount of radioactive substances produced by nuclear power plants is relatively small. For a long time NPPs have been presented as the most environmentally friendly type of power plants and a promising replacement for TPPs, which have an impact on global warming. Among the main problems of using nuclear power plants are the following: *Reactor safety*. All modern reactors expose humanity to the risk of a Chernobyl-like global accident. Such an accident may occur through the fault of the designers, due to operator error, or as a result of an act of terrorism. *Reduction of carbon dioxide emissions.* Replacing thermal power plants with nuclear power plants is thought to help solve the problem of reducing carbon dioxide emissions, one of the major greenhouse gases contributing to the warming of the planet's climate. In reality, however, natural gas combined cycle power plants are not only much more economical than nuclear power plants, but at the same cost, a much greater reduction in carbon dioxide emissions is achieved than with nuclear power. *The problem of disposal of radioactive waste,* which must be reliably isolated and stored in special storage facilities for a long time. (*Nuclear Power and the Environment - U.S. Energy Information Administration (EIA)*, n.d.)

3.7 Energy policy in the EU

The European Union's energy policy aims to ensure a secure, sustainable, and competitive energy supply for its member states. Key priorities include increasing the use of renewable energy, reducing greenhouse gas emissions, and improving energy efficiency. The EU has set a target to reduce greenhouse gas emissions by at least 40% below 1990 levels by 2030, and to increase the share of renewable energy in the EU's total energy mix to at least 27% by 2030. The EU also has policies in place to promote energy efficiency and energy savings, such as the Energy Efficiency Directive and the Energy Performance of Buildings Directive. Additionally, the EU works to improve the security and diversity of its energy supply through measures such as the development of an internal energy market and the promotion of interconnections between member states' energy systems. (El-Agraa, 2011)

3.7.1 Main objectives

The European Union's energy policy has several main objectives:

- Security of supply: Ensuring that EU member states have access to a reliable and diverse energy supply, and reducing the EU's dependence on imported energy.
- Sustainability: Reducing greenhouse gas emissions and air pollution, and increasing the use of renewable energy sources to mitigate the effects of climate change.
- Competitiveness: Promoting a competitive and innovative energy market that supports economic growth and jobs.
- Energy Efficiency: Increasing the energy efficiency of buildings, industry and transport in order to reduce energy consumption and costs.
- Energy Union: Building an interconnected and integrated energy market within the EU, ensuring that energy can flow freely across borders.
- Research and Innovation: Developing new technologies and solutions to support the transition to a low-carbon economy.
- Consumer protection: Ensuring that consumers have access to transparent and reliable information about their energy options and that their rights are protected. (*The European Power Sector in 2018*, n.d.)

The European Union's energy policy has achieved several notable accomplishments:

Reduction in greenhouse gas emissions: Between 1990 and 2020, the EU reduced its greenhouse gas emissions by 24%, exceeding its 2020 target of a 20% reduction.

Increase in renewable energy: The share of renewable energy in the EU's total energy mix has increased from 7.5% in 2005 to 18% in 2020. The EU has set a target to increase this to at least 32% by 2030.

Energy efficiency improvement: The EU has made significant progress in improving energy efficiency, resulting in energy savings and cost reductions.

Development of an internal energy market: The EU has made progress in creating a single, interconnected energy market within the EU, which has increased competition, reduced energy costs, and improved security of supply.

Support for research and innovation: The EU has invested significant funding in research and innovation in areas such as renewable energy, energy storage, and energy efficiency, which has helped to bring new technologies to market.

Consumer protection: The EU has put in place measures to protect energy consumers and provide them with transparent information about their energy options.

Regional and International cooperation: EU has a strong collaboration and partnership with neighbor countries, such as the Energy Community, and actively participates in international efforts to address global energy and climate challenges. (Oberthür & Gehring, 2006)

3.7.2 Energy security

Energy security is a key concern for the European Union (EU) as it seeks to ensure a reliable and diverse energy supply for its member states. The EU's energy security strategy focuses on several key areas: diversification of energy sources, interconnections and integration of energy markets, energy storage, emergency and crisis management, International cooperation, energy diplomacy.

Diversification of energy sources: the EU aims to reduce its dependence on any one energy source by increasing the use of a variety of energy sources, such as renewable energy and natural gas, and by promoting the use of domestic resources. *Interconnections and integration of energy markets* includes a work to improve the interconnectedness of energy systems within the EU and to integrate energy markets, which helps to ensure that energy can flow freely across borders in the event of supply disruptions. *Energy storage* is the investing in research and development of energy storage technologies, such as batteries and hydrogen, to improve the flexibility and resilience of the energy system. *Emergency and crisis management:* the EU has put in place measures to prepare for and respond to energy supply disruptions, including the establishment of an emergency response coordination center and the development of a crisis communication plan. *International cooperation:* the EU works closely with other countries and organizations to address global energy and climate challenges and to promote energy security at the international level. *Energy diplomacy:* the EU is actively involved in energy-related negotiations and partnerships with other countries, regions and international organizations, to ensure the security of energy supply and to promote sustainable energy solutions. (Lombardi & Gruenig, 2016)

4 Practical Part

For the practical part of the thesis, the author first conducts a detailed analysis of each country according to the total consumption and also according to other significant factors that drive a country's total consumption of energy up. In other words, the author creates trends for the variable of total consumption for each country and assesses changes that have been occurring with the total energy consumption of each country. Then, the author assumes that two main driving forces of potential changes in energy consumption are either population growth or industry value added in %, or both altogether. Based on her assumption, she calculates correlation coefficients between the total consumption of energy and industry value added in % of the total GDP, and total consumption of energy and population. Afterwards, the author conducts a test based on the t-value which verifies if a given correlation is significant or not. In addition to that, the author also creates trends for the variable of renewable energy consumption in percentages.

After examining and describing every selected country from the selected perspectives, the author then proceeds to the comparative analysis, where the author compares calculated measures of descriptive statistics for each country's total consumption of energy and renewable sources consumption in % and then compares figures between each other. Also, the author finally compares the prices of electricity in each of the selected countries.

4.1 Country analysis

4.1.1 Spain

First, the author starts with Spain, which is one of the EU's biggest economies and biggest producers of agrarian goods. In Table 1, the author presents the dataset, which was collected based on data from Enerdata and The World Bank.

