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Degrees of Feasibility: An Analysis from a Political
Perspective of Germany's and Poland's Transition from
Fossil Fuels to Renewable Energy in the Context of the
European Green Deal

Master's thesis

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In Prague, on the 25th of June, 2024

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Abstract

The transition from fossil fuels to green energy is a critical challenge, which is addressed against the climate change, particularly within the European Union, which has established ambitious goals through the European Green Deal. This thesis investigates the political scopes of Germany's and Poland's energy transitions, exploring the degrees of feasibility in their shift towards renewable energy sources. By comparing these two countries, this research seeks to discover the political, financial, and technological factors that influence their energy policies and the implementation of renewable energy initiatives. The choice of Germany and Poland is purposeful, given their contrasting energy landscapes, political environments, and levels of progress in adopting renewable energy. Germany is often seen as a leader in renewable energy within the EU, whereas Poland encounters significant obstacles due to its heavy dependence on coal. Understanding these differences offers important perspectives on the wider European context and the diverse pathways to achieving a sustainable energy future.

This thesis builds on the argument presented in the literature that political will, policy frameworks, and socio-economic conditions are pivotal in shaping the trajectory of energy transitions. Through a comparative analysis, this study aims to contribute to the ongoing discussion on sustainable energy by highlighting the critical role of political dynamics. The analysis delves into government commitments, public opinion, and financial contribution towards renewable energy, thereby offering a thorough insight of the interaction between political factors and energy transitions. Through this investigation, the thesis aims to clarify the feasibility of achieving the EU's renewable energy targets, providing recommendations for policymakers to navigate the political challenges important in transitioning to a sustainable energy future.

Abstrakt

Přechod od fosilních paliv k zelené energii je kritickou výzvou, která se řeší proti změně klimatu, zejména v rámci Evropské unie, která si stanovila ambiciózní cíle prostřednictvím Evropské zelené dohody. Tato práce zkoumá politický rozsah energetických přechodů Německa a Polska a zkoumá stupně proveditelnosti jejich přechodu k obnovitelným zdrojům energie. Srovnáním těchto dvou zemí se tento výzkum snaží odhalit politické, finanční a technologické faktory, které ovlivňují jejich energetickou politiku a realizaci iniciativ v oblasti obnovitelné energie. Volba Německa a Polska je účelná vzhledem k jejich kontrastní energetické krajině, politickému prostředí a úrovni pokroku při přijímání obnovitelné energie. Německo je často považováno za lídra v oblasti obnovitelné energie v rámci EU, zatímco Polsko naráží na značné překážky kvůli své velké závislosti na uhlí. Pochopení těchto rozdílů nabízí důležité pohledy na širší evropský kontext a různé cesty k dosažení udržitelné energetické budoucnosti.

Tato práce staví na argumentu prezentovaném v literatuře, že politická vůle, politické rámce a socioekonomické podmínky jsou klíčové při utváření trajektorie energetických přechodů. Prostřednictvím srovnávací analýzy si tato studie klade za cíl přispět k probíhající diskusi o udržitelné energii zdůrazněním zásadní role politické dynamiky. Analýza se ponoří do vládních závazků, veřejného mínění a finančního příspěvku k obnovitelné energii, čímž nabízí důkladný pohled na interakci mezi politickými faktory a energetickými přechody. Prostřednictvím tohoto průzkumu se práce zaměřuje na objasnění proveditelnosti dosažení cílů EU v oblasti obnovitelné energie a poskytuje doporučení pro tvůrce politik, jak se vypořádat s politickými výzvami důležitými při přechodu k budoucnosti udržitelné energie.

Keywords

energy transition, European Green Deal, fossil fuels, renewable energy, feasibility

Klíčová slova

energetický přechod, evropský zelený úděl, fosilní paliva, obnovitelné zdroje energie, proveditelnost

Název práce

Stupně proveditelnosti: Analýza přechodu Německa a Polska od fosilních paliv k obnovitelným zdrojům energie z politické perspektivy v kontextu Zelené dohody pro Evropu.

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Introduction

The transition from fossil fuels to renewable energy has been a global topic, particularly within the case of the European Union. This thesis, “Degrees of Feasibility: An Analysis from a Political Perspective of Germany’s and Poland’s Transition from Fossil Fuels to Renewable Energy in the Context of the European Green Deal” dives into the challenges of transitioning for Germany and Poland while determining how feasible it is to transition from Fossil Fuels to Renewable Energy by 2050. The basis of choosing Germany and Poland is due to their contrasting approach towards the Green Deal and diving into their energy policies, financial mechanisms, and technological advancements. This will offer a perspective on the challenges and opportunities that both countries face within the European Union’s energy transition strategy.

