Renewable Energy Adoption in Eastern and Western Europe: A Comparative Analysis of Poland and the Netherlands Post-Russian Invasion

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1. Introduction

In the evolving landscape of global energy politics, the role of renewable energy as a cornerstone of national security and economic stability has not been more important in Europe since World War II. This thesis explores the strategic responses of Poland and the Netherlands to the major geopolitical conflict in the region – Russian aggression on Ukraine. The focus is on the renewable energy policies introduced by Poland and the Netherlands following the Russian annexation of Crimea in 2014 and the full-scale invasion of Ukraine in 2022. These critical events have highlighted the vulnerabilities associated with external energy dependencies and have accelerated transition toward sustainable energy systems within the European Union.

The annexation of Crimea led to a shift in European geopolitical dynamics, leading to widespread international sanctions against Russia and raising serious concerns about energy security among EU countries. The situation escalated after Russia's invasion of Ukraine in 2022, intensifying the urgency to reevaluate and restructure energy policies across the continent. This study aims to provide a comparative analysis of how Poland and the Netherlands - countries at the geographical and political extremities of Europe - have adapted their energy strategies in response to this crisis.

Poland, located at the frontier of the conflict, has historically relied heavily on coal, making its energy strategy not only crucial for economic independence but also for regional stability. The country's transition to renewable energy is thus both a pressure point and a critical element for its future energy security. The Netherlands, on the other hand, is known for its innovative approach to energy solutions, provides this thesis with an example of how advanced economies can approach renewable technologies to enhance energy security and sustainability.

This thesis seeks to address two main research questions:

Research question 1: How have the approaches to renewable energy adoption differed between Poland and the Netherlands in response to the geopolitical consequences of the Russian-Ukrainian conflict, and what factors have influenced these divergent paths?

Research question 2: To what extent has the impact of the war in Ukraine accelerated or hindered the implementation of renewable energy strategies in Eastern and Western Europe, with a comparative analysis between Poland and the Netherlands?

2. Literature review

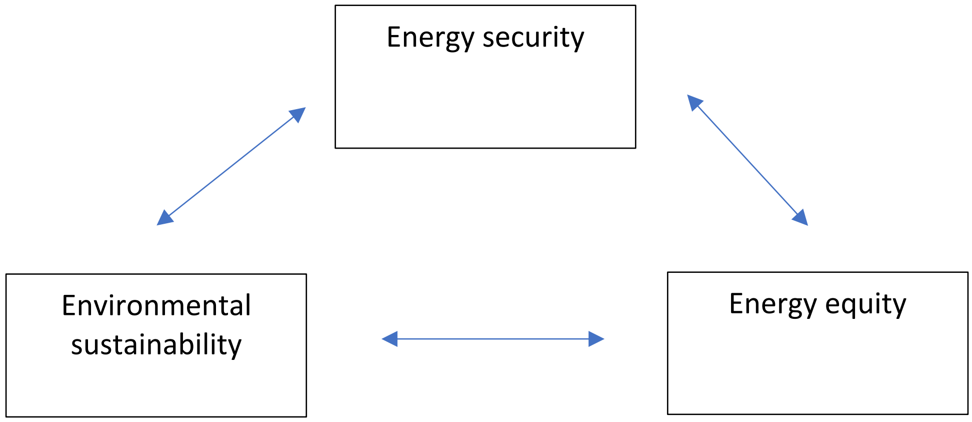
The literature review in this thesis offers research concerning the adoption of renewable energy in Europe, with a specific emphasis on the impact of the Russian-Ukrainian conflict. This section seeks to clarify the difficulties of renewable energy policies, governance structures, and responses to external disruptions within the European environment by reviewing relevant studies, theories, and frameworks. Important topics covered in this review include how renewable energy is conceptualized, the goals of the European Union in relation to climate change and the use of renewable energy, the importance of Russian energy supplies before the conflict in Ukraine.

2.1 Energy market

Energy market primarily deals with trading and distribution of energy, encompassing both the electric energy market and other types of energy resources such as natural gas, oil, coal, and renewable sources like solar, wind, and biofuels. Energy markets are characterized by high innovation ratios and are considered a complex sector considering their significant role in the global economies, the necessity of this sector in power and gas supply, and the financial concerns of energy.(Mousavi et al., 2021). Energy plays an essential role in building and sustaining strong economies. Uğur Soytaş & Ramazan Sarı, 2019 argue that energy is a pivotal driver of economic growth. This causation can be observed in a consistently higher energy consumption per capita in the most developed countries. Specifically, the slope of the logarithmic regression line implies that “a 1% increase in income per capita is associated with a 0.7% increase in energy use per capita” (Ibid.). According to Stern energy and GDP cointegrate which stands in line with the former findings (Stern, 2011). However, the scholar is more skeptical about this issue. He discovered that increased energy availability, technological advancements, and the use of superior fuels have decreased the energy required per unit of output, thereby lessening the limitations that energy resources impose on economic output and growth. However, the scholar indicates that next to capital and labor, energy is essential for economic growth and stability (Ibid.).

Inferring from the literature, it is in the best interest of countries to operate reliable and efficient energy markets. To achieve such a state a concept of “energy trilemma” has been introduced and will be helpful to additionally frame the topic of this thesis. Specifically, the energy trilemma refers to the “competing forces of the economics, environment, and politics” (Heffron et al., 2018). According to a more narrowed-down definition of this concept mostly used in the literature, the energy trilemma includes “Energy security, Energy equity, and Environmental sustainability” (Marti & Puertas, 2022). The scholars analyze the trade-offs between these three aspects, energy security - ensuring reliable energy supply, energy equity - providing affordable energy access, and environmental sustainability - minimizing energy production's ecological impact. The study shows how countries navigate these competing objectives, often facing challenges where prioritizing one aspect can compromise the others. For instance, boosting energy security with fossil fuels may conflict with environmental goals, while enhancing energy equity by lowering costs could increase consumption and strain sustainability efforts. The scholar underlines that this framework helps in assessing and comparing the performance of different countries in managing their energy policies and successfully undertake energy transition towards renewable sources (Ibid.).

Figure 1. Visualization of Energy trilemma



Governments and societies should aspire to achieve a better balance between these three competing aims of energy policy (Heffron et al., 2018). A balanced combination of these three dimensions constitutes the energy trilemma, which promotes affordable, stable, and environmentally sustainable energy systems for the largest benefit of all countries (Shirazi, 2022). Therefore, the concept of energy trilemma is a basis for this analysis and will be referred to in the later stages of this thesis.

2.2 Energy transition

2.2.1 Energy trilemma recent shift

The main focus of this work will be on the impact of the Russian invasion of Ukraine in the context of shock to European energy security, equity, and sustainability. However, the phenomenon that has triggered the status quo concerning energy and the energy trilemma much earlier than the war has been climate change.

Scholars from different disciplines agree that climate change is a fact and that it is caused by an over-emission of greenhouse gasses resulting from human activity (MacCracken, 2008). The list of negative impacts of climate change on the world in the literature seems to be endless. Malhi underlines its adverse effect on the functioning of the biosphere and ecosystems (Malhi et al., 2020). Carol Ziegler, on the other hand, claims that climate change is the "greatest threat to human health, and it influences the 5 domains of social determinants of health" (Ziegler & Muchira, 2023). The general claim about the climate change present in the existing literature is well concluded by Nikendei who stated that global warming is a "fundamental threat to human civilization" (Nikendei et al., 2020). The main reason for the ongoing crisis is the rapid growth of the global population which led to an exponential growth in energy demand (Olabi & Abdelkareem, 2022). It is a problem because, as Olabi states, fossil fuels are still the main contributor to the energy sector both globally and in Europe (Olabi & Abdelkareem, 2022). In this work, it was explained that greenhouse gases such as "methane, carbon dioxide, and nitrous oxide are emitted in large quantities during the combustion process of fossil fuel". This consequently leads to climate change and hence serious human health problems, weather changes, changes in the ecosystem, and sea level rise (Ibid.). In light of the unanimous belief of scholars about the causes of the climate crisis, the literature also agrees on the general solution to this problem. This solution is to restrict the emission of greenhouse gases and introduction of policies for the adoption of renewable energy sources (Mousavi et al., 2021). Therefore, it is the development of renewable energy that is a front-line solution in targeting the climate change crisis.

2.2.2 Renewable energy context

Renewable energy technologies offer the promise of clean, abundant energy gathered from self-renewing sources. Wu et al. (2022) provides a following definition - "renewable Energy is energy that is derived from natural processes that are replenished constantly. In its various forms, it derives directly or indirectly from the sun, or from heat generated deep within the earth" (Wu et al., 2022). In terms of resources, RES (renewable energy sources) includes wind energy, solar energy, hydroelectric energy, tidal energy, geothermal energy, ambient heat captured by heat pumps, solid, gaseous and liquid biofuels and the renewable part of waste, sources that can vary from the point of view of exploitation from one country to another, reason for which the evaluation, the definition of the trend and the highlighting of the disparities between countries for each of them, can sometimes be difficult to measure (Østergaard et al., 2020).

2.3 Renewable energy policy context

According to Youn Chen (2004) renewable energy sources gained significant traction on the global energy stage during the 1970s, spurred by two oil crises. Since then, their contribution to the world's energy supply has steadily grown. The significance of renewable energy was underscored during events such as the 1981 Nairobi UN Conference, where it was recognized as pivotal for achieving a sustainable future. It is important to note that renewable energy has been globally agreed to be a solution to the earth's problems for nearly half a century now. Especially in recent times, amid efforts to establish a sustainable global energy paradigm, there's widespread acknowledgment that renewable energy sources are essential components.

Subsequent to the Earth Summit, the Johannesburg Summit in 2002 emerged as a critical platform to advance sustainable development goals, including renewable energy initiatives. However, despite ambitious goals set during the summit, many countries failed to meet these targets. It was not only the global stage that failed to meet the set goals. European Union adopted the target of increasing the share of renewable energy sources in the world's total primary energy supply (TPES) to 15% by the year 2010 (Fouquet & Johansson, 2008). Neither this attempt nor another initiative that aimed at the goal of 10% share of TPES for the new renewable energy sources succeeded (Chen, 2004).

2.3.1 European Union's goals and targets regarding renewable energy

Within the European Union, efforts to promote renewable energy have been central to its sustainability agenda. However, despite EU directives and commitments, the actual progress in adopting and implementing renewable energy policies varied among member states and historically has not been meeting the established targets. Jacobsson and Lauber (2006) argue that while the EU provided a framework for renewable energy development, national governments lacked sufficient motivation or resources to fully comply with established requirements. This reluctance was evident in the inconsistent progress across EU countries, with some nations demonstrating greater commitment and investment in renewable energy than others.

For instance, in 2009 the EU set a target of achieving at least 20% of its energy consumption from renewable sources by 2020 (Potrč et al., 2021). However, the progress towards this goal has been uneven across member states. While some countries such as Sweden and Finland have surpassed their renewable energy targets, others, including the Netherlands and Poland, have fallen significantly below the target (Ibid.)

However, in recent years, the European Union has reaffirmed its commitment to renewable energy as a key component of its sustainability agenda. The EU has set ambitious renewable energy goals that intend to increase the share of renewable energy in its final energy consumption to 32% by 2030 and later adopted a new goal of "at least" 42,5% reduction by 2045 (Cifuentes-Faura, 2022). The ultimate EU goal in this regard is to become the first environmentally neutral continent in the world with no net emissions of greenhouse gases by 2050 (Ibid.).