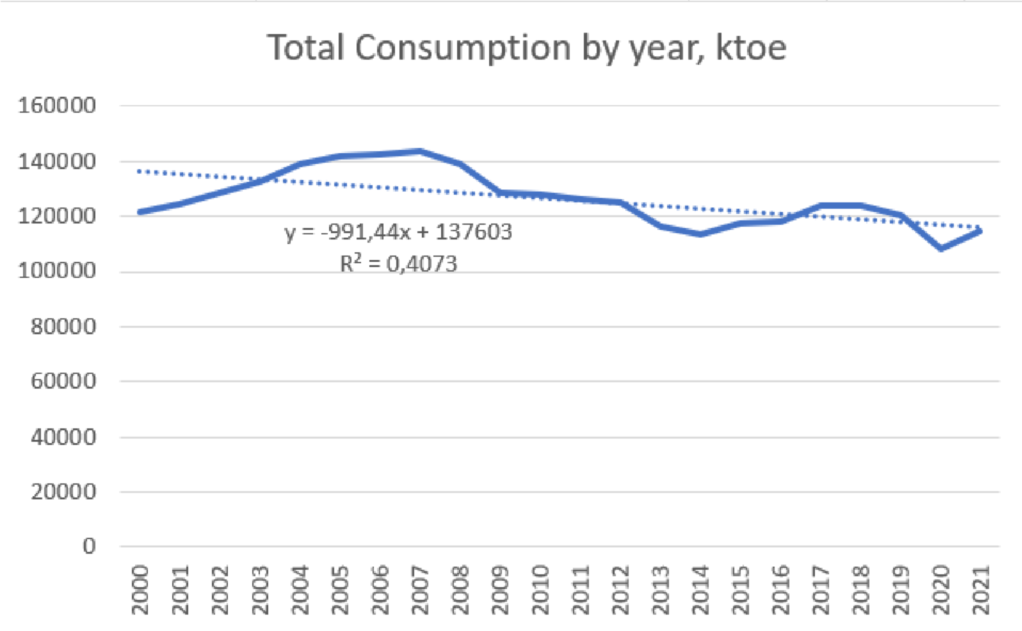
Table 1: Data for Spain

Year	Total consumption, ktoe	GDP, trillion USD	Population, million people	Renewable consumption, %
2000	121501	0,598363313	40,567864	7,88
2001	124739	0,627830029	40,850412	8,93
2002	128474	0,708756677	41,431558	7,42
2003	132834	0,907491523	42,187645	8,92
2004	138787	1,069055675	42,921895	8,05
2005	142049	1,153715823	43,653155	7,3
2006	142526	1,260398978	44,397319	8,49
2007	143666	1,47400258	45,226803	9,02
2008	138936	1,631863494	45,954106	9,76
2009	128287	1,491472924	46,362946	12,25
2010	128007	1,4221082	46,576897	14,44
2011	126014	1,480710496	46,742697	14,79
2012	124755	1,324750739	46,773055	15,83
2013	116165	1,355579536	46,620045	16,99
2014	113437	1,371820538	46,480882	17,41
2015	117457	1,196156971	46,444832	16,33
2016	117925	1,233554967	46,484062	17,21
2017	124123	1,31324533	46,593236	15,71
2018	123722	1,421702715	46,797754	17,42
2019	120175	1,394320055	47,134837	17,27
2020	108361	1,276962686	47,365655	
2021	114490	1,427380681	47,41575	

Source: The World Bank 2022; Enerdata 2022

Evidently, it can be noted that there are some values missing. To be more particular, the values that are missing from the dataset are percentages of renewable sources of energy consumption for 2020 and 2021, which was not present in the dataset offered by the World Bank. First, the author begins with the trend analysis for the total consumption with the trend presented in Figure 4.

Figure 4: Total Consumption Trend for Spain



Source: own research based on Enerdata and The World Bank

According to the estimated trend and by simply judging the development of the indicator over the course of 22 years (from 2000 to 2021 used for the analysis), it can be surely said that the consumption of energy has decreased in Spain – from 121,501 ktoe in 2000 to 114,490 in 2021. Indeed, there was a recent effect of the pandemic present in 2021 since the country's economy was not likely to recover so fact after the pandemic, but the overall tendency over the course of time even during the pre-pandemic era is pretty evident, the country was gradually decreasing its consumption of energy, which is also suggested by the trend created for the indicator – there was an annual decrease equal to 991.44 ktoe. Then, the author proceeds to the correlation analysis, whose result is shown in Table 2.

Table 2: Correlation analisys for Spain

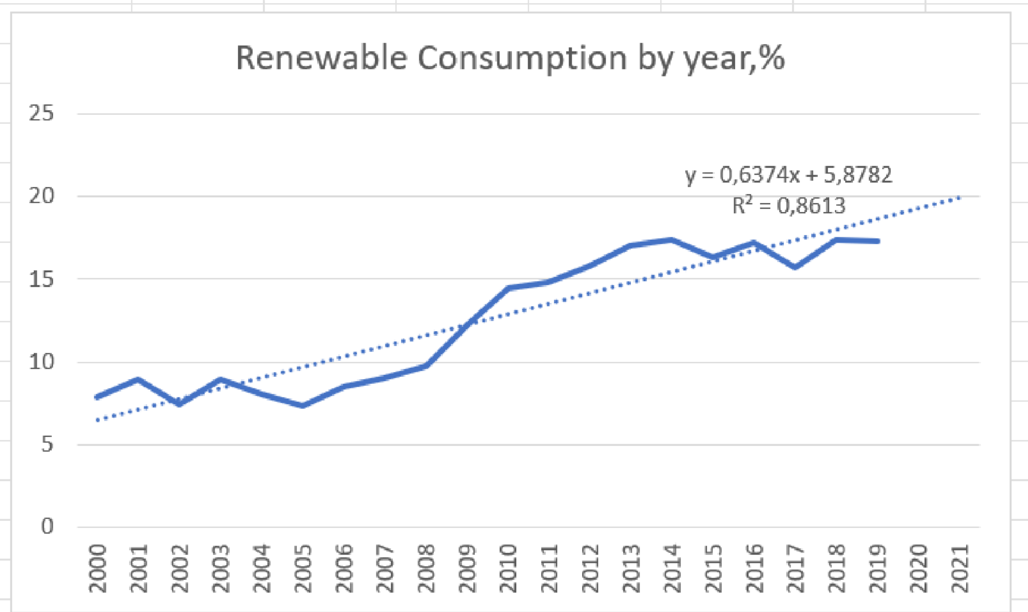
	Pearson correlation coefficient	T-value
Consumption and industry %	0,732960153	4,81851
Consumption and population	-0,399593588	-1,9494

Source: own research based on Enerdata and The World Bank

In fact, the assumption about high positive correlation between consumption and industry value added (including construction) in % is high and what is even more, it is statistically significant at the significance level of 5% selected for the analysis. Clearly, for the case of Spain, it can be suggested that the main driving force behind a decrease of energy consumption over time was related to the structural change of the Spanish economy with more focus being put to services instead of industry, which requires a lot of energy. Contrary to this, the correlation between consumption of energy and population in Spanish are not statistically correlated significantly, according to the testing procedure related to the coefficient. Yet, there is a mild negative correlation, which does not really live up to the author's expectations.

Then, it is important to take a look at the development of another indicator – renewable energy sources consumption in Spain. The author once again uses the trend analysis and in Figure 5, the author presents the output of the analysis.

Figure 5: Renewable Sources Consumption Trend



Source: own research based on Enerdata and The World Bank

Compared to somewhat chaotic development of the total consumption variable with no constant tendency, which might serve as a piece of evidence for the fact that Spanish agenda was quickly changing over time, the development of renewable sources consumption is absolutely different with rather easily predictable pattern, which is also evident by looking at the coefficient of determination, which is rather high. According to the trend, Spain's annual increase in the consumption of renewable sources of energy in % was 0.63 percentage points annually, which suggests that the country was gradually increasing the share of renewable sources of energy and increasing the role that they play in Spain, which is a good sign in the light of the UN's sustainability agenda and also the EU Green Deal.

4.1.2 Germany

Then, the second country on the list is Germany, which is by far the EU's biggest economy, so the author anticipates really high values for the consumption and economic indicators. In Table 3, the author presents the dataset used for the analysis.