Both Germany and Poland have their own approaches in regards to tackling the transition to renewable energy. Germany is known to be a leader of the energy transition across the European Union. It has made large investments in renewable energy, especially in the Wind and Solar sectors. This has been driven by strong energy legislation in the German government and high public approval. In contrast, Poland has been resilient towards the Green Deal as its electricity is still heavily reliant on coal. Poland’s energy policies and financial investments have had mixed reactions within the government.

The research will aim to uncover the political, financial, and technological factors that affect the feasibility of transitioning to renewable energy by 2050, providing insights that are applicable within the framework of the European Union’s Green Deal Strategy.

The thesis is divided into five parts. The first chapter provides a literature review mostly focusing on existing research and the challenges of the EU’s Green Deal ambitions from a political, financial, and technological perspective. The chapter also dives into the EU’s influence on national and local Policies in Germany and Poland within the Green Deal framework. The second chapter discusses the research target and explains how the thesis will approach the research target by examining certain criterias. The research question focuses on three main pillars in relation to transitioning from fossil fuel to renewable energy. The third chapter discusses the political factors, financial conditions, and technological advancements which will aid to assess the feasibility of energy transition in Germany and Poland by 2050. This is then followed by the fourth chapter will discuss the findings of this thesis before concluding and summarizing the thesis.

1 Literature Review

1.1 The Challenges of Europe's Green Ambitions: Issues with Energy Transition

This section describes Europe's challenges and implementation towards adopting its Green Deal strategy. It presents a couple of varying obstacles such as technological, economic, social, and political challenges. This will allow for an easier understanding of the complexity tied towards the adoption of the Green Deal.

1.1.1. Technological Challenges: Bridging the Gap Between Ambition and Reality

As European countries continue to strive towards a green future the path to achieving such an accomplishment is with technological challenges inherited from past dependencies on fossil fuels. The existing energy infrastructure predominantly sourced for non-renewable sources requires significant overhauls and replacements to transition to a sustainable energy system. This is notably difficult given the urgency to diversify the energy portfolio with renewable sources like wind and solar energy which have shown promising potential but also face substantial integration challenges (Five key areas for Europe's energy transition, 2023).

One of the primary technological challenges is the need to upgrade the existing power grid to handle the variable nature of renewable energy. Traditional grids were not able to accommodate the increased supply of wind and solar power leading to potential stability and reliability problems. The grid must be modernized to be more capable of balancing supply and demand in real-time. This allows using advanced technologies such as smart grids which use digital communication tools to watch and manage the transport of energy from all generation sources to meet the increased energy demands (Energy Transition in the EU, 2023).

Another difficult technological challenge is the construction and use of efficient energy storage systems. Renewable energy generation is a challenge itself; for instance, solar power is only available when the sun shines and wind power fluctuates with wind speed. To ensure a stable and reliable energy supply, it is essential to store excess energy produced during peak production times for use during periods of low generation. This requires advancements in energy storage technologies such as high-capacity batteries pumped hydroelectric storage. Effective storage will mitigate the problems associated with renewables and provide a buffer to maintain a consistent energy supply enhancing grid reliability (Five Important Areas For Europe's Energy Transition, 2023).

Expanding the EU energy grid to accommodate the increased supply of renewable energy also involves significant political and regulatory challenges. Political intervention and market reforms are necessary to make a conducive environment for technological advancements and to incentivize investments in green energy. Policymakers must address regulatory barriers provide financial incentives and establish clear and supportive regulatory frameworks that foster the integration of renewable energy and the construction of storage technologies (Energy Transition in the EU, 2023).

Investment in reliable energy storage systems is an important area where technological innovation and policy support must align. The financial backing for research and construction in storage technologies coupled with incentives for their use is important for ensuring these systems can be scaled up to meet the demands of a renewable energy grid. These systems will play a role in maintaining a steady energy supply during periods of such as cloudy weather or calm days with low wind (Five important areas for Europe's energy transition 2023).

While the technological challenges are significant, they are not difficult. With increasing political incentives towards green deal initiatives and a strong contribution from both the public and private sectors, Europe can close the gap between its climate policy intentions and the reality of a greener future. Continued investment in research infrastructure, modernization, and policy support will be essential to overcoming these technological challenges and achieving a sustainable energy transition. By addressing these challenges, Europe can pave the way for a robust and resilient energy system that supports its ambitious climate goals (Energy Transition in the EU 2023).