Importantly the UE set these ambitious goals not only in order to target climate change, but as Ali argues, to become independent from Russian energy supplies. Russia holds the position of being the third-largest global producer of oil and has been playing a fundamental role in the supply of oil and gas to Europe (Ali et al., 2023).

Academic research has highlighted the EU's efforts in promoting renewable energy, emphasizing the importance of policy frameworks and regulatory measures in driving renewable energy deployment. For instance, a study by Haas et al. (2011) examines the impact of renewable energy policies on the growth of renewable energy capacity in the EU. The study finds that supportive policies, such as feed-in tariffs and renewable energy auctions, have expanded renewable energy capacity in the EU. The literature agrees with the fact that the EU has one of the highest environmental standards in the world and is the global environmental leader (Cifuentes-Faura, 2022).

According to Blazquez - energy transition is a complex social and economic transformation process involving the coordination of many actors and factors. (Blazquez et al., 2018). This is why it is important to see the differences in the approaches to renewable energy adaptation between different countries based on their current energy status, economic power, and potential to change. Every country and energy market is different which is a reason for significant differences within the EU itself. To analyze these differences two different countries from the EU were selected as the focus economies. Specifically, these are Poland and the Netherlands representing eastern and western Europe. These two countries were selected for this comparison analysis due to three reasons. (1) Poland and the Netherlands represent different geo-political contexts as Poland is a neighboring state to Ukraine while the Netherlands is distant from the conflict. This leads to different perspectives regarding national security in general terms but also in the sense of energy security. (2) The countries have different economic and energy profiles. Poland is a rapidly growing economy with increasing energy needs and a historical reliance on coal. The Netherlands, with a more mature economy, has been a leader in adopting renewable energy and innovative energy solutions. (3) Different technological backgrounds - The Netherlands is known for its high adoption rates of advanced technologies in wind and solar power, whereas Poland's adoption has been slower but is gaining visible momentum (Kern & Smith, 2008). This is why the first research question is:

Do the approaches to renewable energy adaptation differ between Poland and the Netherlands and if so what factors influence these divergent paths?

Hypothesis 1: The Netherlands, due to its advanced economy, and non-coal oriented energy market in contrast to Poland is expected to have a more advanced infrastructure and hence a higher rate of renewable energy adaptation.

2.4 War and energy markets

2.4.1 Impact of wars on energy markets

Multiple studies have been conducted to analyze the impact of war on the energy market. War is associated with uncertainty and instability which is a negative factor for the economy including the energy sector in general. However, Dutta found that "the information content of the crude oil volatility index improves the volatility forecasts for the clean energy equity market" (Dutta, 2017). This means that the instability in crude oil sector positively influences the development of the renewable energy. This indicates that the wars that destabilize the energy market may positively impact renewable energy. Kuang's (2021) findings reflect this statement but from a financial perspective. Specifically, the scholar argues that clean energy is more attractive to down the risk than dirty energy stock markets. Despite the paper being focused on a different perspective on renewable energy, this insight proves that in unstable times green energy might serve the purpose of a safe haven (Kuang, 2021). Lastly, Sweidan (2021), by using cointegration analysis, came to the conclusion that geopolitical risks including war have a positive strong effect on renewable energy development. Therefore, wars are not only a barrier but an opportunity for the expansion of green energy (Sweidan, 2021). However, such impact differs depending on the engagement of a country in a conflict or its individual level of risk in the context of a war. The two countries - Poland and the Netherlands represent different levels of risk regarding the potential further expansion of

Russian aggression. This is mostly because of the geographical location of the two countries. Therefore, the second hypothesis is:

Hypothesis 2: Due to the geographical location of Poland (directly next to war-torn Ukraine) Polish legislation and national actions towards the development of renewable energy will be more decisive than the Netherlands.

3. Energy and economic background

This thesis is centered around Poland and the Netherlands as the countries represent (1) different geo-political contexts; (2) different economic and energy profiles, as well as (3) different technological backgrounds. However, in successfully answering the research questions a closer overview of Polish and Dutch energy and economic backgrounds is needed.

3.1 Poland energy and economic background

Poland is the fifth-largest energy consumer in Europe (Kardaś, 2023). Historically, Poland has been heavily dependent on coal for its energy needs, with coal accounting for approximately 80% of the energy mix in 2017 (Wierzbowski et al., 2017). It makes Poland one of the most carbon-intensive countries in Europe (Ibid.) This is why decarbonization is a huge challenge for the Polish government. Nevertheless, it is essential not due to the EU policies but also because the country must diversify its energy sources in the context of national security and become independent from Russian energy imports (Chomać-Pierzecka et al., 2022).

Importantly, Poland does not only have the motivation to increase its share of renewables due to climate change and the war in Ukraine. Poland is also still in the development period meaning its energy demand is increasing (Wierzbowski et al., 2017). Having one of the biggest GDP growths in Europe. Specifically, Poland has a 3.9% GDP average annual growth rate from 2005 to 2022 (European Commission, n.d.). This constitutes to Poland being the third fastest developing EU economy in terms of GDP growth (directly below Ireland and Malta). The Polish economy is considered as secure and stable, even in the face of recent disturbances and financial crises (Ibid.). The year 2009 proves this stability and strong growth best as Poland was the only EU country that did not experience a GDP contraction. To compare, the EU average GDP growth in the same period (2005-2022) was 1.3% (Ibid.). The Netherlands, on the other hand, in the period of 2005 and 2022 had a GDP average annual growth of 1.5%.

To visualize this economic phenomenon a summary table with selected EU countries is provided below.

*Table 1. EU countries with **GDP** average annual growth rate from 2005 to 2022*

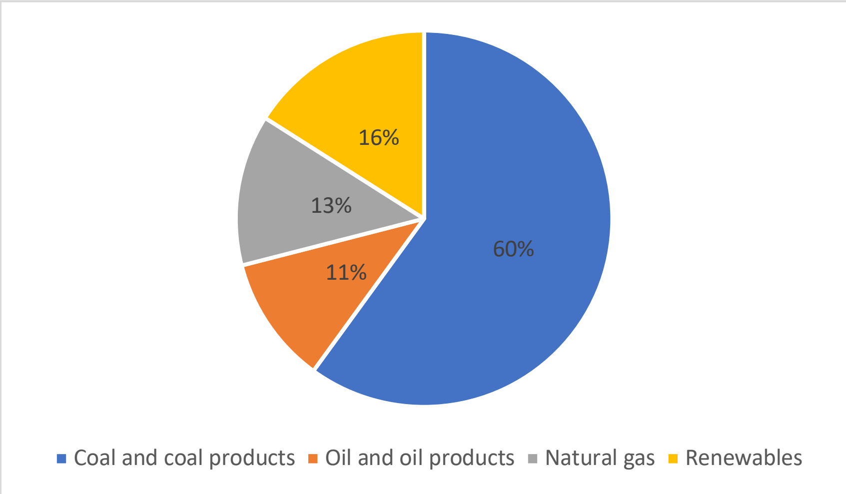
Country	**GDP average annual growth rate from 2005 to 2022 (%)**
Ireland	5.3
Malta	4.6
Poland	3.9
…	…
The Netherlands	1.5
Belgium	1.5
…	…
Cyprus	0.0
Greece	-0.8

Source: Eurostat

Consequently, Poland has been progressing in this matter for almost two decades now. From the renewables share in the energy gross final consumption of 8% in 2008 the country managed to achieve 15.6% in 2021 (Eurostat, 2023). Moreover, Poland has committed itself to achieving a 23% share of renewable energy in gross final energy consumption by 2030 (Ibid.) which proves the country's perspective on further development in the renewable energy sector.

Therefore, Poland in addition to its geographical location in the context of the ongoing war serves well the purpose of this thesis as it represents a country with historically high dependence on coal and rapid renewable energy growth.

Figure 2. Poland energy mix 2021



Source: Eurostat, 2022.

3.2 The Netherlands energy and economic background

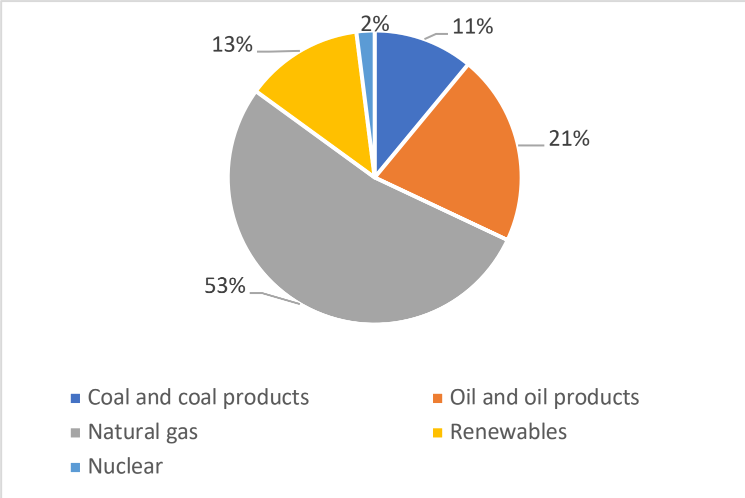
The Netherlands has diversified energy sources compared to other European countries, reflecting a mix of traditional energy sources and emerging renewable energy initiatives. Historically, natural gas has been a dominant source of energy in the Netherlands, especially from the Groningen gas field, one of the world's largest gas fields and the biggest one in Europe. In 2021, the share of gas in the Dutch energy mix was

53%, proving the strong reliance on this fossil fuel (Eurostat). However, due to earthquakes caused by gas extraction, there has been a strong public and political movement to end gas production in Groningen. Consequently, gas production in Groningen is almost fully eliminated today and the senate decided on the final closure of the facility by 1st of October 2024. This has led to an increased reliance on gas imports, making the Netherlands a net gas importer since 2018 (Luginbuhl et al., 2018). The closing of gas fields also opens doors for the Dutch development of renewable energy which is another reason this country has been chosen for this analysis.

The Netherlands has been influenced by broader European trends, policies, and the war as well. While geographically distant from Russia compared to Poland, the energy situation in the Netherlands has also been affected as the Netherlands before the war was highly dependent on Russian gas which constituted 12.5% of all consumed gas in the Netherlands (Ibid.). New initiatives regarding renewable energy have emerged in the Netherlands, especially after 2000. Oteman et al. (2017) noted that this shift toward renewable energy was driven by a combination of policy incentives, environmental awareness, and grassroots movements. The government's support for offshore wind farms and the increasing use of solar energy reflect these efforts. Moreover, community awareness and grassroots initiatives play a significant role in the Netherlands' approach to renewable energy. As Iskandarova et al. (2021) indicate, the Dutch public has a higher level of trust in renewable energy companies and institutions, leading to greater community support for renewable energy projects.

The Netherlands aims to achieve 27% renewable energy consumption by 2030, indicating a strong commitment to the EU's climate goals (Ibid). In 2021, the share of renewable energy in the Netherlands was 13%, falling behind gas (53%) and oil (21%). Therefore, to meet its target, the Netherlands needs to double the share of RE in only 9 years. This stands to a much higher development of Dutch RE (needs to increase 14% points by 2030) compared to the Polish rate to meet its target (needs to increase 3% points by 2030). The different need for RE growth between the two countries is another reason why they were chosen for this analysis.