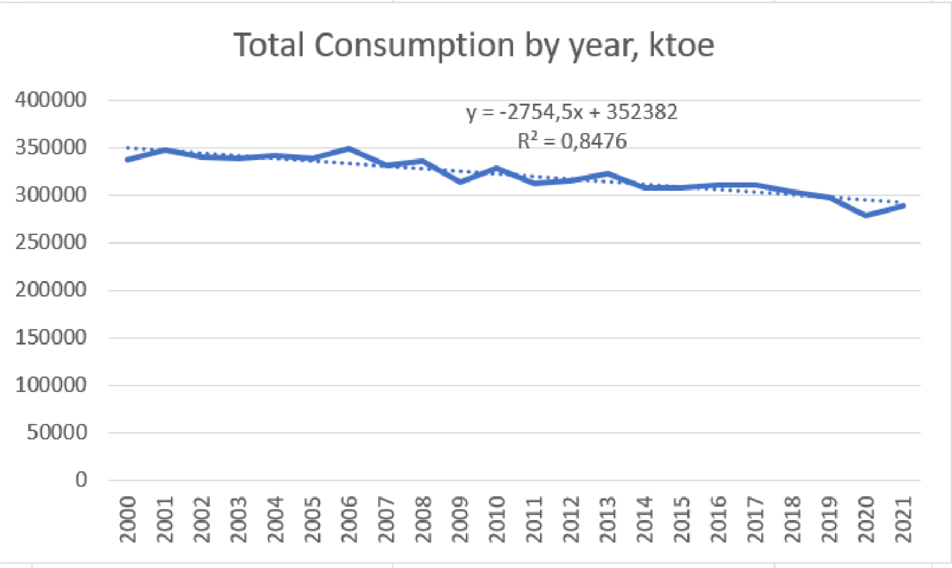
Table 3: Data for Germany

Year	Total consumption, ktoe	GDP, trillion USD	Population, million people	Renewable consumption, %
2000	337016	1,947981991	82,211508	3,7
2001	347101	1,945790974	82,349925	3,9
2002	339324	2,078484517	82,488495	4,41
2003	338685	2,501640388	82,534176	5,44
2004	341113	2,814353869	82,51626	6,34
2005	339225	2,846864211	82,469422	7,28
2006	349314	2,994703642	82,376451	8,59
2007	331192	3,425578383	82,266372	10,47
2008	335387	3,745264094	82,110097	10,25
2009	313243	3,411261213	81,902307	10,72
2010	328829	3,39966782	81,77693	11,61
2011	312706	3,749314991	80,274983	12,54
2012	315001	3,527143189	80,425823	13,64
2013	321735	3,73380465	80,645605	13,63
2014	307702	3,889093051	80,9825	14,02
2015	308142	3,357585719	81,686611	14,55
2016	310447	3,469853464	82,348669	14,24
2017	311388	3,690849153	82,657002	15,22
2018	303682	3,974443355	82,905782	16,12
2019	297048	3,888226036	83,092962	17,17
2020	278538	3,889668895	83,160871	
2021	288697	4,259934912	83,196078	

Source: The World Bank 2022 and Enerdata, 2022

In fact, the numbers for Germany are significantly higher than the numbers for Spain, but there can be noticed a serious decrease over time in the value of energy consumption, especially when comparing figures from 2021 to 2000. Yet, once again, the author believes that values for 2021 are largely affected by the ongoing pandemic of the coronavirus. Nevertheless, the author proceeds to the trend analysis for the selected indicator.

Figure 6: Total Consumption Trend for Germany



Source: own research based on Enerdata and The World Bank

Evidently, there is a gradual decrease of energy consumption in Germany over time and this increase is somewhat conscious and might be a part of the government's agenda due to really low variability, which suggests that the situation is somewhat controlled, which can be identified by looking at the coefficient of determination equal to 0.84 or 84%. In addition to that, it is wise to say that the annual decrease is equal to 2754.5 ktoe per year, which is a significant value. In fact, the author believes that this all is a part of the German government's agenda related to closing of nuclear plants and transition to ecology-friendly economy. The author proceeds with the correlation analysis in Table 4 on the next page.

Table 4: Correlation analisys for Germany

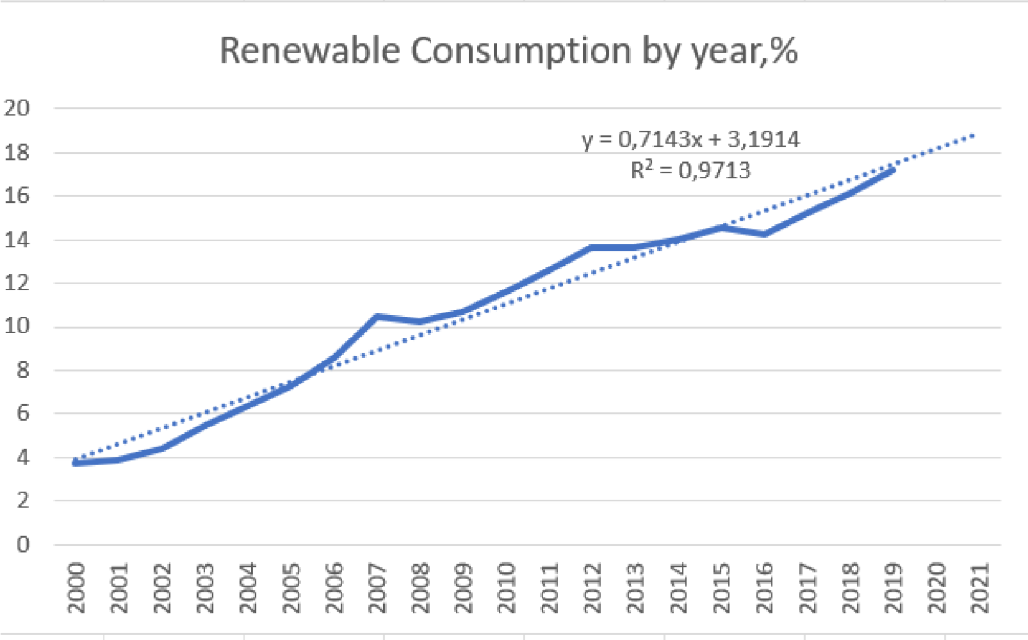
	Pearson correlation coefficient	T-value
Consumption and industry %	-0,0611847	-0,2741399
Consumption and population	-0,101438232	-0,4559977

Source: own research based on Enerdata and The World Bank

Interestingly enough, the decrease in the consumption is not likely to be caused by neither, as the correlation is proven to be statistically insignificant. Therefore, it is wise to say that the decrease in the energy consumption might be explained by changes in behaviour or preferences of consumers or energy-saving government agenda.

Finally, the author proceeds to the analysis of the final variable related to the case of Germany – renewable sources of energy consumption from the total consumption. Below, in Figure 7, the author presents the result for the analysis.

Figure 7: Renewable Sources Consumption Trend



Source: own research based on Enerdata and The World Bank

The trend for the variable of renewable sources of energy consumption in Germany is almost a perfect line with the variation not explained equal to just 2.87%, which is a very good result suggesting that the government is actively pursuing a strategy of shifting from traditional sources of energy to the renewable ones. The author believes that this transition is relatively rapid, as the annual increment is equal to 0.71 percentage points and this might be explained by the fact that Germany willingly refused to use nuclear energy, so it is pretty logical that they will focus on alternatives to traditional sources and to nuclear.

4.1.3 France

The EU's second economy – France is the third country selected for the analysis. In Table 5, the author presents the dataset which is used by the author for the estimation.