The existing energy infrastructure, predominantly designed for non-renewable sources, requires significant overhauls and replacements to transition to a sustainable energy system. This is especially critical given the urgency to diversify the energy portfolio with renewable sources like wind and solar energy, which have shown promising potential but also face substantial integration challenges (Five key areas for Europe's energy transition, 2023).

Expanding the EU's energy grid to accommodate the increased demand of renewable energy also involves significant political and regulatory challenges. Political intervention and market reforms are necessary to create technological advancements and incentives for investments in green energy. Policymakers must address regulatory barriers, provide financial incentives, and establish clear and supportive regulatory frameworks that encourage the integration of renewable energy and the development of storage technologies. Additionally, cross-border cooperation within the EU is

crucial for creating a more interconnected and resilient energy grid that can efficiently distribute renewable energy across member states (Energy transition in the EU, 2023).

Investment in reliable energy storage systems is a key area where technological innovation and policy support must converge. The financial backing for research and development in storage technologies, coupled with incentives for their deployment, is vital to ensure these systems can be scaled up to meet the demands of a renewable-heavy energy grid. These systems will play a crucial role in maintaining a steady energy supply, especially during periods of natural variability such as cloudy weather or calm days with low wind (Five key areas for Europe's energy transition, 2023).

Expanding the EU's energy grid to accommodate the increased supply of renewable energy is a vital point for a greener future. It involves political intervention and market reforms to ensure an efficient transition (Five Key Areas for Europe's Energy Transition, 2023). To add, the investment in reliable energy storage systems is needed to accommodate such expansions. The systems installed will ensure a steady flow in energy supply and increase the energy capacity when natural changes (cloudy weather, rain, etc...) occur. While technological challenges are significant, they are not difficult to solve. With the increase of political incentives towards green deal initiatives, Europe will be able to close the gap between its Climate Policy intentions and the reality for a greener future. (Energy transition in the EU, 2023).

1.1.2. Economic Considerations of Transitioning

The transition to green energy is a critical component of Europe's strategy to combat climate change and achieve its goal of becoming the first climate-neutral continent by 2050. However, this transition is not without its economic challenges. Balancing the need for substantial investments in green technologies and infrastructure with the necessity for affordability is a difficult task that requires careful consideration and strategic planning (Acheampong et al., 2023).

The transition involves significant upfront costs. These include investments in renewable energy sources such as wind, solar, and hydropower, as well as the development and deployment of energy-efficient technologies and infrastructure. Additionally, there are costs associated with the decommissioning of fossil fuel-based power plants and the retraining of workers in the energy sector. These investments are critical not only for reducing greenhouse gas emissions but also for ensuring a sustainable and resilient energy system capable of meeting future demands (Prandecki et al., 2022, p. 149).

Both the government and the private sector play crucial roles in financing the green energy transition. Government subsidies and incentives can help stimulate private investment in green technologies and infrastructure. For example, grants, tax credits, and low-interest loans can lower the financial barriers for companies and investors. At the same time, the private sector's innovation and entrepreneurial spirit can drive the development and deployment of cost-effective green energy solutions, thereby accelerating the transition process (Soderholm, 2022).

While the need for substantial investments in the green energy transition is clear, these investments must be balanced with the necessity for affordability. High energy costs can place a significant burden on households and businesses, particularly those in lower-income brackets. Therefore, it is essential to implement strategies that can help mitigate the impact of energy transition costs on energy prices (Acheampong et al., 2023).

Several strategies can help balance the need for investments in the green energy transition with the necessity for affordability. First, by phasing-out fossil fuel funding. Redirecting the funds currently used for fossil fuel subsidies towards investments in green energy can help reduce the overall cost of the energy transition. This reallocation of resources not only supports the development of renewable energy infrastructure but also aligns with broader climate goals (Acheampong et al., 2023). Second, Implementing a carbon pricing mechanism can help make fossil fuels more expensive and renewable energy more competitive, thereby stimulating investment in green energy. Carbon pricing can take the form of carbon taxes or cap-and-trade systems, both of which incentivize emissions reductions and generate revenue that can be reinvested in sustainable energy projects (Prandecki et al., 2022, p. 149). Third, promoting energy efficiency can help reduce energy demand and thus the overall cost of the energy transition. Enhancing the energy efficiency of buildings, industries, and transportation can lead to substantial energy savings, reducing the pressure on energy supply and lowering costs for consumers (Soderholm, 2022). Lastly, leveraging EU's various funds and programs that can help member states finance their green energy transitions. For instance, the European Green Deal and the NextGenerationEU recovery plan allocate substantial resources to support renewable energy projects, grid modernization, and research and innovation in green technologies (Five Key Areas For Europe's Energy Transition, 2023).