Figure 3. Netherlands energy mix 2021



Source: Eurostat, 2022.

As both Poland and the Netherlands represent fossil-reliant energy profiles it is important to make a distinction between the main sources in their energy mixes. From the environmental perspective natural gas despite being a fossil fuel is significantly less harmful compared to the coal effects. As Radka (2023) states "natural gas is a cleaner fuel in the sense that burning it produces fewer conventional air pollutants, like sulfur dioxide and particulates, than does burning coal or oil". Therefore, despite the two countries being dependent on fossil, they still represent different energy backgrounds with Poland causing more environmental harm compared to the Netherlands. These divergent paths serve as another reason for choosing these countries.

What Poland and the Netherlands have in common is: (1) fossil oriented energy market (with ambitions to develop renewable energy); (2) a partnership in the EU (find concrete RE requirements towards its members); (3) both countries used to rely on Russian gas supplies which is not the case anymore.

Hence, Poland and the Netherlands represent different economic and energy backgrounds allowing a deep analysis of how different economies react to the same stimulus (war). Simultaneously, both countries have an incentive to pursue renewable energy mostly due to the three causes listed above. This, on the other hand, allows the creation of an objective research methodology as countries have common points.

4. Methodology

A mixed-method approach will be adopted to investigate renewable energy adoption in Poland and the Netherlands, integrating both quantitative and qualitative analyses.

The quantitative method will consist of three main parts:

1) Data collection – based on Eurostat. The use of Eurostat as a primary data sources assures objectivity of the comparison between the two countries. The data on the RE and other energy types as well as the changes in the energy markets in both Poland and the Netherlands will allow to test the set hypotheses.
2) Analytical techniques with focus on descriptive statistics will be used to provide a foundational understanding of the datasets acquired from Eurostat. This step ensures a thorough initial examination of the quantitative data before deeper analysis. This approach will include measures of central tendency (mean). The main element of the descriptive statistics will be graphs representing shares renewable energy as well as two main independent variables that may have impact on it. Namely these two additional variables are – *GDP per capita* and *Energy imports dependency*. This visual technique provides the evolution of variables over time and can highlight trends or correlations between different data sets. By using descriptive statistics it is aimed to provide a clear, concise view of the data, enabling readers to understand the trends and relationships within the data.

3) Data interpretation to put the quantitative outcomes into the context and to understand the differences between Poland and the Netherlands.

The qualitative method will consist of:

1) Qualitative analysis of policy documents, strategic government reports, and relevant legislative. Specifically, the documents that will be analyzed for Poland are: The National Energy and Climate Plan (NECP), The Energy Policy of Poland until 2040 (PEP2040) and REPowerEU. For the Netherlands, the analysed documents will be: the National Energy and Climate Plan (mandatory for the EU countries), REPowerEU, Temporary Climate Fund Act, and the National Strategy on Spatial Planning and the Environment ('NOVI'). Moreover, there are smaller policies such as the North Sea Programme 2022-2027 introduced in March 2022 – offshore wind energy policy. The main purpose of this method will be understanding the goals and paths of the two countries in the RE development. As the Russian full scale invasion on Ukraine has begun 2022 it is expected that the quantitative analysis will not be able to capture the entire effect of the ongoing war on the governmental actions both in PL and NL regarding the energy transition.

2) Hall's policy paradigm level framework. Hall argues that paradigms consist of four interconnected levels and paradigm shifts occur when fundamental changes take place across all four at once (Hall, 1993). These levels are summarized in Table 2.

Table 2. Hall's policy paradigm

Paradigm level	Description or key question
Interpretive framework	Ideas about the subject and how it should be governed
Policy goals	What should be pursued?
Policy instruments	Through which means?
Governance institutions	Through which political structures?

A policy paradigm is a dominant and accepted worldview about: policy goals, the nature of a policy problem, and the instruments to address it. Hall identified 3 orders of policy paradigms.

1st order: routine bureaucratic changes to instruments while keeping the policy targets the same

2nd order: less frequent, non-routine changes (or use of new instruments) while keeping the policy targets the same

3rd order: happens rarely and is considered "radical". It assumes only a crisis in which "policymakers cannot solve a policy problem or explain why policy is failing" can lead to an actual rejection of the dominant paradigm which can be then replaced by another (Hall, 1993). Hall gave an example of rapid paradigm shift in UK economic policy – from 'Keynesianism' to 'Monetarism' – within *a very short period*.

The theory focuses on how the paradigm levels interact and influence each other during times of policy change, potentially triggered by crises that reveal the shortcomings of the current paradigm. It suggests that if all four levels align, a comprehensive shift in the policy paradigm, moving beyond superficial changes or minor adjustments can happen. This method will allow to uncover the visible changes in policy outputs but also the subtler shifts in governance and strategic direction that underpin the transition to renewable energy (Kern et al., 2014).

The qualitative methods will be mostly performed in answering the *Hypothesis 2: Due to the geographical location of Poland (directly next to war-torn Ukraine) Polish legislation and national actions towards the development of renewable energy will be more decisive than the Netherlands.* The "decisiveness" will be interpreted on three main factors: (1) Legislative activity – number and scope of laws passed regarding RE. This includes subsidies, tariffs, and regulations that encourage renewable energy development. (2) Governmental commitment - targets set for renewable energy proportions within the national energy mix by specific years. (3) Investment levels amount of public and private investment directed towards renewable energy projects.

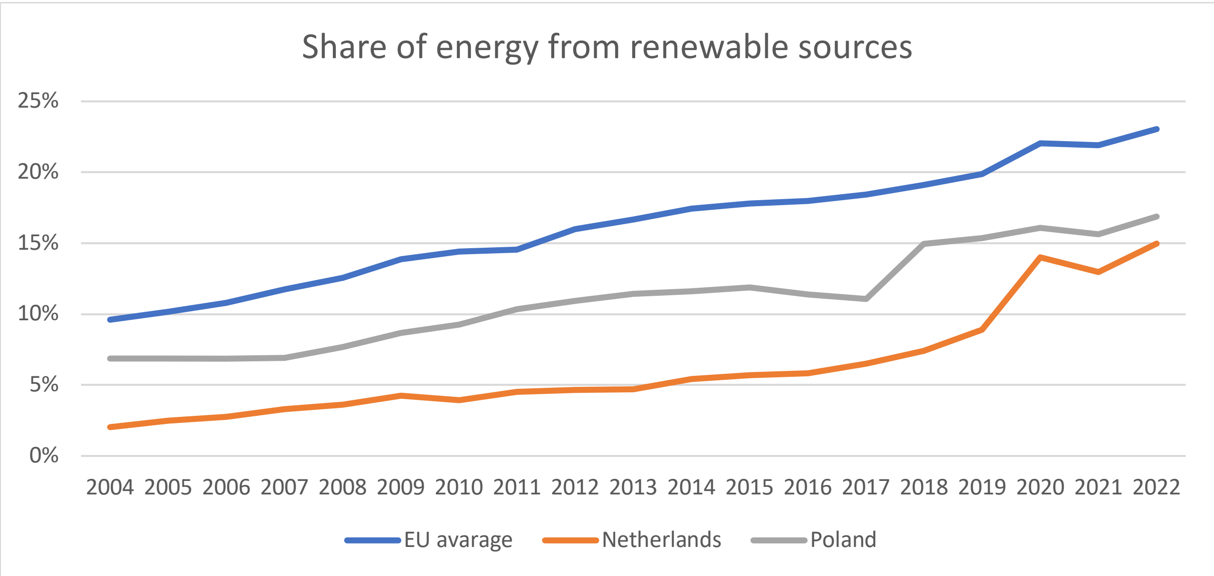
5. Results

5.1 Descriptive statistics results

5.1.1 Energy situation and trends in Poland and the Netherlands

The graph below presents the share of energy from renewable energy sources (RES) for Poland, the Netherlands, and the EU average. Both Poland and the Netherlands show significant progress in RE adaptation between the years 2004 and 2022. Between the years 2007 and 2015, Poland presented a stronger commitment to increasing RE in its energy consumption. The Netherlands, on the other hand, in the period of 2017-2020 noted a rapid growth of its RE share. The absolute change of the RE in the given period for the EU average was 13.3%. It was followed by the Netherlands (13%) and Poland (10.1%).

Figure 4. Share of energy from renewable sources (% of gross final energy consumption)



Source: Eurostat, 2024, data code: nrg_ind_ren

The most fundamental indicator that must be included in this analysis is the growth rate of share of energy from renewable sources. The selected timeline (2004-2022) includes the period before Russian aggression on Ukraine (2004-2014), the year of Russian annexation of Crimea (2014) as well as the full scale invasion from 2022.

Tabel 3. RE growth rates of Poland, Netherlands and EU

Year	EU avarage	Netherlands	Poland
2005	6,0	22,1	-0,2
2006	5,9	12,1	-0,1
2007	9,0	18,7	0,6
2008	6,8	9,0	11,4
2009	10,3	18,7	12,9
2010	4,0	-8,2	7,0
2011	1,0	15,5	11,4
2012	10,0	2,9	5,9
2013	4,1	0,7	4,5
2014	4,6	15,4	1,3
2015	2,3	5,5	2,4
2016	0,9	2,3	-4,1
2017	2,4	11,3	-3,0
2018	3,7	13,6	35,0
2019	4,2	20,2	3,0
2020	10,8	57,6	4,7
2021	-0,7	-7,2	-3,0
2022	5,3	15,3	8,1
Mean growth rate	5,0	12,5	5,4

Source: my calculations

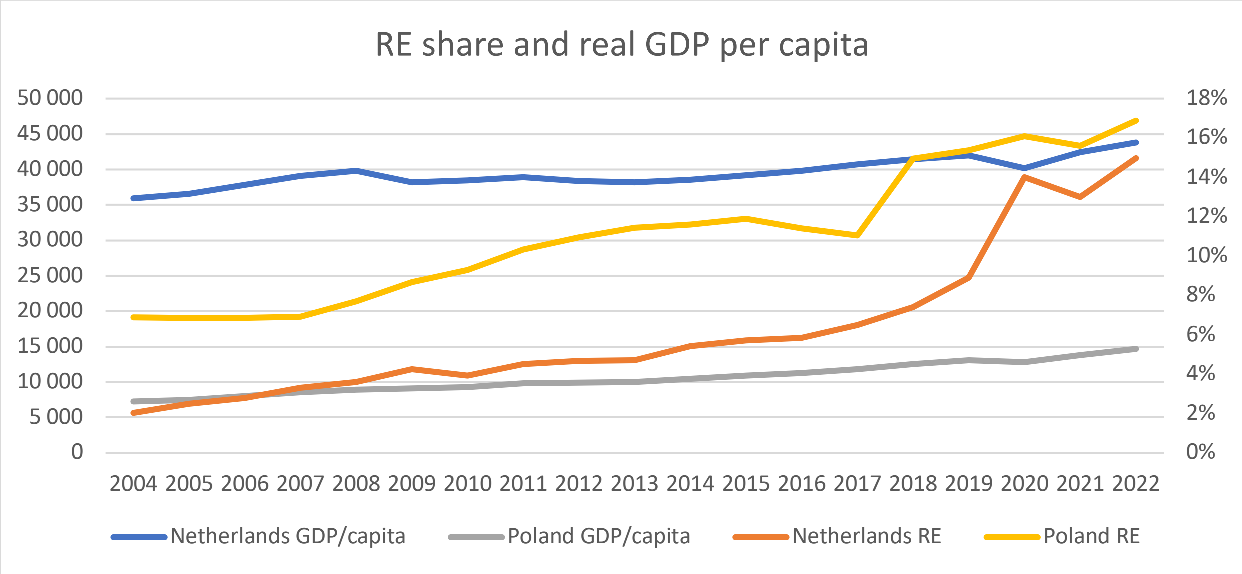
The growth rate of renewable energy analysis suggests that the H1 is correct, underlining that the Netherlands has a higher rate of renewable energy adaptation. The Dutch average growth rate (12.5%) in the analyzed period is over 2 times higher compared to Poland (5.4%). The Dutch high RE growth rate is even clearer compared to the EU mean growth rate (5.0%).