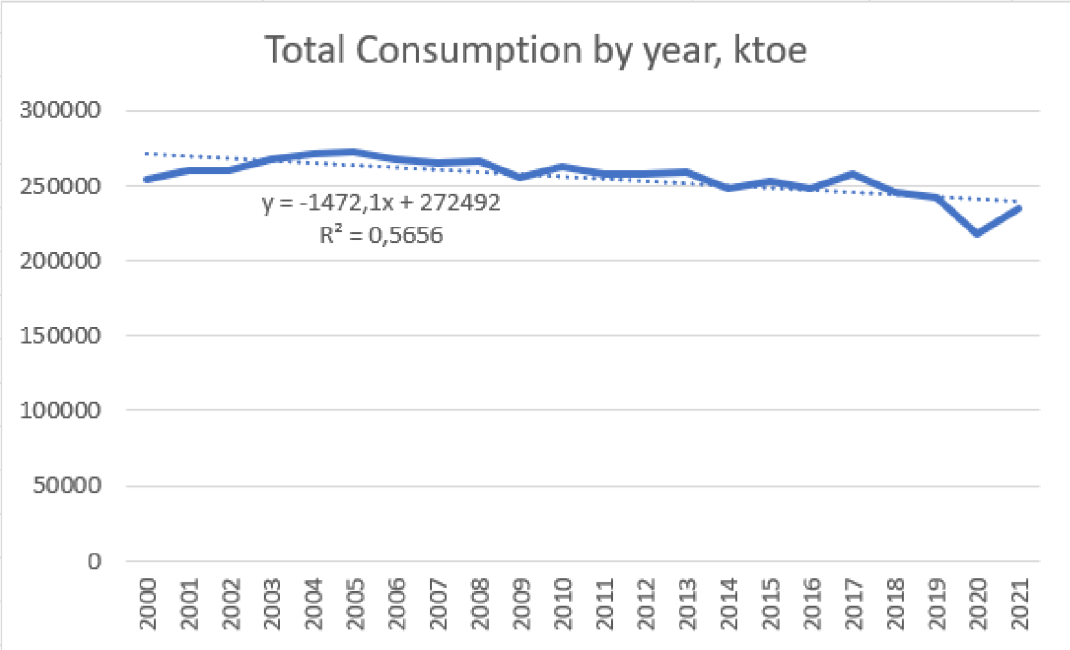
Table 5: Data for France

Year	Total consumption, ktoe	GDP, trillion USD	Population, million people	Renewable consumption, %
2000	254599	1,365639661	60,921384	9,32
2001	260146	1,377657339	61,367388	9,46
2002	260736	1,501409383	61,816234	8,73
2003	267320	1,844544792	62,25697	8,91
2004	271051	2,119633182	62,716306	8,95
2005	272218	2,196945232	63,188395	8,66
2006	267917	2,320536221	63,628261	8,52
2007	265031	2,660591246	64,021737	9,46
2008	266311	2,930303781	64,379696	10,6
2009	254853	2,700887367	64,710879	11,32
2010	262675	2,645187882	65,030575	11,99
2011	257594	2,865157542	65,345233	10,66
2012	257400	2,683671717	65,66224	12,34
2013	258475	2,811876903	66,002289	13,42
2014	248447	2,855964489	66,312067	13,2
2015	252346	2,439188643	66,548272	13,34
2016	247580	2,472964345	66,724104	14,24
2017	257412	2,595151045	66,91802	14,12
2018	245797	2,790956879	67,158348	15,21
2019	242224	2,728870247	67,388001	15,53
2020	218103	2,639008702	67,571107	
2021	234143	2,957879759	67,749632	

Source: The World Bank 2022 and Enerdata, 2022

As for France, one of the oldest members of the European Union and G7 has also managed to decrease its overall consumption of energy when comparing figures from 2000 with the ones in 2021. The author proceeds to the trend analysis for the variable of total consumption for the case of France in Figure 8.

Figure 8: Total Consumption Trend for France



Source: own research based on Enerdata and The World Bank

More or less similar tendency is identified for the case of France as for Germany and Spain with the difference in the intensity of decrease. Compared to other two countries, France was seemingly pursuing a slightly different strategy and the country was not really aiming at significantly diminishing its energy consumption. If not for the logical drop in the consumption in 2020 causes by the pandemic of coronavirus and its consequences, the level of consumption for the last observed years could have been the same as in 2000. Then, the author proceeds to the correlation analysis, which is shown in Table 6.

Table 6: Correlation analisys for France

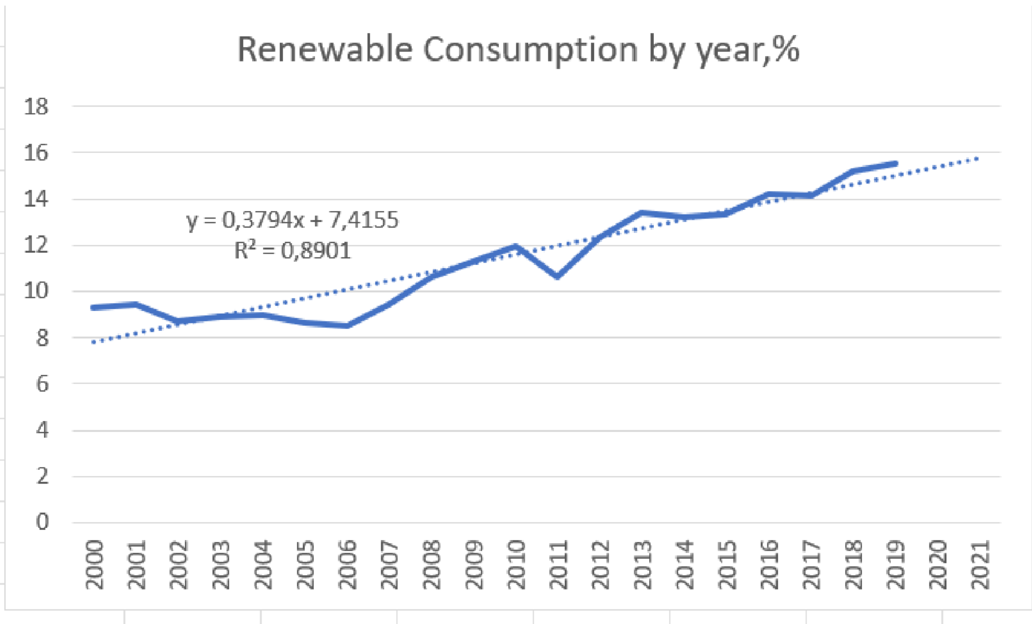
	Pearson correlation coefficient	T-value
Consumption and industry %	0,660181655	3,9307664
Consumption and population	-0,679110856	4,13750445

Source: own research based on Enerdata and The World Bank

According to the analysis, it can be said that both factors seem to have a significant impact on the consumption, since they both are considered to have a significant statistical effect on consumption. However, the author believes that the second relationship does not in particular mean that higher population means lower consumption since it is fully irrational. On the contrary, the author believes that energy consumption patterns have changed in such a way that rise in the population did not really lead to significantly higher consumption, which suggests that there is a structural change in the way how energy is being produced and consumed in France. However, the author believes that the first paid – industry value added in % and consumption is much more interesting because it proves the fact that France was shifting from relatively polluting practices and industry to slightly different specialization, such as services, which generally leads to lower ecologically negative footprint.

Then, when considering the environmental aspect of energy industry in France, which is known to be significantly dependent on nuclear sources of energy, it is wise to take an insight into the development of the share of renewable sources of energy in the total consumption. The author presents the trend in Figure 9.

Figure 9: Renewable Sources Consumption Trend



Source: own research based on Enerdata and The World Bank

In fact, the country was seeking to increase the share of renewable sources of energy – the same as Germany and Spain. However, the pace at which France was increasing its share is significantly different (lower) from the case of Germany and Spain, but the author believes that it comes from the historical background of the country and the focus of the country's current president on nuclear energy. All in all, the annual increase was equal to 0.37 percentage points, which is still a good result. At the same time, the original level of the share of renewable sources in the total consumption was significantly higher than for Germany and slightly higher than for Spain, which might be another explanation for such a slow increase.