Balancing investments with affordability in the European green energy transition is a complex but achievable task. With strategic planning, innovative financing mechanisms, and a commitment to fairness and equity, Europe can lead the way in creating a sustainable and affordable green energy

future. The journey may be challenging, but the rewards—a healthier planet, a robust green economy, and a sustainable energy system—are well worth the effort (Acheampong et al., 2023).

Europe's energy transition is not simply a technological challenge; it also presents significant economic challenges. Developing renewable energy infrastructure like wind farms and solar parks requires substantial upfront investments. These costs encompass not only the construction of the facilities themselves but also the research and development of efficient renewable energy technologies and grid modernization projects (Prandecki et al., 2022, p. 149).

Furthermore, transitioning away from fossil fuels has implications for energy prices. While renewable energy sources offer long-term cost benefits, the initial investment costs can lead to short-term price fluctuations for consumers. Soderholm (2022) highlights the "need for significant investments in renewable energy technologies, grid infrastructure, and energy storage". Governments need to strike a delicate balance between promoting the transition with necessary investments and ensuring energy affordability for households and businesses.

Beyond infrastructure and technology, the energy transition also has implications for the job market. The decline of fossil fuel industries like coal mining is likely to lead to job losses in these sectors. Developing effective policies and programs to support workers through this transition is crucial. Governments can play a vital role in retraining workers for new opportunities in the green economy, such as jobs in renewable energy technology manufacturing, installation, and maintenance. By implementing targeted support programs, social safety nets, and reskilling initiatives, the negative economic impacts of the transition can be mitigated (Five key areas for Europe's energy transition, 2023).

The transition to green energy is a critical component of Europe's strategy to combat climate change and achieve its goal of becoming the first climate-neutral continent by 2050. However, this transition is not without its economic challenges. Balancing the need for substantial investments in green technologies and infrastructure with the necessity for affordability is a complex task that requires careful consideration and strategic planning. The transition to green energy involves significant upfront costs. These include investments in renewable energy sources such as wind, solar, and hydro power, as well as the development and deployment of energy-efficient technologies and infrastructure.

Additionally, there are costs associated with the decommissioning of fossil fuel-based power plants and the retraining of workers in the energy sector.

Both the government and the private sector play crucial roles in financing the green energy transition. Government subsidies and incentives can help stimulate private investment in green technologies and infrastructure. At the same time, the private sector's innovation and entrepreneurial spirit can drive the development and deployment of cost-effective green energy solutions.

While the need for substantial investments in the green energy transition is clear, these investments must be balanced with the necessity for affordability. High energy costs can place a significant burden on households and businesses, particularly those in lower income brackets. Therefore, it is essential to implement strategies that can help mitigate the impact of energy transition costs on energy prices.

There are several strategies that can help balance the need for investments in the green energy transition with the necessity for affordability. These include phasing out fossil fuel subsidies by redirecting the funds currently used for fossil fuel subsidies towards investments in green energy can help reduce the overall cost of the energy transition. Implementing a „Carbon Pricing“ mechanism can help make fossil fuels more expensive and renewable energy more competitive, thereby stimulating investment in green energy. Promoting investments in energy efficiency so that it can help reduce energy demand and thus the overall cost of the energy transition. Finally, leveraging the EU to provide various funds and programs that can help member states finance their green energy transitions.

Balancing investments with affordability in the European green energy transition is a complex but achievable task. With strategic planning, innovative financing mechanisms, and a commitment to fairness and equity, Europe can lead the way in creating a sustainable and affordable green energy future. The journey may be challenging, but the rewards - a healthier planet, a robust green economy, and a sustainable energy system - are well worth the effort (Acheampong et al., 2023).

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Beyond infrastructure and technology, the energy transition also has implications for the job market. The decline of fossil fuel industries like coal mining is likely to lead to job losses in these sectors. Developing effective policies and programs to support workers through this transition is crucial. Governments can play a vital role in retraining workers for new opportunities in the green economy, such as jobs in renewable energy technology manufacturing, installation, and maintenance. By implementing targeted support programs, social safety nets, and reskilling initiatives, the negative economic impacts of the transition can be mitigated (Five key areas for Europe's energy transition, 2023).