Importantly, both countries highly increase the RE in their energy mixes being higher compared to the EU average. Therefore, in regard to RQ1, it can be stated that the main approach concerning RE is the same for both countries – strong growth. However, despite this most fundamental finding, the growth rates strongly differ between countries. The Netherlands has taken stronger steps in RE adaptation in a given period. However, further analysis must be performed to find out the reasons for this outcome.

Moreover, the findings offer the initial answer to RQ2. The results show that the beginning of Russian aggression in Ukraine (2014) motivated the Netherlands to undertake strong steps towards RE implementation. It is so as in 2014 the RE growth rate of the country was 15.4% which is higher than the average growth in the entire period. Furthermore, it can be observed both on the graph and from growth rates that 2014 was the moment of a positive shift in RE adaptation in the Netherlands. On the other hand, the effect of the Russian military actions is less visible for Poland in the sense of additional development of renewable energy. However, the Russian invasion of 2022 impacted the RE implementation in both countries and the EU in general. It was 15.27% in the Netherlands (compared to a negative growth rate of -7.22 in the previous year) and 8.11% in Poland (compared to a negative growth rate of -3.04 in the previous year).

The findings prove Hypothesis 1 – the Netherlands has a higher rate of RE adaptation compared to Poland. However, it is still not clear what factors influence these divergent paths. As suggested in the literature it can be caused by the economic strength of both countries. To investigate the correlation between economic situation and share of RE a regression analysis will be performed.

Figure 5. RE share and Real GDP/capita of Poland and Netherlands



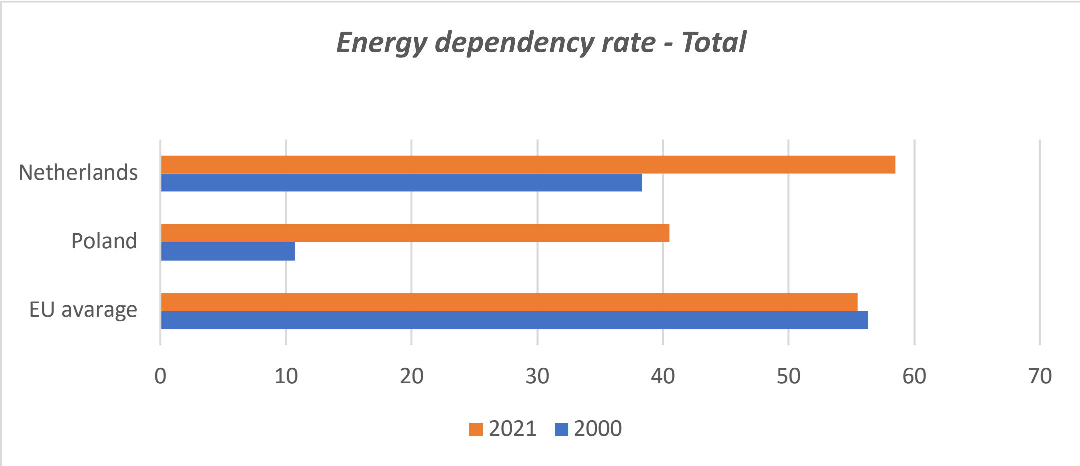
Source: Eurostat, 2024, data code: nrg_ind_ren and sdg_08_10

Above, a graph of RE share and Real GDP per capita values for the timeline of 2004-2022 is presented. In 2022, the Netherlands with its score (4.3800 euro per person) recorded as the 4th highest level of real GDP per capita in the EU.

Both countries show that the share of RE gradually increases along with the GDP per capita. The Netherlands shows a more pronounced fluctuation in GDP per capita but demonstrates a significant rise in RE share, especially after 2015. Poland, while experiencing steadier economic growth, presents a more gradual increase in RE share until around 2017, after which there is a sharp rise. This significant rise may indicate a threshold point where economic conditions began to more strongly support renewable energy investments as there was also a steady increase of GDP per capita that year.

5.1.2 Dependency on Russian energy supply

Figure 6. Energy dependency rate – Total (% of net imports in gross available energy)



Source: Eurostat, 2024, online data code: nrg_ind_id

The graph above presents the % of net imports in gross available energy of the analyzed countries for both 2000 and 2021. The EU has been highly dependent on imported energy with 56.3% in 2020 and 55.5% in 2021. This proves that Europe has been highly dependent on energy imports for 2 decades. The fact that the EU dependency levels have not changed in this period of 21 years shows that it was not recognized as a significant problem by the majority of European countries. For Poland, energy dependency has increased nearly 4 times from 10.7% in 2000 to 40.5% in 2021. The same trend can be observed in the Netherlands with energy imports growing from 38.3% (2000) to 58.4% (2021). Importantly, however, Poland has always been below the EU average while the Netherlands with its dependency growth came to the level of 58.4% of net imports in gross available energy in 2021. This is above the EU average and can be considered a high dependency rate.

Table 4. EU Energy trade with Russia 2013-2023

Energy	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Export	1,1	0,7	0,6	0,6	0,6	0,7	0,6	0,6	0,8	0,5	0,0
Import	154,6	130,9	87,8	75,3	93,5	109,7	99,6	59,3	102,2	147,3	29,3
Balance	-153,5	-130,1	-87,2	-74,7	-92,9	-108,9	-99,0	-58,7	-101,4	-146,8	-29,2

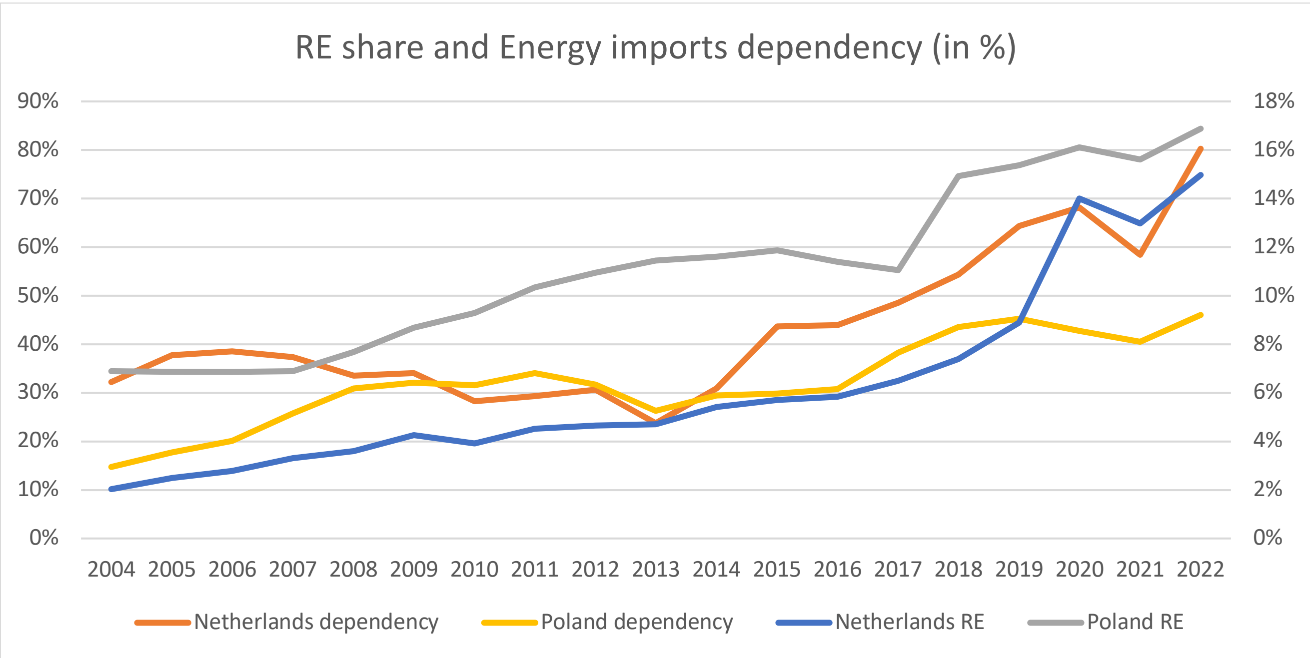
Source: Eurostat, 2024, online data code: ext_lt_maineu

The table above presents the EU energy trade with Russia in the last decade (2013-2023). It is clear that energy imports from Russia were high in the past 10 years. Furthermore, the amounts of energy imported from Russia differed between the years. A significant decline in the imports occurred after the Russian invasion of Crimea (2014). In 2013 the EU imported the highest amount of Energy from Russia (worth €154.6 billion) during the analyzed period. The following years presented a gradual decrease of these imports. Moreover, the effect of the 2022 invasion is clear. The EU imported the least energy from Russia in this timeframe in 2023 (worth €29.3 billion).

5.1.3 Energy dependency and the RE share

To fully answer the Research question 1 - so what drives the divergent paths of RE adaptation between Poland and the Netherlands one more correlation should be analyzed. Specifically, in line with Hypothesis 1 the correlation between energy dependency and the RE levels.

Figure 7. Renewable energy share and energy imports dependency (in %)



Source: Eurostat, 2024, nrg_ind_id

The graph above shows RE share and energy import dependency in the form of a percentage of entire energy consumption. The graph visualizes the changes in these variables in the period 2004-2022 for both Poland and the Netherlands. Importantly, the energy import dependence increased for both countries after 2014. Moreover, after 2014 the energy dependency rises together with RE share for both countries. In the years 2004-2014, this correlation was not this clear presenting various fluctuations mainly in the dependency variables.

5.2 Qualitative results

As the quantitative analysis provided this thesis with insights the direct effect of the 2022 invasion could not be fully measured due to lack of sufficient data. Therefore, a qualitative approach will be used to present the complete picture. Specifically, the analysis will include policy documents, strategic government reports, and relevant legislation for both countries.

5.2.1 Poland

"It is worth redeveloping our energy architecture in every possible way using renewables of the future, which, together with the nuclear, will certainly be the backbone of our energy industry in the 2030s, in the 2040s and in the decades to come" – Mateusz Morawiecki, 2023. Prime minster of Poland at the time of beginning of Russian invasion

This section of the thesis will provide an answer to the question of whether the Polish prime minister's words have been reflected by policies and legalized plans for the RE adaptation as a result of the Russian aggression in Ukraine.

Polish energy and climate policies are stated in three main documents: the National Energy and Climate Plan (NECP), which is mandatory for EU countries, REPowerEU (which is part of an EU recovery and resilience plan), and the country-specific Energy Policy of Poland until 2040 (PEP2040). Furthermore, the qualitative analysis will include the European Commission's

Assessment of Poland's updated National Energy and Climate Plan in order to include an objective third-party perspective on the Polish progress.