4.1.4 Czech Republic

The Czech Republic is also included into the author's analysis as it can provide a good overview of how a relatively new EU member that managed to recently finish its transition from the planned type of economy to the market one behaves itself in terms of energy consumption. Table 7 presents the dataset which will be used by the author for the analysis of the Czech Republic's energy sector.

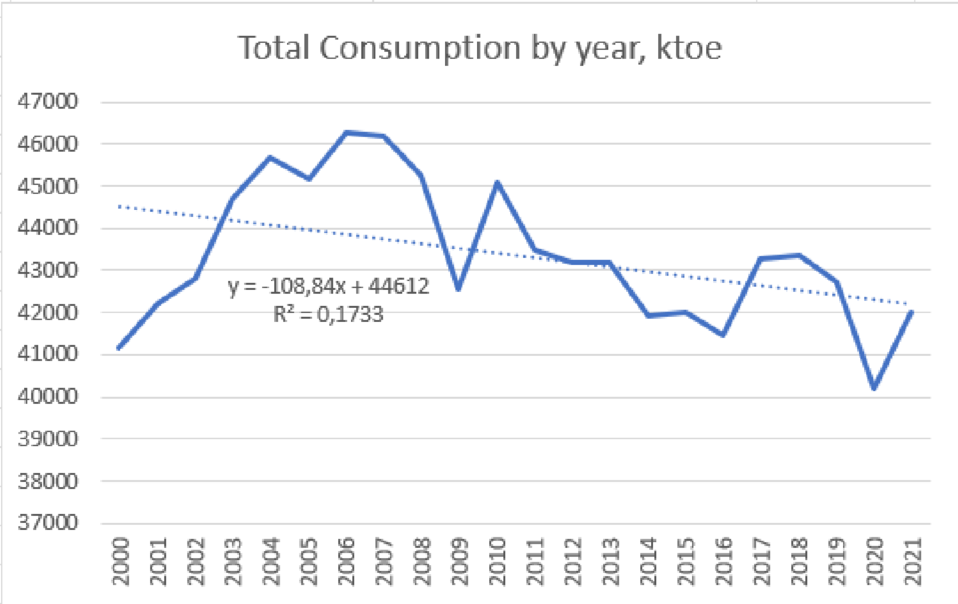
Table 7: Data for the Czech Republic

Year	Total consumption, ktoe	GDP, trillion USD	Population, million people	Renewable consumption, %
2000	41154	0,061828166	10,255063	5,94
2001	42230	0,067808033	10,216605	6,29
2002	42809	0,082196001	10,196916	7,28
2003	44693	0,100090468	10,193998	6,72
2004	45697	0,119814434	10,197101	7,13
2005	45184	0,137143471	10,211216	7,53
2006	46247	0,156264096	10,238905	7,88
2007	46182	0,190183801	10,298828	8,32
2008	45264	0,236816486	10,384603	8,99
2009	42554	0,207434297	10,443936	10,25
2010	45103	0,209069941	10,47441	10,95
2011	43486	0,229562733	10,496088	12,16
2012	43187	0,208857719	10,510785	12,8
2013	43183	0,211685617	10,514272	13,95
2014	41927	0,209358834	10,525347	14,85
2015	41998	0,18803305	10,546059	14,84
2016	41469	0,196272069	10,566332	14,77
2017	43294	0,218628941	10,594438	14,46
2018	43353	0,249000541	10,629928	14,72
2019	42705	0,25254818	10,67187	15,85
2020	40179	0,245974559	10,697858	
2021	42027	0,281777887	10,505772	

Source: The World Bank 2022 and Enerdata, 2022

Undoubtedly, the level of energy consumption in the Czech Republic is really insignificant compared to other three countries included into the analysis, but it is primarily justified by the scale of the Czech economy, as well as the total population of the country, which is significantly lower than the domestic population of any country discussed earlier. The author proceeds to the trend analysis in Figure 10.

Figure 10: Total Consumption Trend for the Czech Republic



Source: own research based on Enerdata and The World Bank

Obviously, it is fair to say that the development of the variable for the case of the Czech Republic is really chaotic and variable with no particular agenda or direction visible for the whole period analyzed, which has its direct implication on the coefficient of determination, which is equal to just 0.17 or 17%, which is really low. However, based on the aggregate data and the trend created, it can be said that the Czech Republic on average managed to annually decrease its total consumption by 108.84 ktoe. However, the author suggests that this variable is highly influenced by a large number of external determinants that are responsible for constant ups and down of the variable. Nevertheless, the author proceeds to the correlation analysis indicated in Table 8.

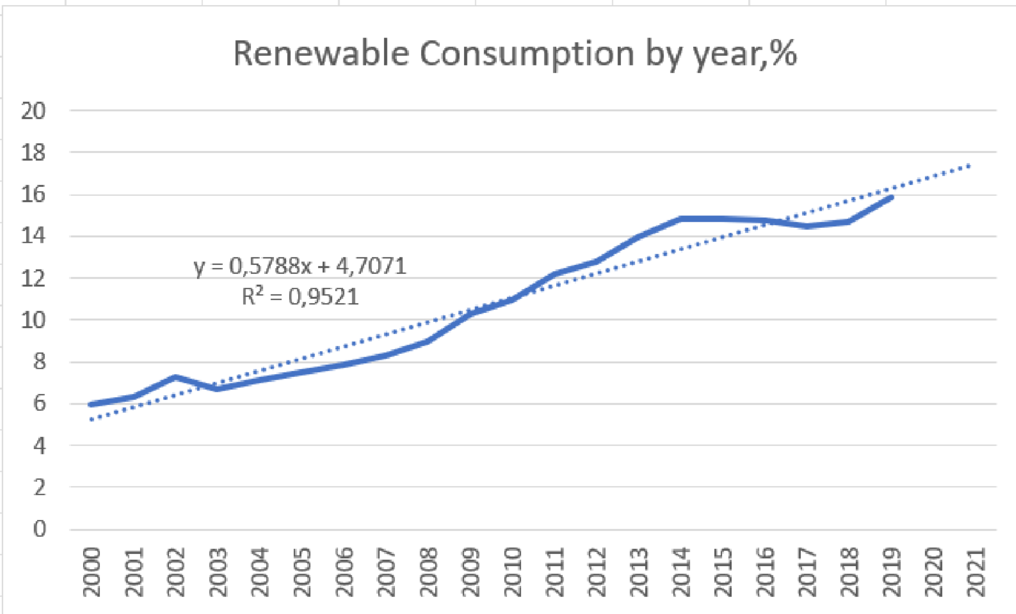
Table 8: Correlation analisys for the Czech Republic

	Pearson correlation coefficient	T-value
Consumption and industry %	0,447459572	2,23760565
Consumption and population	-0,517889578	2,70743987

Source: own research based on Enerdata and The World Bank

Based on the analysis, both factors are significantly correlated with the consumption variable in the Czech Republic, but the author believes that the second pair of correlation is explained in the same manner as the author identified it for France, while the first pair suggests that in fact, industry value added in % is a significant factor affecting the consumption of energy in the country. Then, the author proceeds to the variable related to renewable sources of energy, which is indicated in Figure 11.

Figure 11: Renewable Sources Consumption Trend



Source: own research based on Enerdata and The World Bank

Despite significantly different level of economic output produced in the Czech Republic compared to other countries discussed in the analytical part of this bachelor thesis, the Czech Republic does not fall behind the rest in the domain of green or renewable energy as the country has more or less identical level of renewable sources of energy input in the total consumption of energy. With the average annual increment of 0.57 percentage points, it can be said that the Czech government seems to be pursuing an evident strategy related to the increase of the role that renewables play in the Czech energy sector, which can especially be important in the light of recent circumstances with one of the biggest suppliers of the Czech Republic of energy-related commodities – the Russian Federation.