1.1.3. Social and Political Resistance: Navigating Public Perception and Policy Commitment

Public perception plays a critical role in the success of the EU Green Deal. Many citizens are supportive of climate action, recognizing the importance of addressing climate change. However, there are also substantial concerns regarding the economic implications of the Green Deal. In regions heavily reliant on fossil fuels, such as coal-mining areas, there is significant anxiety about job losses and economic decline. The transition to a green economy is perceived as a threat to livelihoods, particularly in industries facing obsolescence under stricter environmental regulations (IEA, 2024). Moreover, the financial burden of implementing green policies, such as carbon taxes and investment in renewable energy infrastructure, is a contentious issue. Many fear that these costs will be passed on to consumers through higher energy prices or increased taxes, disproportionately affecting lower-income households. This concern is particularly acute in countries with a lower GDP per capita, where citizens may be more resistant to measures that could increase their cost of living (IEA, 2024).

Political resistance to the EU Green Deal also varies significantly across member states, influenced by national interests, economic conditions, and political ideologies. Some countries, particularly those with strong environmental movements and higher economic resilience, have embraced the Green Deal, viewing it as an opportunity for economic innovation and leadership in green technology. In contrast, others, particularly those with economies heavily dependent on fossil fuels, have been more resistant (Acheampong et al., 2023).

For example, Poland, which heavily relies on coal for energy, has expressed concerns about the economic impact of transitioning away from coal. The Polish government has sought to delay the phase-out of coal and has pushed for greater financial support from the EU to mitigate the social and economic impacts of the transition. This stance highlights a broader challenge within the EU, where different member states have different capacities and readiness levels to adopt green policies (Jałowiec et al., 2021).

Political resistance is also fueled by concerns over national sovereignty and the perceived imposition of EU-wide regulations. Some member states are wary of ceding too much control over their energy policies to the EU, fearing that EU regulations might not fully consider national circumstances. This tension complicates the EU's efforts to implement a cohesive and effective climate policy across the continent.

The EU has adopted a multifaceted approach. The Green Deal includes not only environmental targets but also economic and social measures designed to ensure a fair and inclusive transition. The Just Transition Mechanism, for example, provides financial assistance and technical support to the most affected regions and sectors. Additionally, the EU is engaging in public consultations and dialogue to address public concerns and build broader consensus for the Green Deal (IEA, 2024).

Effective communication and inclusive policy-making are essential to overcoming social and political resistance. By clearly articulating the long-term economic and environmental benefits of the Green Deal, and ensuring that the transition does not disproportionately burden vulnerable populations, the EU can foster greater public support and mitigate political opposition. The successful implementation of the Green Deal will ultimately depend on the EU's ability to balance these diverse interests and navigate the complex landscape of public perception and political dynamics.

While the European Union's Green Deal Strategy sets an ambitious path towards climate neutrality, its implementation is not without significant challenges. Social and political resistance, driven by public perception and varying levels of policy commitment among member states, presents major hurdles. Addressing these concerns through inclusive and equitable policies will be crucial for the EU to achieve its climate goals and ensure a sustainable future for all its citizens.

1.2 The EU Green Deal's Influence on National and Local Policies in Germany and Poland: A Multi-Level Governances Approach:

The European Green Deal, with its ambitious target of achieving climate neutrality by 2050, is a significant driver of environmental policy across the European Union. This paper examines the influence of the Green Deal on national and local environmental policies in Germany and Poland. While both countries are members of the EU and committed to its goals, the way this commitment translates into action differs significantly. This analysis explores these differences through the lens of multi-level governance, highlighting the interplay between national and local policy frameworks, along with the role of local initiatives in driving national change.

The deal outlines a bold roadmap for the EU to achieve climate neutrality by 2050 (European Parliament. Energy Transition in the EU, 2023). This ambitious goal necessitates a significant transformation across various sectors, including energy production, transportation, and infrastructure. To achieve this transformation, the Green Deal relies on a multi-level governance approach, pushing for national and local governments to adopt and implement policies that align with its environmental objectives.

Likewise, the European Union Green Deal influences national and local policies in Germany and Poland. These two countries offer contrasting perspectives on the Green Deal's implementation. Germany, a long-standing leader in environmental protection, demonstrates a strong national alignment with the Green Deal's goals; Poland, however, faces a more complex situation due to its historical reliance on coal-fired power plants and its difficult alignment with the Green Deal's goals.

Despite these contrasting starting points, both countries show evidence of the Green Deal's influence on environmental policies at national and local levels. This paper explores this influence through the lens of multi-level governance, analyzing how the European Union sets the broad framework, national governments translate it into specific policies, and local authorities implement and innovate within this framework.