The Energy Policy of Poland until 2040 (PEP2040), first created in 2021 sets the framework for the energy transition in Poland. It was introduced by the Ministry of Climate and Environment and is the central energy legislation in the country. The initial document (2021 version) focused on 3 pillars: "just transformation, zero-emission energy system, and good air quality" (PEP2040, 2021). However, in March 2022 the government updated the PEP2040. As the new legislation states itself the reason for its modernization was the "need to change the approach to ensuring energy security towards a greater diversification and independence". The document also directly points to the reason for decreased energy security - the Russian invasion of Ukraine. The updated energy policy of Poland includes the fourth pillar – "energy sovereignty with its specific component of quick decoupling of the national economy from the imported fossil fuels (coal, oil, and natural gas) from the Russian Federation and other economically sanctioned countries". The legislation states 4 ways in which this target will be achieved: (1) diversification of supplies; (2) investments in production capacity; (3) linear infrastructure and storage; and most importantly PEP2040 identifies (4) alternative fuels as one of the main solutions to achieve energy sovereignty.

This legislation puts focus on energy security addressing the Russian aggression. To achieve the security, energy diversification is needed. The document identifies renewable energy sources (RES) as one of the key answers to the situation. "RES is one of the components of energy mix diversification" (PEP2040, 2022) which is the reason for the investments and plans in this sector.

The National Energy and Climate Plan (NECP) is mandatory for all EU countries and hence is supervised by the European Commission (European Commission, 2022). It is a plan centered around clean energy transformation till 2030. The European Commission sets different targets for member states. The NECP states policies and measures to be undertaken by Poland to meet its energy targets established by EU directives. Lastly, REPowerEU (part of the Recovery and Resilience Plan) is another EU initiative in which both Poland and the Netherlands are obligated to participate. The REPowerEU program was created to address the energy instability and to become independent from the Russian energy supplies by 2030 (European Commission, 2022). As the EU document states the main objective of the program is "to phase out Russian fossil fuel imports" (European Commission, 2022). Moreover, it is to secure stable energy supplies as well as accelerate the transition to clean energy (Ibid.).

To present the main findings in a comparable way Hall's policy paradigm-level framework (see Methodology) will be used. Hall's theory states that if all four levels align, a comprehensive shift in the policy paradigm, moving beyond superficial changes or minor adjustments can happen. According to the theory, the paradigm policy shift can only occur in light of the current paradigm crisis. As the war in Ukraine led to the energy crisis which affected both Poland and the Netherlands it is possible that it created a 3rd order policy paradigm shift. This means "radical" that takes place when the prior paradigm was challenged by a crisis.

The framework will allow us not only to assess the impact of the Russian invasion on countries' RE direct reactions but also the expected long-term strategies of Poland and the Netherlands. The analysis was performed based on the NECP, PEP2040, and REPowerEU.

Table 5. Hall's framework analysis for Poland

Paradigm level	Poland
Interpretive framework	The updated PEP2040 frameworks represent a shift in Polish interpretive framework towards a more sustainable energy model. This paradigm shift is evidenced by the government's recognition of renewable energy not only as an environmental imperative but also as a strategic component of national security. The policy increasingly views energy independence and the reduction of reliance on external fossil fuels, especially from Russia, as essential for the Polish long-term stability and security. The NECP update and REPowerEU were created after the war begun to address it directly. Hence, these documents and their execution by Poland, further support that Poland aims to become independent from Russian energy by developing its RE sector.
Policy goals	Energy mix goals: The main policy goal of the updated PEP2040 is to achieve "about a half of energy production from RES" by 2040 (~50%). Apart from further development of wind and solar capacities, the measures aiming at development of RES which

	are independent from atmospheric conditions i.e. using the energy of water, biomass, biogas or geothermal energy, will be promoted. For 2030 it is to reach at least 23% share of renewables in the total final energy consumption and 51% of the electricity (in 2022 the share of RE in energy consumption was 17% and in final consumption of electricity it was 21% (Statistics Poland, 2023)). However, the updated NECP (from 2024) declared an increase of the target up to 29.8 % in the share of RE in gross final energy consumption by 2030**.** RE capacity expansion: PEP2040 assumes an increase in installed offshore wind energy capacity to approximately 5.9 GW by 2030 and further extend it to 11 GW by 2040. For onshore wind energy the target is to increase capacity to 10 GW by 2030. For the solar energy it is aimed to achieve 5-7 GW by 2030 and 10-16 GW by 2040. Infrastructure development: Completion of strategic gas infrastructure projects like the Baltic Pipe, which is expected to be operational and contributing to energy diversification by reducing reliance on Russian gas supplies. Poland's **REPowerEU chapter** consists of **seven new reforms** and ten investments.
Policy instruments	1. **Investments commitments** - The planned expenditure of approximately PLN 1.6 trillion (= €373 billion) in the energy sector by 2040. This is stated in PEP2040. The main components of these investments will be in the fuel and energy sectors of approx. PLN 867-890 billion (= €207 billion). The estimated outlays in the electricity generation sector will amount to approx. PLN 320-342 billion (= €80 billion), of which approx. 80% will be allocated to zero-emissions units. Importantly, the 2022 update additionally states that "financial support for the instruments promoting energy self-sufficiency of households is to be increased". Additionally, Poland was granted for its REPowerEU grants €2.8 billion by the Commission covering 6 out of 10 REPowerEU investments in Poland. Remaining 4 investments are in the form of loan, with an allocation of €22,52 billion. Therefore, the total budget of Poland in REPowerEU = €25 billion. 2. **Infrastructure projects** - Strategic projects like the Baltic Pipe, expansions of LNG facilities and offshore wind power plants to diversify energy sources and enhancing national energy infrastructure 3. **Legislation** – the PEP2040 has the power to revise energy laws and regulations that facilitate the transition to renewable energy and ensure the integration of these energy sources into the national grid.

Governance institutions	"The minister responsible for energy, climate and environment has a leading and coordinating role in the development and implementation of the state's energy policy". However, the transition involves both national and local government as well as business entities. Moreover, the legislation underlines that households are also an important stakeholder and their good practices matter to the project. It is to ensure the RES are implemented effectively across different regions.

Furthermore, the National Energy and Climate Plans (NECP) which are created by national governments together with the EU provide important details on the progress of RE implementation. Moreover, the EU makes assessments of the NECP of all member states together with recommendations in light of their progress. Poland's goal for the electricity production in the updated NECP is set to be 50.1 % from the RES by 2030. Moreover, according to the original NECP, submitted in 2019 for Poland the target of share of renewable energy in gross final consumption for 2030 was set to be 23%. However, as stated in the updated NECP, submitted on 1 March 2024 this target was increased up to 29.8 %. As the updated legislation states this increase of the target is possible to be accomplished "thanks to the development of RES in recent years (in particular in the electricity sector)".

The EU report assessing "Poland's draft updated National Energy and Climate Plan" communicates that the goal for 2030 submitted in the draft updated NECP is 29.8%, being slightly below the EU recommendation - 32% which is set "according to the formula set out in *Annex II of the Regulation (EU) 2018/1999 on the Governance Regulation of the Energy Union and Climate Action*" (EC, NECP assessment, 2024)".

Yet, the EU report positively assessed RE adoption of Poland. "On **renewable energy** and to support renewable energy technology deployment and shifting away from coal, the draft plan provides measures that Poland has adopted or intends to adopt even though more details and accelerated adoption is needed". Despite the positive EU opinion on the Polish RE adoptation the recommendation was added to "raise the ambition of a share of renewable energy sources to at least 32% as a contribution to the Union's binding renewable energy target for 2030" (European Comission, 2024, Updated NECP Poland).

Table 6. Summary graph of the European Commission's Assessment of Poland's updated National Energy and Climate Plan from 2024

Objective	2030 value submitted in the draft updated NECP	2030 target under EU legislation	Assessment of 2030 ambition level
Renewable Energy (Share of renewable energy in gross final consumption)	29.8%	32%*	Positive: "Draft plan shows a high level of ambition, emhasising the importance of energy sovereignty and resilience to geopolitical distrubances and it includes detailed objectives and measures across sectors".

Source: European Comission, 2024, Poland's draft updated National Energy and Climate Plan Assessment

*according to the formula set out in Annex II of the Regulation (EU) 2018/1999 on the Governance Regulation of the Energy Union and Climate Action (see the Apendix).

5.2.2 Poland Policy Paradigm Shift

Poland presented characteristics of a third-order change in Hall's policy paradigm framework which is supported by radical revisions in energy policy post-Russian invasion of Ukraine. The updates to PEP2040, including the addition of a new pillar focused on "energy sovereignty" and significantly revised renewable energy targets, indicate a fundamental shift in how energy policy is viewed and enacted in response to a crisis. This paradigm shift is driven by a recognition that energy independence is crucial for national security, leading to an actual shift in energy strategies, including substantial investments in renewable energy and a diversified energy mix aimed at reducing reliance on external fossil fuels.

5.3.3 Netherlands

"What the Netherlands would actually like to achieve is being independent of Russian gas and Russian oil before the end of the year (2022) we can achieve this by working hard on a mix of energy savings and sustainability, but it will also have to lead to the import of energy from other countries, including liquid natural gas" - Mark Rutte, April 2022, Dutch prime minister at the time of beginning of Russian invasion.

The Dutch leader follows the narrative of the Polish PM that energy diversification is the key to addressing Russian aggression. Mark Rutte recognized the importance of becoming independent from Russian energy and that RE is a critical part of the solution. The analysis below will assess whether the vision of the Dutch leader has been reflected by the country's legislation and legalized targets.

The most powerful Dutch legislation concerning RE are the National Energy and Climate Plan (mandatory for the EU countries), REPowerEU, Temporary Climate Fund Act, and the National Strategy on Spatial Planning and the Environment ('NOVI'). Moreover, there are smaller policies such as the North Sea Programme 2022-2027 introduced in March 2022 – offshore wind energy policy.

The NECP for the Netherlands was first introduced in 2019. However, it was updated (same as for Poland) after the Russian invasion. Specifically, the update occurred in June 2023. The Netherlands also participates in the EU energy legislation - the REPowerEU program which aims to "phase out Russian fossil fuel imports by 2030" (European Commission, 2022). The Temporary Climate Fund Act (2023) was also created to address the Russian invasion of Ukraine and its consequences on the energy market. The country-specific leading RE legislation – NOVI is "is the long-term (30 years) vision on the future development of the living environment in the Netherlands". It was first introduced in 2020, but again it was updated following the Russian aggression in 2024.

To present the main findings in a comparable way Hall's policy paradigm level framework will be used. The analysis was performed based on the NECP, the NOVI, REPowerEU, the Temporary Climate Fund Act, and the North Sea Programme 2022-2027.