4.1.5 Sweden

Finally, the last country included into the analysis belongs to somewhat entirely different domain – it is not really a driving force of the EU economy but at the same time, it is not a member that joined recently and neither it is a member which is somehow less economically advanced than others. The author believes that Sweden represents the list of the so-called welfare states, which are really strong in terms of the social domain and in terms of the ecological footprint that the country leaves. Nevertheless, in Table 9, the author presents the dataset used for the analysis of Sweden's energy sector.

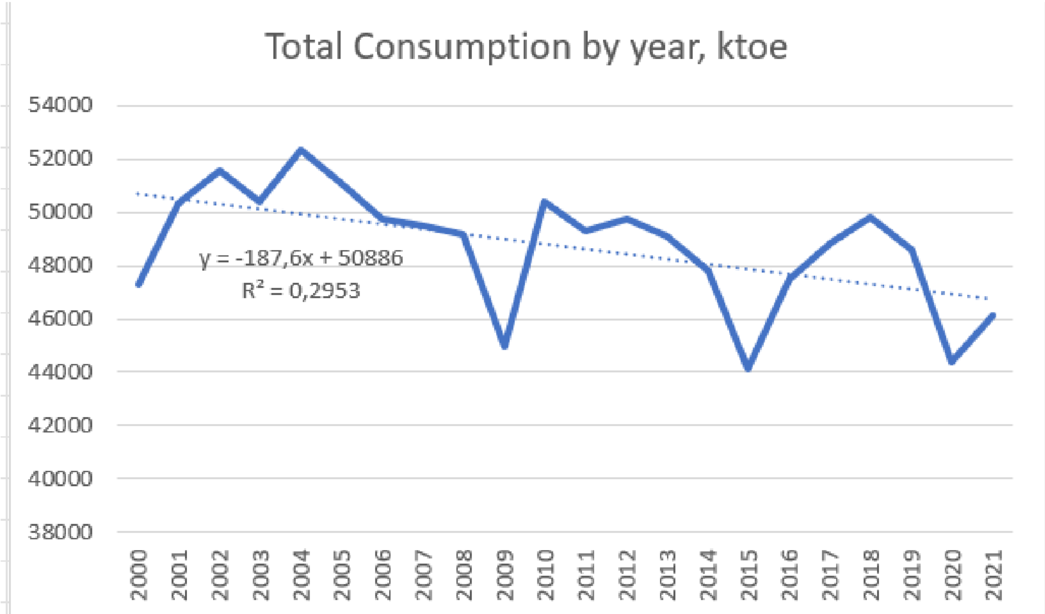
Table 9: Data for Sweden

Year	Total consumption, ktoe	GDP, trillion USD	Population, million people	Renewable consumption, %
2000	47263	0,262835454	8,872109	39,82
2001	50346	0,242395852	8,89596	37,38
2002	51574	0,266849062	8,924958	35,85
2003	50411	0,334337212	8,958229	34,56
2004	52369	0,385118045	8,993531	35,49
2005	51089	0,392218089	9,029572	39,3
2006	49751	0,423093437	9,080505	40,08
2007	49508	0,491252589	9,148092	41,75
2008	49142	0,517706149	9,219637	43,2
2009	44945	0,436537014	9,298515	45,71
2010	50392	0,495812559	9,378126	44,7
2011	49282	0,574094113	9,449213	45,43
2012	49725	0,552483727	9,519374	48,29
2013	49075	0,586841822	9,600379	47,27
2014	47817	0,581964017	9,69611	48,61
2015	44096	0,505103781	9,799186	51,91
2016	47492	0,515654671	9,923085	50,89
2017	48818	0,54101875	10,057698	51,81
2018	49834	0,555455371	10,175214	51,54
2019	48579	0,533879529	10,278887	52,88
2020	44388	0,547054174	10,353442	
2021	46125	0,635663801	10,415811	

Source: The World Bank 2022 and Enerdata, 2022

In fact, the level of consumption is much different from figures for Germany, Spain and France and it can be actually compared to the figures for the Czech Republic – the same applies to the country's population. Nevertheless, the author proceeds to the trend analysis, which is shown in Figure 12.

Figure 12: Total Consumption Trend for Sweden



Source: own research based on Enerdata and The World Bank

Generally, the author believes that the pattern of the development can serve as a piece of evidence for the fact that the country was gradually decreasing its energy consumption over time with some years being really low in terms of the energy consumption. Unsurprisingly, those years are affiliated with crises, such as the Great Recession in 2008 and a logical fall in the total value of energy consumption and the coronavirus pandemic in 2020. The author can say that the average annual decrease is equal to 187.6 ktoe per year, which indicates that the country managed to decrease its total consumption over time.

Then, the author continues to the correlation analysis shown in Table 10.

Table 10: Correlation analisys for Sweden

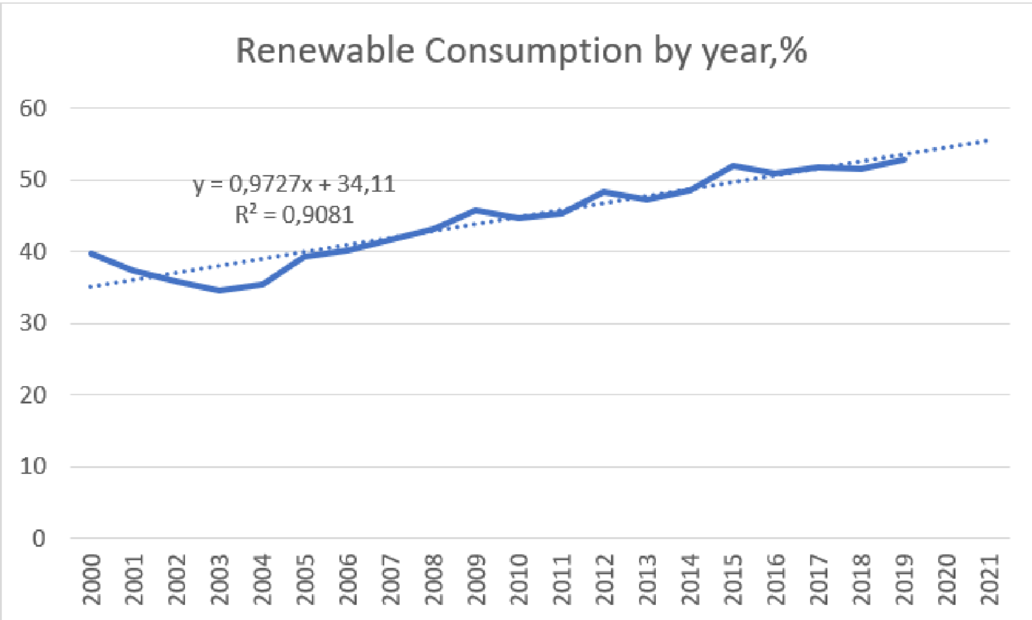
	Pearson correlation coefficient	T-value
Consumption and industry %	0,570761432	3,10860209
Consumption and population	-0,548837013	-2,9362214

Source: own research based on Enerdata and The World Bank

The second correlation once again suggests that despite a positive increment in the total population of the country, the authorities managed to decrease the overall consumption of energy, which is a good sign. Effectively, both correlations are statistically significant but the first pair provides a valuable insight that the country's decrease in consumption is largely explained by the decrease of the share of industry and transition to services.

Then, the author proceeds to the trend analysis of the role of renewable sources of energy in the total consumption of the country, which is by far seems to be really significant. The analysis is shown in Figure 13.