1.2.1. Germany: A Leader in Green Transformation

Germany is a current lead in the EU's green transition. This leadership comes from a long-standing national commitment to environmental protection and awareness. In act of leadership, Germany introduced the world's first national feed-in tariff for solar power in 1991, demonstrating a proactive approach to renewable energy (Burstedde et al., 2021).

The country has well-established its national policy framework by promoting renewable energy resources (RES), energy efficiency, and advocating for sustainable means of transportation. The Key elements in its framework include ambitious CO2 reduction targets enshrined in the Climate Protection Act, the Bundes-Klimaschutzgesetz (Bundesministerium Der Justiz Und Für Verbraucherschutz, 2021). Additionally, financial incentives like subsidies for homeowners installing solar panels further accelerate the transition towards clean energy (Burstedde et al., 2021).

Germany's federal system adds another layer of complexity. The states (Länder) hold significant legislative power, allowing them to enact supplementary environmental regulations tailored to their specific circumstances. This multi-level governance fosters innovation and experimentation with green policies at the regional level (Burstedde et al., 2021).

A crucial element in Germany's climate policy is the heavy emphasis on renewable energy sources – mostly Wind and Solar power. The Renewable Energy Act (EEG) was established to provide financial incentives for renewable energy production. The incentives that the EEG are feed-in tariffs and grid access (JÄNICKE et al., 2020). As a result Germany has seen an increase in renewable energy capacity accounting for over 40% of electricity generation in 2020 (Bundesnetzagentur and Bundeskartellamt, 2023). Germany has also imposed measures to improve energy efficiency across its infrastructure (buildings, industry, transportation, etc...) by conducting energy audits, building retrofits, and creating a fuel efficiency standard for vehicles (German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2019).

In 2019, Germany had enacted the Climate Action Law which commits the country long-term climate ambitions into law. The law establishes a workflow for monitoring the progress of its climate goals while allowing public participation in the decision-making process (German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety, 2019).

Germany's response to the European Union's Green Deal Strategy paints a strong commitment alignment to the EU's own goals. With a combination of ambitious political framework, Germany is positioned to be as the leader of a „low-carbon“ economy within the European Union.

1.2.2 Poland: Navigating the Green Transition

On the contrary, Poland represents an opposite case. Poland, historically, has had a strong presence with coal-powered power plants for energy. This, of course, resonates the number of jobs Poland's population has with the coal industry. The independence on coal has traditionally led to resistance from those regions with Green Deal legislations throughout the country.

The climate policy landscape in Poland has had its fair share of challenges and has ambitious targets in hopes to reach a „low-carbon“ economy. The Polish government has set a strategy, the National Energy and Climate Plan (NECP PL) in order to align itself with the EU's Green Deal initiative. Some goals such as reducing greenhouse gas emissions, increasing renewable energy share within the energy market and improving the energy efficiency in Poland (Jałowiec et al., 2021). Poland's heavy reliance on Coal Power in its energy mix poses as a potential problem into achieving the NECP goals. The coal industry in Poland has been a pivot in its economy providing jobs and economic stability in many regions (Jałowiec et al., 2021).

To tackle the challenges, the Polish government has addressed and implemented political initiatives in aim to promoting renewable energy. Poland has encouraged the use of Renewable Energy such as its support for renewable energy projects, utilizing feed-in tariffs, an equivalent approach that is seen in Germany, and incentivizes investment within the Renewable Energy sector. To add, the government has also launched a series of campaigns to improve energy efficiency in buildings such as the „Clean Air Program“ – which aims to substitute old heating systems with more environmentally-friendly alternatives (The Principles And Implementation Of The Countrywide Clean Air Programme In Poland, 2021).

Poland has made certain progress in Climate Policy; however, aligning most of its national policies with the European Green Deal remains a challenge obstacle. The continued reliance on coal and a political pushback on phasing out coal-powered power plants have raised concerns about meeting the Green Deal's targets. To add, Poland has opposed many initiatives brought forth by the European Union, such as the Carbon Border Adjustment Mechanism, has caused Poland to be isolated in its progress to achieve the EU's goals (Poland And The European Green Deal - Publications Office Of The EU, 2022).