Table 5. Hall's framework analysis for the Netherlands

Paradigm level	Netherlands
Interpretive framework	The integration of REPowerEU priorities within the updated NECP along with introducing legislation directly addressing the Russian aggression (here focus on Temporary Climate Fund Act and Offshore wind energy policy) presents the will to increase RE and reduce dependency on Russian energy imports. Moreover, Dutch legislation identifies the RES as the central solution to achieve energy independence as well as limit the GHG . NEVI states that to "reduce national GHG emissions by 95% in 2050 (compared to 1990), fossil fuels have to be replaced by renewable energy sources, such as wind and solar energy".
Policy goals	Policy goals: In line with REPowerEU objectives, the updated NECP set ambitious goals to increase the share of renewable energy. The plan targets to achieve a 27% share of energy from renewable sources by 2030, aligning with REPowerEU's push for a rapid cut in fossil fuel use. Moreover, the NECP includes a target for renewable energy in the electricity sector at 74.4% for 2030 (in 2022 the share of RE in the Netherlands was 15% and RE in electricity was 40% (Statistics Netherlands, 2023)). The offshore wind policy set a target of delivering 21 gigawatts (GW) of offshore wind energy by the end of 2030. These wind farms will then supply 16% of the energy needed in the Netherlands. In the legislation a quotation by Rob Jetten, Minister for Climate and Energy is included: "This is an important milestone in the transition to more sustainable energy. In comparison, 10.7 GW extra is twice as much as all Dutch households currently use. By 2030, we want 21 GW of offshore wind, making offshore wind our largest source of electricity by then. When designating the wind energy areas, careful consideration was given to the other interests in the North Sea, such as shipping, fisheries, nature, and defence." Moreover, "The Government is aiming to have approximately 50 GW of offshore wind energy installed in 2040 and approximately 70 GW in 2050" (to compare the 2022 average capacity of the offshore windfarms was 10 GW). This means the Netherlands plans to double the delivery from offshore wind farms in only 10 years. Moreover, the country plans to increase delivery from this source 7 times by 2050.

	Infrastructure development: in the RE context mostly focus on high expansion of the offshore wind farms that which is a “major contribution to helping the Netherlands become more sustainable”.
Policy instruments	The NECP incorporates specific financial incentives such as subsidies for renewable energy projects, and regulatory measures like faster permitting processes to facilitate the installation of renewable energy infrastructure. REPowerEU grant (which is received from the EU) allocated to the Netherlands is worth €454 million. Additionally, the Netherlands has asked for a share of its Brexit Adjustment Reserve to be transferred to the plan, amounting to €280 million. The Temporary Climate Fund Act - this act will allocate €34,12 billion towards the development of a greenhouse gas-neutral energy supply by 2050 and for encouraging energy efficiency techniques and the use of renewable energy in industry and the built environment.
Governance institutions	There is focus on both national and local governments in achieving these updated targets, with an integrated approach that involves various stakeholders including industries, NGOs, and citizen groups. Morover, the Dutch legislation acknowledges the role of EU-wide initiatives and funding in supporting national efforts, which is a core aspect of the REPowerEU plan.

In regard to the National Energy and Climate Plan (NECP) of the Netherlands, as this is a mandatory policy created in collaboration with the EU, the European Commision assessed the progress made by the Netherlands. The assessed legislation was the updated version of NECP, submitted in June 2023. As the assessment of the Commision states the Netherlands is advised to “significantly raise the ambition to a share of renewable energy sources of at least 39% as a contribution to the EU’s binding renewable energy target” (European Comission, 2023). Furthermore, the European Commission reports that the Netherlands should “provide estimated trajectories and a long-term plan for the deployment of renewable”.

Tabela 8. Summary graph of the European Commission's Assessment of Poland's updated National Energy and Climate Plan from 2024

Objective	2030 value submitted in the draft updated NECP	2030 target under EU legislation	Assessment of 2030 ambition level
Renewable Energy (Share of renewable energy in gross final consumption)	27%	39%*	Negative: "the Netherlands has to raise the overall ambition significantly and for specific targets and lacks additional measures to achieve those ambitions".

Source: European Commission, 2024, Netherlands' draft updated National Energy and Climate Plan Assessment

* according to the formula set out in Annex II of the Regulation (EU) 2018/1999 on the Governance Regulation of the Energy Union and Climate Action.

5.3.4 The Netherlands Policy Paradigm Shift

The Netherlands' response, while substantial, varies in intensity compared to Poland's. The updated NECP and the introduction of specific legislative measures such as the Temporary Climate Fund Act post-invasion show significant adjustments in legislation and targets. However, the core goals of increasing renewable energy share and achieving energy independence have been amplified and accelerated rather than completely redefined, which leans towards a strong second-order change moving towards third-order. The commitment to drastically expand offshore wind capacity is a strong move that represents a significant shift but remains within the framework of existing long-term energy independence and sustainability goals.

6. Discussion

The undertaken descriptive statistics analyses and measures have answered the Research question 1 and shed light on Research question 2. In regard to RQ1 it was proven that the two countries, while strongly developing the RE sector, represent different approaches towards RE adaptation.

The Netherlands has demonstrated a 2 times higher growth rate in RE adoption over the analyzed period compared to Poland and even stronger growth rate compared to entire EU. This suggests that the Netherlands has implemented more effective policies. This exceptional growth of RE in the Netherlands is also related to the law share of RE at the starting year of the analysis. However, the Russian occupation of Crimea (2014) may be the reason reinforcing this trend as it was a year in which the Netherlands noted exceptionally high RE growth rate (15.44%). Therefore, it addresses the Hypothesis 2 as well. Specifically, it suggests that the war in Ukraine accelerated the implementation of renewable energy strategies. Therefore, it seems to be in line with the assumptions that the war attracts governments to increase energy mix diversity and hence increase RE sector. Moreover, the Russian invasion of 2022 impacted the RE implementation in both countries and EU in general. It is observed that the expansion of war had a direct effect on high RE growth levels. These findings suggest that the war motivated European governments, including Poland and the Netherlands, to diversify the energy sources which led to strong increase of RE adaptation in a direct response to the 2022 Russian invasion. Moreover, both countries experienced significant fluctuations in yearly growth rates, with the Netherlands showing an exceptionally high spike in 2019-2020. This could indicate specific policy impacts or substantial investments. In the later part of this thesis the potential correlation between these spikes and major policy changes or renewable energy projects will be analyzed.

Along with the RE growth rates the absolute changes for the analyzed period also must be interpreted. Between years 2004 and 2022 the absolute change of the Netherlands – 13% does not outstand that strongly from Poland – with 10.1%. Moreover, the absolute change in the share of Dutch renewable energy is below the EU average (13.3%). This proves, that indeed the Netherlands progressed more in adaptation of the RE compared to Poland. However, this difference is not as huge as the growth rates suggest. Yet, both the RE growth rates and absolute changes of RE adaptation prove that the Netherlands undertook strongers steps in this direction, proving Hypothesis1.

The descriptive statistics of GDP per capita and the share of renewable energy for all 3 actors: Poland and the Netherlands show that as GDP per capita increases, there is a general trend of increasing RE share, suggesting a positive correlation between economic prosperity and the adoption of renewable energy. This correlation can be indicative of higher economic capacity enabling more substantial investment in renewable technologies. Moreover, it was found that The Netherlands shows a more pronounced fluctuation in GDP per capita, especially after 2015. This suggests economic upturns in the Netherlands are utilized to boost renewable energy projects and infrastructure. In Poland, the sharp rise of RE annotation from 2017 to 2020 does not seem to be reflected by a strong GDP growth. Overall, these findings suggest that the economic strength positively affects the RE implementation. This was visible mostly in the Netherlands with the close correlation between the two factors. However, in the broader perspective it is also applicable to Poland as the RE share has been growing steadily along with the GDP growth.

The table presenting the European energy imports from Russia indicates that indeed the Russian aggressions on Ukraine (both in 2014 and 2022) are reflected by the energy dependency on the aggressor. Therefore, it tackles the RQ2 proving the “positive” effect of Russian aggression on RE development in the EU including Poland and the Netherlands. The EU imported second highest amount of energy from Russia directly prior the war in 2022. However, the EU reacted to the war which consequently led to the lowest import level in the entire decade which happened in 2023 (worth €29.3 billion). This proves that EU reacted directly to the Russian aggression. The rapid decline resulting from the war is further supported by the fact that Russia's share in extra-EU imports of petroleum oil fell from 30 % in the first quarter of 2022 to 3 % in the first quarter of 2024 (Eurostat).

Lastly, a graph of the RE shares and energy imports dependency was presented. In the Netherlands, as the dependency on energy imports fluctuates, there is a generally positive trend in RE share, especially notable after 2015. This might suggest efforts to reduce dependency on external energy sources by increasing renewable energy investments. For Poland, both energy imports dependency and RE share move upward. Interestingly, as dependency increases, RE share also rises, particularly from 2015 onwards. This suggests that despite increasing imports, there is a simultaneous push towards renewable energy, possibly to diversify and stabilize energy sources. Consequently, the relation between the share of RE and dependency on energy imports is not clear and hence it does not seem to be the reason for the divergent paths the 2 countries present on their RE pursuit.

The first finding from the qualitative analysis is the fact that both Poland and the Netherlands reacted to the Russian aggression on Ukraine in the context of RE adaptation. Both countries introduced their legislation directly targeted at Russia and energy insecurity created by the conflict – REPowerEU (introduced in May 2022). Moreover, both countries updated their version of "The National Energy and Climate Plans" (NECPs) – the leading European energy legislation concerning the energy transition (first introduced in 2019). The updates of both countries took place in 2023. Moreover, Poland, in response to the Russian invasion, updated its leading national legislation – PEP2040 in which it is directly stated that the war is the reason for the update and increase of RE is key. Lastly, smaller legislatures in both countries were created in response to the war in Ukraine, such as the "Offshore wind energy policy" in the Netherlands. The fact that these legislations came into existence makes it clear that the two countries reacted to the Russian attack and that the leading response is the development of RE.

Poland has committed to ambitious RE targets aiming for about 50% of energy production from renewables by 2040. This illustrates a clear acceleration in the response of Poland to the war. Importantly, Hall's framework and the analysis performed using it confirmed that this acceleration is not merely a reaction to immediate energy security threats but a strategic reorientation towards long-term stability and independence from Russian fossil fuels.

Moreover, Poland's other ambitious goal is the energy production of 29.8% from RES by 2030. It is a strong commitment as in 2022 the share of RE in Poland was 17%. This indicates that Poland has committed to nearly doubling its RE share in only 8 years. This rate of growth, in light of the provided data on RE growth rates in Poland, Netherlands, and the EU so far, can be assessed as a remarkably ambitious goal. Importantly, directly touching upon Hypothesis 2, Poland committed to a significant change in targeting the share of the RE in its energy mix. In the first version of the same legislation (NECP), it was 23% (2019 version), and in the updated version 29.8% (2024 version). This finding strongly suggests that the Russian invasion of Ukraine speeded up the RE adaptation (specifically by +7% until 2030)

The Netherlands, on the other hand, plans to achieve a 27% share of energy from renewable sources by 2030. The target was identified in the original version of the Dutch National Energy and Climate Plan (introduced in 2019) as well as in the updated version of the legislation from 2023. Such a target suggests the strong commitment of the Netherlands as the RE in the country's energy mix in 2022 was 15%. Crucially, the positive shift in RE expansion in the Netherlands is clear. Additionally, the analysis undertaken with the use of Hall's framework suggests that this is a strategic reorientation towards long-term independence from Russian fossil fuels and other energy imports.

However, as there are many factors shaping the capabilities of countries in adapting their RE policies, the European Commission's assessments of NECPs were analyzed as well. As the EU functions as the supervisory entity of this project it provides objective insights about how the countries manage to meet their targets. The Commission's positive assessment for Poland and negative for the Netherlands on the level of RE implementation strongly supports Hypothesis 2, meaning Poland has presented more decisive legislation on RE.