Figure 13: Renewable Sources Consumption Trend



Source: own research based on Enerdata and The World Bank

Effectively, the level of renewables in the total energy consumption of Sweden is incredibly high. Apart from that, the country was managing to keep the annual increment equal to almost 1 percentage point – 0.97 percentage points. Clearly, the country managed to exceed the level of 50% and in 2019, the country's energy consumption was already consisting of mostly renewables, which is a really outstanding result.

4.2 Comparative analysis

After analyzing each country's individual situation, the author proceeds to the comparative analysis of those countries according to two variables – the total consumption of energy in ktoe (ton of oil equivalent) and the percentage of renewable sources of energy in the total consumption. For this analysis, the author uses measures of central tendency (mean, median), two measures of dispersion (standard deviation and coefficient of variation derived from it) and the base index with the year 2000 selected as the base year for all countries. The author uses the first column of databases indicated for the case of each country and then generates Table 11, containing output for the comparative analysis of those countries.

Table 11: Comparative analisys of total consumption

	Spain	Germany	France	Czech Republic	Sweden
Mean	126201	320705	255563	4336	48728
Median	124747	318368	257503	43185	49212
St. Deviation	10088,15472	19428,06099	12710,21412	1697,53816	2241,735997
Variability	8%	6%	5%	4%	5%
Base Index (2000 - base)	-6%	-14%	-8%	2%	-2%

Source: own research based on Enerdata and The World Bank

When comparing all countries between each other, the country with the biggest consumption of energy is by far Germany, followed by France, then Spain, Sweden and the Czech Republic. Spain has the highest variability of energy consumption, which might be explained by uncertainty in economic development of the country, while other countries seem to have the situation under control, and they rather follow a particular agenda. Out of all countries, Germany was the one that managed to decrease the consumption by the biggest number – 14%, followed by France with 8%, Spain with 6% and Sweden with 2%. The Czech Republic is the only outlier, whose consumption in 2020 was higher than in 2000, but this might be explained by the fact that the country has one of the highest shares of industry value added out of all OECD member-states. Overall, the author believes that in terms of consumption, all countries pursue the strategy of decreasing it and the most successful one whose transition is the fastest is Germany.

Then, the author proceeds to the comparative analysis of the share of renewables in the consumption, which is shown in Table 12.

Table 12: Comparative analysis of renewable sources of energy in the total consumption

	Spain	Germany	France	Czech Republic	Sweden
Base Index (2000 - base)	119%	364%	67%	167%	33%
Average Chain Base Index	5%	9%	3%	5%	2%

Source: own research based on Enerdata and The World Bank

In fact, Germany is has also the best result for the renewable sources of energy variable as the country's base index is equal to 364%, which suggests that the country managed to increase its share of renewables by 364% in 2019 compared to 2000, which is an incredible result. The second-best country in that regard is the Czech Republic with 167%, followed by Spain, France and Sweden. The numbers for Sweden might be misleading, but it is wise to understand that in 2019, the country already managed to have the highest portion of its consumption supported by only renewable sources of energy and clearly, further development for the country is significantly higher than for other European partners, whose situation in 2000 was much worse. In fact, the renewable miracle of Germany is also explained by the fact that the country had just somewhat 2% of the total consumption supported by renewables in 2000, which is a really low value for a developed economy. Nevertheless, the author believes that all countries are in the transition to green energy, which fully aligns with the European Green Deal.

Finally, in Table 13 the author presents the average price for electricity in kWh for the first quarter of 2022 and for 2000 in selected countries.

Table 13: Comparative analysis of prices for kWh in 2000 and 2022 for the selected countries

	Spain	Germany	France	Czech Republic	Sweden
Price ($ per kWh), 2000	0,035	0,07	0,09	0,075	0,015
Price ($ per kWh), 2022	0,32	0,44	0,18	0,29	0,27

Source: own research based on Global Petrol Prices

Based on the analysis, it can be concluded that the country with the most expensive electricity in 2022 by far is Germany, which might be partially tied to the strategy of decreasing energy consumption in the country. The second country with the largest price is Spain, followed by the Czech Republic, Sweden and France. In fact, it is wise to mention that all those countries have a different price level and when considering purchaser parity concept, it can be assumed that the worst situation is identified in the Czech Republic, which is undergoing an energy crisis at the moment whose degree is much more serious than for other countries from the list and the price of 0.29 USD in 2022 is crucial for the country whose price level and the level of minimal wage is significantly lower than for Germany, France and Sweden. The author believes that the situation of France is one of the best once, which might serve as additional argument in favor of keeping nuclear energy as the main source for the country. Then, the author believes that in terms of the price level if Sweden, the price for electricity there is really acceptable and good.

5 Results and Discussions

5.1 Energy Sector of Selected Countries

To begin with, it is essential to start with a very important observation made by the author – all 5 countries selected for the analysis and most likely, all countries of the

European Union as well have been undergoing a transition in terms of the energy utilization, production and, what is more important, consumption. The author in her analytical part has focused on the consumption, but she believes that the same pattern persists in other domains related to energy sector with countries trying to decrease the burden that this sector has on the environment. In addition to structural changes that were happening with European economies (shift from industry to services), the situation also changed for the energy utilization, as industry in general is the most energy-intensive and energy demanding sector of economies, which also accounts for the biggest negative footprint for the environment. Based on the correlation analysis conducted by the author, she suggests that one of the main justifications for the ongoing decreases in the overall energy consumption in the selected European States is attributed to the decrease of the role that the industrial sector plays for the European States. The share of industry inevitably decreases as all members states, even including the ones that have joined relatively recently shift to the production of other goods which have a higher value added, which is also suggested by Rachwal (Rachwał, 2011), who concluded that the role that industry plays inevitably decreases. Based on the author's assumption as well as on the results of the correlation analysis, the author suggests that the tendency for decreasing total consumption will continue in the nearest future until the share of industry reaches approximately 20-23% for all member states. The author coincides with the findings of Xin-Gang (Xin-gang, 2022), who concluded that the main reason behind the increase in the consumption of energy in China is attributed not to the population growth, despite a common belief but to the ever-increasing role of industry in the country's GDP. Therefore, the empirical part of the analysis and the correlation described by the author of this bachelor thesis and Xin-Gang is the same with the only exception – China is delivering an opposite policy to the EU, whereas the EU member-states are focused on moving towards more productive and wealthy sectors trying to finally get rid of the industrial past. In addition to that, Xin-Gang also suggests that the impact of the increase in the consumption on the acceleration of climate change is significant with carbon footprint increasing more and more each year. This helps the author to proceed to the second justification of the ongoing policy in the selected EU member-states.

Evidently, another concern that prompts countries to decrease their energy consumption, as well as decrease the output of industry for the country's GDP, according to the author's perception is the EU's alignment with the goals of sustainable development provided by the United Nations and also focus of the EU on the environment and sustainable future for the planet. Of course, despite the fact that The European Green Deal was accepted and approved in 2020 and the ultimate goal of the Green Deal is to make the Union climate neutral by 2050, the Union had started to implement environment-focused policies even earlier with the first ones dating back to even 70s, when the Union was called the European Community, which is mentioned by Jordan (Jordan, 1999). Of course, the EU's agenda pursued European governments to transition shifting from relatively non-environmentally friendly sources of energy and also energy utilization practices to more environmental-friendly ones. Therefore, the author suggests that the EU policy aimed at environment partially succeeded, if referring to the results of the author analysis, where almost all member states (apart from the Czech Republic) managed to decrease consumption and by doing so, it is believed to have helped the environment in a serious way, which is also concluded by Knill (Knill C., 2000). Therefore, the author underpins her findings that two of the most important driving forces behind changes in the energy sector are structural changes of the EU economies and shift to more productive industries and sectors and persuasion of the EU officials who were really keen on reaching the goals of the EU environmental policy.