There are vital opportunities for Poland to accelerate its transition to a low-carbon economy and align its national policies with the European Green Deal. Poland can start by continuing its investment in diversifying its energy portfolio and increase spend in renewable energy products, energy infrastructure, and increasing energy efficiency in its infrastructures. One of the main tasks with the Polish government is the need of support for those who work in the Coal industry and Coal Energy sector. Increased collaboration with the European Union and other regional stakeholders will be deemed to be essential in overcoming such barriers and creating new opportunities for regions that are heavily dependent on the Coal industry (Kierasiński, 2023). Despite Poland's challenges, recent political developments have suggested a „potential“ shift in Poland's environmental policies. The 2023 election had brought acknowledgment of the need to increase renewable energy diversification to align with the EU's Green Deal strategy. This commitment may potentially allow Poland to achieve the EU's target for a net-zero climate by 2050 (The European Green Deal – An Analysis Of Key Aspects, 2021).

1.2.3 The Role of Local Governments as Green Actors

Local policies across the European Union act as initiators for Climate policies. Such initiatives (ex. car-free zones) can be seen in many cities across the EU. Those policies may pave way and influence national policy changes. Local governments may share their initiatives and steps taken by assessing their effectiveness with other local governments and national policy makers (Multilevel Governance Is Key To EU's Climate Ambitions, 2023).

1.2.4 Germany's Local Governments Approach Towards the Green Deal:

Municipalities in Germany play a vital role in enacting the EU's Green Deal initiative by adopting policies which adhere to an environmentally-friendly urban development (The multi-level context for local climate governance in Germany: The role of the federal states, 2021). The initiatives are supported by strong political commitment and active citizen participation – Germany's commitment to climate protection.

Berlin, for example, has implemented the „Berlin Energy and Climate Protection Program“ (BEK) to address climate change and aims to reduce greenhouse gas emissions. The BEK aims to reach climate neutrality by 2050 by including initiatives such as enhancing energy efficiency in buildings, increasing renewable energy production, and promoting eco-friendly automobiles (The multi-level context for local climate governance in Germany: The role of the federal states, 2021)

The approach of Berlin for promoting eco-friendly transportation demonstrates its commitment on „green-infrastructure“ by creating cycling lanes and increasing its public transportation networks. Such policy not only reduces reliance on private automobiles, but also promotes other sustainable modes of transportation (Urban-Rural Cooperation for an Economy with 100% Renewable Energy and Climate Protection towards 2030-the Region Berlin-Brandenburg, 2023). Berlin, and other German cities, have implemented the „Climate Protection Program 2030“. The program aims to tackle climate change in accords to the Paris Agreement and the EU’s Green Deal Strategy by setting up ambitious targets by diversifying its renewable energy intake, increasing energy efficiency in buildings and infrastructure, and incentivizing sustainable transportational methods (Urban-Rural Cooperation for an Economy with 100% Renewable Energy and Climate Protection towards 2030-the Region Berlin-Brandenburg, 2023).

To add, Munich’s commitment to Climate Policy is apparent through the local governments initiatives such as the expansion of their public transportation networks, the utilization of electric buses, and promoting car-sharing services as means of transportations. Such measures will aid Munich to tackle its own problems such as traffic congestion, improving the city’s overall air quality, and increasing the quality of life of its residents (Urban-Rural Cooperation for an Economy with 100% Renewable Energy and Climate Protection towards 2030-the Region Berlin-Brandenburg, 2023).

To conclude, Germany’s approach to the European Union’s Green Deal Strategy at the Local Level promotes the importance of strong governmental policies and active citizen engagement in order to achieve the Green Deal. Such is achieved by diversifying the energy sector of German cities, increasing energy efficiency in infrastructure, and expand public transportation networks. Cities like Berlin and Munich serve as leaders for an effective Climate governance and Green Action.

1.2.5 Poland’s Local Government Green Deal Policies with Local Governments:

To the contrary of its national policies, Polish cities are increasingly enacting green initiatives into its laws. Polish cities have increased its investment with creating green spaces in urban areas by also promoting items which can be seen in German cities, such as increasing energy efficiency in the city’s infrastructure and creating bike lanes. Local efforts within Polish cities will apply pressure on the national government to apply green policies across the country (Kierasinski, 2023).

Several municipalities in Poland have already begun enacting green-deal strategies. The city of Krakow has implemented an urban mobility plan which aims to reduce the traffic congestion and

reduces air pollution all while promoting bike-sharing lanes and expanding its public transportation network. The city has also been actively engaging in „retrofit“ programs by replacing buildings with old technologies with those that are energy-efficient. The city of Wrocław has also seen an increase in green policies by advocating for „community-led“ renewable energy projects and by advocating for increased energy-efficiency in its infrastructure. (The Principles And Implementation Of The Countrywide Clean Air Programme In Poland, 2021)

Despite the work of some municipalities, local governments still face several challenges: bureaucratic obstacles, limited financial resources, legislation challenges, and minimal availability of technical expertise may delay further implementation of climate initiatives at the local level, Polish municipalities may overcome this obstacle by through collaboration and efficient financial mechanisms (Kierasiński, 2023).