Moreover, this positive reflection is further supported by the fact that the Polish government invests and plans to invest more in this sector compared to the Netherlands. Specifically, Poland, according to PEP2040, plans to invest €373 billion by 2040. Additionally, Poland is being financially supported by the EU with €25 billion for pursuing REPowerEU. These financial inputs prove the Polish commitment to the RE adaptation and suggest that the documents will realistically deliver the set goals.

The investment level in the RE sector seems to be significantly lower. The acquired data includes the budget of the Temporary Climate Fund Act - €34,12 billion. Importantly, this is a plan reaching up to 2050. Therefore, compared to the Polish PEP2040 with its €373 billion budget, the Climate Fund Act stays behind. A direct comparison between the two countries can be observed on the REPowerEU budgets. The Netherlands will be granted €454 million for this project from the EU. Again, it is significantly lower compared to Poland with total EU support of €25 billion. It must be remembered that that it consists of "only" €2.8 billion grant and the rest (€22,52 billion) is in the form of a loan. Nevertheless, the Polish government has negotiated a significantly higher budget for the REPowerEU. This is significant as this project is meant to directly address the energy transition in light of the Russian invasion of Ukraine. Unfortunately, the NOVI budget has not been specified which will be further discussed in the "limitations" section. Nevertheless, in light of these findings, it is clear that Poland has designated a significantly higher budget for RE adoption compared to the Netherlands. Hence, these findings bring us closer to ultimately accepting Hypothesis 2.

Lastly, the strategic differences can be seen between the countries. Both countries have intensified their renewable energy strategies and their approaches reflect different energy backgrounds. Poland's focus has been more on a broad-based increase across various forms of renewable energy, driven by an urgent need to reduce heavy coal dependency and cut off energy ties with Russia. In contrast, the Netherlands, with its existing infrastructure and technological edge, has been able to more rapidly scale up specific sectors. It can be observed with the analysis of the offshore wind policies of both countries. By 2030 the Netherlands plans to generate 21GW from this renewable source. Poland, on the other hand, set a target of 5.9GW, for the same year. This proves the high disproportion between these two countries in this regard. It is worth noticing that this comparison is fair because, as stated in the analyzed policies, the main RES generated in both countries comes from wind. This finding once again proves, in reference to RQ1, that the two countries have different approaches to RE.

6.1 Limitations

The main limitation to the descriptive statistics section is that it is predominantly based on data available up to the year 2022, with only some metrics extending into 2023. This limitation restricts the ability to fully capture the long-term effects of the war in Ukraine, especially in the sense of full scale invasion from 2022. Moreover, significant policy changes, technological advancements, or economic shifts that may have occurred post 2022 are not reflected in the data. This could potentially affect the accuracy and relevance of the conclusions drawn, as renewable energy markets and policies are rapidly evolving. Consequently, the findings may not fully represent the current state or future trajectories of renewable energy adoption in Poland and the Netherlands.

The second limitation is the transparency of the energy imports post the reduction of direct energy purchases from Russia. Official statistics indicate a significant decrease in energy imports from Russia, there is a lack of detailed tracking of the origin of energy procured from new suppliers. It is possible that these new suppliers might still be sourcing energy indirectly from Russia, thereby negating the intended diversification away from Russian energy dependencies. This limitation poses a significant challenge in accurately assessing the effectiveness of both Poland and the Netherlands at reducing dependency on Russian energy sources. The potential indirect reliance on Russian energy would indicate that all European and national cuts from Russian supplies were falsified in a way. Therefore, it would lead to a misinterpretation of energy security and sustainability metrics.

In regard to qualitative analysis, the strongest limitation was that governments did present all the budgets for the energy innovation projects to the public. Best example is the Dutch NOVI which presents ambitious targets, yet without stating specific investments. This, to some extent, weakened the set comparisons. However, as explained in the *Results* section, the budget differences were significant enough to come to clear conclusions.

7. Conclusions

This thesis performer a comparative analysis of renewable energy adoption in Poland and the Netherlands in the context of the Russian-Ukrainian conflict. By exploring the responses of these two European countries to the geopolitical instability and internal imperatives for energy security and sustainability, this research addressed two fundamental questions about the adoption of renewable energy in a time of crisis.

Research Question 1: How have the approaches to renewable energy adoption differed between Poland and the Netherlands in response to the geopolitical consequences of the Russian-Ukrainian conflict, and what factors have influenced these divergent paths?

The findings indicate that the paths to renewable energy adoption in Poland and the Netherlands have indeed differ during the analyzed period. The Netherlands in the period 2004-2022 presented a stronger renewable energy (RE) growth. That was proven by both higher RE growth rates, higher mean of all the RE growth rates for a given period as well as by the absolute change in the share of RE in that period. However, the absolute changes of RE share are not high and Poland still represents higher share of RE in its energy mix. Therefore, despite the Netherlands representing faster RE adaptation in the last two decades the two countries have proven to be developing the RE in comparable pace.

One of the primary factors influencing these different paths, as supported by the data, is economic strength indicated by GDP per capita. The Netherlands, with a higher GDP per capita has been able to invest more substantially in renewable technologies. Poland's approach, which was more rapid and probably reactive, is a reflection of a need to reduce dependency on external energy sources, particularly from Russia, which is in line with country's strategies for economic growth and national security.

Research Question 2: To what extent has the impact of the war in Ukraine accelerated or hindered the implementation of renewable energy strategies in Eastern and Western Europe, with a comparative analysis between Poland and the Netherlands?

Both Poland and the Netherlands reacted to the Russian aggression on Ukraine in the context of RE adaptation. Both countries introduced their legislation directly targeted at Russia and energy insecurity created by the conflict – REPowerEU (introduced in May 2022). Moreover, both countries updated their version of "The National Energy and Climate Plans" (NECPs) – the leading European energy legislation concerning the energy transition (first introduced in 2019). The updates of both countries took place in 2023. Moreover, Poland, in response to the Russian invasion, updated its leading national legislation – PEP2040 in which it is directly stated that the war is the reason for the update and increase of RE is key. Lastly, smaller legislatures in both countries were created in response to the war in Ukraine, such as the "Offshore wind energy policy" in the Netherlands. The fact that these legislations came into existence makes it clear that the two countries reacted to the Russian attack and that the leading response is the development of RE.

From the qualitative analysis it can be concluded that the Polish legislative reaction to the Russian invasion of Ukraine in 2022 was more decisive compared to the Netherlands. This conclusion is supported by the application of Hall's policy paradigm framework. As the analysis showed, Poland presented characteristics of a third-order change which is a radical shift in policy paradigms. This was a reaction to immediate and realistic threat posed by a crisis both on energy and national security levels. The third-order change assumes deep and long-term shift. This paradigm shift is driven by a recognition that energy independence is crucial for national security, leading to an actual shift in energy strategies, including substantial investments in renewable energy and a diversified energy mix aimed at reducing reliance on external fossil fuels.

In contrast, the Netherlands demonstrated a second-order change, characterized by adjustments within existing frameworks rather than a complete paradigm change. This includes escalated goals and improved policy instruments but remains within the existing paradigms of energy policy. It was strongly proven with the offshore wind energy projects which are very ambitious in the Netherlands. Yet this project, despite bringing strong positive change, remains in the existing paradigm.

In the context of the Russian invasion of Ukraine in 2022 both countries' actions are in line with the concept of the "energy trilemma," which involves balancing energy security, energy equity, and environmental sustainability. The energy trilemma framework is crucial in understanding how both nations navigate these competing objectives. Poland's response has been significantly shaped by its immediate need for energy security, leading to strong changes in its energy policy targets and investments. Meanwhile, the Netherlands continues to advance in its balanced approach, aiming to achieve energy equity and environmental sustainability without the rapid shifts seen in Poland.

8. Bibliography

Abraham-Dukuma, M. (2019). Energy Trilemma: Climate Policy Pluralism in the United States – Domestic and International Implications. *Carbon & Climate Law Review*, *13*(1), 63–76. https://www.jstor.org/stable/26739644

Adolfsen, J. F., Kuik, F., Schuler, T., & Lis, E. (2022). The impact of the war in Ukraine on euro area energy markets. *Economic Bulletin Boxes*, *4*. https://ideas.repec.org/a/ecb/ecbbox/202200041.html

Aitken, C., & Ersoy, E. (2022). War in Ukraine: the options for Europe's energy supply. *The World Economy*, *46*(4). https://doi.org/10.1111/twec.13354

Ali, M., Seraj, M., Alper, E., Tursoy, T., & Uktamov, K. F. (2023). Russia-Ukraine war impacts on climate initiatives and sustainable development objectives in top European gas importers. *Environmental Science and Pollution Research International*. https://doi.org/10.1007/s11356-023-29308-9

AYADI, F., COLAK, I., GARIP, I., & BULBUL, H. I. (2020, September 1). *Targets of Countries in Renewable Energy*. IEEE Xplore. https://doi.org/10.1109/ICRERA49962.2020.9242765

Berk, I., & Yetkiner, H. (2014). Energy prices and economic growth in the long run: Theory and evidence. *Renewable and Sustainable Energy Reviews*, *36*, 228–235. https://doi.org/10.1016/j.rser.2014.04.051

Brown, G. (2021, February 17). *How to Avoid a Climate Disaster by Bill Gates review – why science isn't enough*. The Guardian. https://www.theguardian.com/books/2021/feb/17/how-to-avoid-a-climate-disaster-by-bill-gates-review-why-science-isnt-enough

Chen, Y., & Copenhagen : Nordic Council of Ministers. (2004). *Promotion of renewable energy globally : based on Johannesburg follow-up*. https://ebookcentral.proquest.com/lib/uvtilburg-ebooks/reader.action?docID=3383271&ppg=8

Cherp, A., & Jewell, J. (2014). The concept of energy security: Beyond the four As. *Energy Policy*, *75*, 415–421. https://doi.org/10.1016/j.enpol.2014.09.005

Chomać-Pierzecka, E., Sobczak, A., & Soboń, D. (2022). The Potential and Development of the Geothermal Energy Market in Poland and the Baltic States—Selected Aspects. *Energies*, *15*(11), 4142. https://doi.org/10.3390/en15114142

Cifuentes-Faura, J. (2022). European Union policies and their role in combating climate change over the years. *Air Quality, Atmosphere & Health*, *15*. https://doi.org/10.1007/s11869-022-01156-5

Crossley, P. (2022). What is "renewable energy"? – conceptualizing the legislative definitions of renewable energy. *Renewable Energy Law and Policy Review*, *10*(3/4), 39–56. https://www.jstor.org/stable/27192728

Curtin, J., McInerney, C., Ó Gallachóir, B., Hickey, C., Deane, P., & Deeney, P. (2019). Quantifying stranding risk for fossil fuel assets and implications for renewable energy investment: A review of the literature. *Renewable and Sustainable Energy Reviews*, *116*, 109402. https://doi.org/10.1016/j.rser.2019.109402

Dutta, A. (2017). Oil price uncertainty and clean energy stock returns: New evidence from crude oil volatility index. *Journal of Cleaner Production*, *164*, 1157–1166. https://doi.org/10.1016/j.jclepro.2017.07.050

European Comission. (2023). *THE NETHERLANDS' DRAFT UPDATED NATIONAL ENERGY AND CLIMATE PLAN*. https://commission.europa.eu/system/files/2023-12/Factsheet_Commissions_assessment_NECP_Netherlands_2023.pdf

European Commission. (n.d.). *National accounts and GDP*. Ec.europa.eu. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=National_accounts_and_GDP#Developments_for_GDP_in_the_EU:_the_rebound_observed_in_2021_continued_in_2022

European Commission. (2022). *REPowerEU: affordable, secure and sustainable energy for Europe*. European Commission. https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en

European Commission. (2023). *Renewable Energy Targets*. Energy.ec.europa.eu. https://energy.ec.europa.eu/topics/renewable-energy/renewable-energy-directive-targets-and-rules/renewable-energy-targets_en

Fischer, S. (2015). European Union sanctions against Russia: objectives, impacts and next steps. In *SSOAR* (Vol. 17/2015). Stiftung Wissenschaft und Politik -SWP- Deutsches Institut für Internationale Politik und Sicherheit. https://www.ssoar.info/ssoar/handle/document/42578

Fouquet, D., & Johansson, T. B. (2008). European renewable energy policy at crossroads—Focus on electricity support mechanisms. *Energy Policy*, *36*(11), 4079–4092. https://doi.org/10.1016/j.enpol.2008.06.023

Gates, B. (2021). *How to Avoid a Climate Disaster : the Solutions We Have and the Breakthroughs We Need.* Random House Inc.