Clearly, one of the biggest goals of the EU environmental policy was and still is transition from the transitional energy sources to alternative ones with the best alternative often being renewable sources of energy. The author's results suggest that all member states have made a tremendous step forward in that domain by increasing the share of renewables by high numbers, where some countries even managed to increase it by more than three times, such as Germany. In fact, the author reaches the same conclusions about Germany as other authors, such as Gawel (Gawel et al., 2014) who explains changes in the energy consumption and production patterns is explained by the country's goal to become carbon and nuclear-free by approximately the same year as the EU's Green Deal is expected to reach its goals. What is more interesting is the fact that in that regard, all countries are quite successful – the author analyzed 5 with absolutely different history and different time being a part of the EU family, but all of them seem to have achieved significant results by reaching the level of approximately 18% (out of selected 4 countries – Czech Republic, Spain, Germany and France). However, there was an outlier when it came to renewables – Sweden, as the country's level of renewable output was already high back in the beginning of the 00s and by 2019, the country was even able to exceed the level of 50% of consumption being produced by renewable sources of energy, which is a tremendous result suggesting that in the list of countries used for the analysis, Sweden is by far the best-performing one in terms of eco-friendly energy production, which is also partially reflected on the price of one kWh. The justification for this situation can be found in academic titles, such as in the article produced by Nilsson (Nilsson, 2004) who highlighted that the main driving factor of such an overwhelming success in terms of the share of renewables is the energy policy that had already been in use for 25 years in 2004. In addition to that, he specifies that good energy policy was not the only factor that led to such a situation. In fact, the country is endowed with renewable resources, which are quite effectively and efficiently allocated, so the country is located in the list of the most advanced ones in terms of energy production and utilization.

Finally, it is also essential to reflect on the price differences between the selected EU countries, where France has the lowest price even despite the fact that the country has a really high price level, which is somewhat similar or partially identical to the one in Germany, which is not at all surprising as two countries are the EU's largest economies. However, there is a huge gap between them in terms of price per one kWh and the author believes that the main reason lies in the energy production – Germany tries to pursue a strategy where the country will eventually become carbon and nuclear free, as the author has specified it earlier, while France is largely focused on nuclear energy as the main source of energy for the country. Despite the number of growing concerns related to potential danger of nuclear energy and its effect on the environment, the reality is that the production of this kind of energy helps France to maintain really low figures for electricity prices, which is good for domestic producers and households, while the foreclosure of all nuclear plants has partially been responsible for the growing problem with energy in Germany. Many articles underpin the author's assumption, such as Boccard (Boccard, 2014), who performed a comparison of energy cost for the American households and firms and the French ones, where the second group was far better off and enjoying much cheaper energy. However, this is contradicted by Petit (Petit, 2013), who does not really think that in the long-term perspective, presence of nuclear plants has an enormous effect on energy prices. Nonetheless, the author believes that the first argument is likely to be closer to reality as the time has indeed shown that the phase out of nuclear energy in Germany took a toll on the prices. However, the author believes that the worst situation in terms of pricing is identified in the Czech Republic with the country having rather high figures for the price per 1 kWh in 2022 especially when considering the price level and the overall level of economic development of the country.

5.2 Future of Energy in the EU

When answering the question of the future of energy in the European Union, it is wise to understand that if one had been asked this question prior to the 24^{th} February of 2022, the answer would have been significantly different from what it is today. In fact, the outbreak of the Ukrainian conflict changed everything and not only it did change the situation with energy suppliers, but it also changed the agenda of the EU quite radically by postponing all goals of the EU's environmental policy for years to come.

To be more specific, it is wise to understand that according to official statistics provided by the EU itself, the main supplier of energy to the Union was (until February-March of 2022) the Russian Federation. However, there were numerous reports and articles which suggested that there is a significant need to switch to alternative partners – the following was suggested by Baran (Baran, 2007) and Bocse (Bocse, 2019) but evidently, the EU did not manage to finish this transition, for which the German former ruler Angela Markel is blamed for, according to Forsberg (Forsberg, 2016). For the nearest future (2023-2024), the European Union finds itself in a serious need of finding alternative suppliers of energy resources and related commodities or the Union faces a need to restore energy extraction from sources that are far from being considered as eco-friendly and in fact, there is not much that the EU can do. In fact, this whole situation significantly interrupts the Union's Green Deal agenda, but as the author sees it, the Union is not expected to trade their dream of becoming eco-friendly and green by 2050 for the security of the Union and integrity of Ukraine, as political agenda prevailed and the Union decided to postpone the original agenda but strengthen the political domain and focus on providing a solidary response to the external aggression.

In fact, the author believes that the ongoing crisis is likely to shift the attention of the EU from environmental issues more to issues related to integrity, which might prove itself to be really crucial during the process of transitioning to the final stage of Economic integration – political union, which is only possible when the political will of all member-states coincides. In such complicated times, unfortunately for the planet, the author believes that the environmental agenda will not be fully cancelled, but its delivery and implementation will be significantly halted but not cancelled entirely.

6 Conclusion

To conclude, the author is able to say that the results of her analysis are positive and pessimistic at the same time. First, when it comes to the overall tendency of consumption in the European Union, the author believes that the situation is improving as economies shift more to services and slowly abandon their industries, especially it is visible among the so-called "new" member-states who joined the Union in the 21st century and who often had a history of planned economy. Thus, all selected countries for the analysis to some extent move in the same direction, where the main goal lies in decreasing the overall intensity of energy sector and decreasing the consumption or keeping it on the same level even despite an increase of populations by implementing specific energy policies, such as the one in Sweden, which has proven itself to be highly fruitful.

In parallel to the decrease in consumption, the author also identifies that selected countries were rapidly increasing the role of renewables in the energy sector, which is driven by the EU's environmental agenda, conclusion of Paris Agreement and also the Green Deal of the EU. The author believes that all countries prior to 2019 were moving at a good rate, but she suggests that the situation might be significantly different after the pandemic in 2020 and after the start of the Russia-Ukraine conflict in 2022, so the author suggests that researching the same topic in a matter of few years will prove itself to be highly valuable for expanding the current scientific framework. As for the empirical part of the analysis, the author believes that the best situation in terms of energy transition and energy policy is identified in Sweden, where the share of renewables exceed the boundary of 50% and it is explained to the largest part by the country's endowment with renewable resources and proper allocation of those resources thanks to the energy policy.

Then, the author believes that both France and Germany are doing good jobs in terms of energy transition, and it is very important for the EU that even the biggest economies consider the importance of transitioning from traditional non-eco-friendly sources of energy to renewables, where Germany has made the largest leap forward by reaching the increase of 364% in 2019 compared to 2000. However, the author believes that the current energy policy of Germany has its limitations – consumers are left worse off as the prices for energy remain high partially due to phasing out of nuclear stations in the country. Especially it is visible when comparing Germany with France, with the second country enjoying the cheapest energy out of selected five countries even despite a relatively high price level and advanced economy. In addition to that, it is wise to say that the worse situation is identified in the Czech Republic, where the country seems to have the highest price of electricity when considering the overall price level and the level of economic development of the country.

All in all, the author believes that this positive dynamics for selected countries and other EU member-states is likely to be obscured by repercussions of the Russia-Ukraine conflict which will inevitably hit the EU's energy sector and also postpone the EU Green Deal by an unknown number of years.

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