Haas, R., Panzer, C., Resch, G., Ragwitz, M., Reece, G., & Held, A. (2011). A historical review of promotion strategies for electricity from renewable energy sources in EU countries. *Renewable and Sustainable Energy Reviews*, *15*(2), 1003–1034. https://ideas.repec.org/a/eee/rensus/v15y2011i2p1003-1034.html

Hall, P. A. (1993). Policy Paradigms, Social Learning, and the State: The Case of Economic Policymaking in Britain. *Comparative Politics*, *25*(3), 275–296.

Heffron, R. J., McCauley, D., & de Rubens, G. Z. (2018). Balancing the energy trilemma through the Energy Justice Metric. *Applied Energy*, *229*, 1191–1201. https://doi.org/10.1016/j.apenergy.2018.08.073

Horta, K. (2011). Two Decades after the Rio Earth Summit: Sustainable Development Quo Vadis? *Janus.net*, *2*(2). https://doaj.org/article/a8e19e33d1df411ea86d6d272e060094

Iskandarova, M., Dembek, A., Fraaije, M., Matthews, W., Stasik, A., Wittmayer, J. M., & Sovacool, B. K. (2021). Who finances renewable energy in Europe? Examining temporality, authority and contestation in solar and wind subsidies in Poland, the Netherlands and the United Kingdom. *Energy Strategy Reviews*, *38*, 100730. https://doi.org/10.1016/j.esr.2021.100730

Jacobsson, S., & Lauber, V. (2006). The politics and policy of energy system transformation—explaining the German diffusion of renewable energy technology. *Energy Policy*, *34*(3), 256–276. https://doi.org/10.1016/j.enpol.2004.08.029

Jaworski, S., Chrzanowska, M., Zielińska-Sitkiewicz, M., Pietrzykowski, R., Jezierska-Thöle, A., & Zielonka, P. (2023). Evaluating the Progress of Renewable Energy Sources in Poland: A Multidimensional Analysis. *Energies*, *16*(18), 6431. https://doi.org/10.3390/en16186431

Jin, J. C., Choi, J.-Y., & Yu, E. S. H. (2009). Energy prices, energy conservation, and economic growth: Evidence from the postwar United States. *International Review of Economics & Finance*, *18*(4), 691–699. https://doi.org/10.1016/j.iref.2008.09.014

Kardaś, S. (2023, September 27). *From coal to consensus: Poland's energy transition and its European future*. ECFR. https://ecfr.eu/publication/from-coal-to-consensus-polands-energy-transition-and-its-european-future/

Kern, F., Kuzemko, C., & Mitchell, C. (2014). Measuring and explaining policy paradigm change: the case of UK energy policy. *Policy & Politics*, *42*(4), 513–530. https://doi.org/10.1332/030557312x655765

Kern, F., & Smith, A. (2008). Restructuring energy systems for sustainability? Energy transition policy in the Netherlands. *Energy Policy*, *36*(11), 4093–4103. https://doi.org/10.1016/j.enpol.2008.06.018

Kuang, W. (2021). Are clean energy assets a safe haven for international equity markets? *Journal of Cleaner Production*, *302*, 127006. https://doi.org/10.1016/j.jclepro.2021.127006

Luginbuhl, M., Rundle, J. B., & Turcotte, D. L. (2018). Natural time and nowcasting induced seismicity at the Groningen gas field in the Netherlands. *Geophysical Journal International*, *215*(2), 753–759. https://doi.org/10.1093/gji/ggy315

MacCracken, M. C. (2008). Prospects for Future Climate Change and the Reasons for Early Action. *Journal of the Air & Waste Management Association*, *58*(6), 735–786. https://doi.org/10.3155/1047-3289.58.6.735

Malhi, Y., Franklin, J., Seddon, N., Solan, M., Turner, M. G., Field, C. B., & Knowlton, N. (2020). Climate Change and ecosystems: threats, Opportunities and Solutions. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *375*(1794). Royal Society Publishing. https://doi.org/10.1098/rstb.2019.0104

Marti, L., & Puertas, R. (2022). Sustainable energy development analysis: Energy Trilemma. *Sustainable Technology and Entrepreneurship*, *1*(1), 100007. https://doi.org/10.1016/j.stae.2022.100007

Mearsheimer, J. (2014). Why the Ukraine Crisis Is the West's Fault: The Liberal Delusions That Provoked Putin. In *Foreign Affairs*. https://www.mearsheimer.com/wp-content/uploads/2019/06/Why-the-Ukraine-Crisis-Is.pdf

Mousavi, F., Nazari-Heris, M., Mohammadi-Ivatloo, B., & Asadi, S. (2021). Energy market fundamentals and overview. *Energy Storage in Energy Markets*, 1–21. https://doi.org/10.1016/b978-0-12-820095-7.00005-4

Netherlands, S. (2023, March 6). *Renewable electricity share up by 20 percent in 2022*. Statistics Netherlands. https://www.cbs.nl/en-gb/news/2023/10/renewable-electricity-share-up-by-20-percent-in-2022

Nikendei, C., Bugaj, T. J., Nikendei, F., Kühl, S. J., & Kühl, M. (2020). Klimawandel: Ursachen, Folgen, Lösungsansätze und Implikationen für das Gesundheitswesen. *Zeitschrift Für Evidenz, Fortbildung Und Qualität Im Gesundheitswesen*, *156-157*, 59–67. https://doi.org/10.1016/j.zefq.2020.07.008

Olabi, A. G., & Abdelkareem, M. A. (2022). Renewable energy and climate change. *Renewable and Sustainable Energy Reviews*, *158*(C). https://ideas.repec.org/a/eee/rensus/v158y2022ics1364032122000405.html

Osička, J., & Černoch, F. (2022). European energy politics after Ukraine: The road ahead. *Energy Research & Social Science*, *91*(1), 102757. https://doi.org/10.1016/j.erss.2022.102757

Østergaard, P. A., Duic, N., Noorollahi, Y., Mikulcic, H., & Kalogirou, S. (2020). Sustainable development using renewable energy technology. *Renewable Energy*, *146*, 2430–2437.

Oteman, M., Kooij, H.-J., & Wiering, M. (2017). Pioneering Renewable Energy in an Economic Energy Policy System: The History and Development of Dutch Grassroots Initiatives. *Sustainability*, *9*(4), 550. https://doi.org/10.3390/su9040550

Potrč, S., Čuček, L., Martin, M., & Kravanja, Z. (2021). Sustainable renewable energy supply networks optimization – The gradual transition to a renewable energy system within the European Union by 2050. *Renewable and Sustainable Energy Reviews*, *146*, 111186. https://doi.org/10.1016/j.rser.2021.111186

Powirska, L. (2022, May 18). *Through the Ashes of the Minsk Agreements*. Epicenter.wcfia.harvard.edu. https://epicenter.wcfia.harvard.edu/blog/through-ashes-minsk-agreements

Rankin, J. (2022, November 17). *Three men found guilty of murdering 298 people in shooting down of MH17*. The Guardian. https://www.theguardian.com/world/2022/nov/17/three-men-found-guilty-of-murdering-298-people-in-flight-mh17-bombing

Rawtani, D., Gupta, G., Khatri, N., Rao, P. K., & Hussain, C. M. (2022). Environmental damages due to war in Ukraine: A perspective. *Science of the Total Environment*, *850*(157932), 157932. https://doi.org/10.1016/j.scitotenv.2022.157932

Saluschev, S. (2014). Annexation of Crimea: Causes, Analysis and Global Implications. *Global Societies Journal*, *2*(0). https://escholarship.org/uc/item/5vb3n9tc

Shirazi, M. (2022). Assessing energy trilemma-related policies: The world's large energy user evidence. *Energy Policy*, *167*, 113082. https://doi.org/10.1016/j.enpol.2022.113082

Stern, D. I. (2011). The role of energy in economic growth. *Annals of the New York Academy of Sciences*, *1219*(1), 26–51. https://doi.org/10.1111/j.1749-6632.2010.05921.x

Sweidan, O. D. (2021). The geopolitical risk effect on the US renewable energy deployment. *Journal of Cleaner Production*, *293*, 126189. https://doi.org/10.1016/j.jclepro.2021.126189

Tang, C. F., & Tan, E. C. (2013). Exploring the nexus of electricity consumption, economic growth, energy prices and technology innovation in Malaysia. *Applied Energy*, *104*, 297–305. https://doi.org/10.1016/j.apenergy.2012.10.061

Uğur Soytaş, & Ramazan Sarı. (2019). *Routledge Handbook of Energy Economics*. Routledge.

Wang, M., & Tian, L. (2015). *Regulating effect of the energy market—Theoretical and empirical analysis based on a novel energy prices–energy supply–economic growth dynamic system*. *155*, 526–546. https://doi.org/10.1016/j.apenergy.2015.06.001

Wierzbowski, M., Filipiak, I., & Lyzwa, W. (2017). Polish energy policy 2050 – An instrument to develop a diversified and sustainable electricity generation mix in coal-based energy system. *Renewable and Sustainable Energy Reviews*, *74*, 51–70. https://doi.org/10.1016/j.rser.2017.02.046

Włodarczyk, B., Firoiu, D., Ionescu, G. H., Ghiocel, F., Szturo, M., & Markowski, L. (2021). Assessing the Sustainable Development and Renewable Energy Sources Relationship in EU Countries. *Energies*, *14*(8), 2323. https://doi.org/10.3390/en14082323

Wu, H., Mentel, U., Lew, G., & Wang, S. (2022). What drives renewable energy in the group of seven economies? Evidence from non-parametric panel methods. *Economic Research-Ekonomska Istraživanja*, 1–27. https://doi.org/10.1080/1331677x.2022.2092525

Yang, X., Pang, J., Teng, F., Gong, R., & Springer, C. (2021). The environmental co-benefit and economic impact of China's low-carbon pathways: Evidence from linking bottom-up and top-down models. *Renewable and Sustainable Energy Reviews*, *136*, 110438. https://doi.org/10.1016/j.rser.2020.110438

Ziegler, C., & Muchira, J. (2023). Climate Change. *Primary Care: Clinics in Office Practice*, *50*(4), 645–655. https://doi.org/10.1016/j.pop.2023.04.010