1.2.6 German Linkages between Political Perspectives and Renewable Energy Transitions

Germany's ambitious "Energiewende," the transition towards a renewable energy-based future, is a complex undertaking shaped by a diverse political landscape. Different parties have varying stances on the pace, cost, and overall impact of this transition.

These parties, like the Greens ("Bündnis 90/Die Grünen") and The Left ("Die Linke"), advocate for a rapid departure from fossil fuels. They view renewable energies as the cornerstone of environmental and climate protection efforts. Their policies often prioritize ambitious targets for renewable energy expansion and stricter regulations on fossil fuel use (Jänicke et al. 2020). Beyond environmental benefits, they emphasize social justice concerns. The coal industry's decline could lead to job losses, and these parties advocate for government support and retraining programs to ensure a just transition for affected workers. They also see potential for job creation in the burgeoning renewable energy sector (Jänicke et al. 2020).

The Christian Democratic Union (CDU) and its Bavarian sister party, the Christian Social Union (CSU), generally support the energy transition but emphasize economic considerations. They advocate for a measured approach that balances environmental goals with maintaining a secure and affordable energy supply for businesses and consumers (Strum, C., 2020). The CDU/CSU worry about the rising costs of the Energiewende, particularly for households, and the potential impact on energy-intensive industries that are crucial to the German economy (Strum, C., 2020).

They often favor technological innovation to make renewables more cost-competitive, believing this will ease the transition for industry and consumers.

The Free Democratic Party (FDP) champions a market-oriented approach to the energy transition. They believe that fostering competition and technological innovation within the energy sector will drive down costs and accelerate progress. They are often skeptical of heavy government intervention and subsidies for renewable energy sources, arguing that market forces can deliver the most efficient solutions (Strum, C., 2020).

Lastly, the Alternative for Germany (AfD) is largely critical of the Energiewende. They view it as too expensive, unreliable, and disruptive to German industry. They often prioritize domestic fossil fuel sources and downplay the urgency of climate change concerns (Strum, C., 2020).

This spectrum of viewpoints can create political challenges for the Energiewende. Reaching compromises and establishing long-term, multi-party strategies are crucial for achieving Germany's ambitious goals (Strum, C., 2020). Finding a balance between environmental protection, economic growth, and social justice remains a key challenge in navigating the energy transition.

1.2.7 Poland's linkages between Political Perspectives and Renewable Energy Transitions

Historically, Poland has been heavily dependent on coal for energy production, a legacy of its industrial base and economic policies during the communist era. This reliance on coal is not only an economic issue but also a politically charged topic, deeply entwined with national identity and employment in coal mining regions. The coal sector is a significant employer and has been a cornerstone of Poland's energy security strategy. Consequently, political parties and leaders have often been cautious about rapid transitions away from coal, fearing social and economic disruptions (International Trade Administration, 2023).

For decades, Law and Justice (PiS), the current governing party, has championed coal, the lifeblood of Polish industry and a significant source of jobs, particularly in Silesia (International Trade Administration, 2023). This stance resonates with a segment of the population who fear the economic consequences of a rapid shift. PiS, which has been in power since 2015, has had a particularly complex relationship with renewable energy. The party has generally prioritized energy security and economic stability over aggressive climate action. This stance is partly due

to concerns over the potential impact of rapid energy transitions on coal-dependent regions and the national economy.

Despite the conservative government's cautious approach, there has been progress in Poland's renewable energy sector. This progress is driven by a combination of EU regulations, economic incentives, and growing public awareness of environmental issues. Poland's obligations under the EU's climate policies, including the European Green Deal, have compelled the government to acknowledge the necessity of transitioning to cleaner energy sources. However, the environmental costs of coal combustion and the global push for decarbonization have forced PiS to acknowledge the need for change. Their recent endorsement of nuclear power and a revised target for renewables (51% by 2040) suggest a grudging acceptance of a more diversified energy mix. But the pace and extent remain debatable, as evidenced by PiS's continued emphasis on domestic coal use (Jänicke et al. 2020).

Political debates in Poland often reflect a tension between national interests and EU directives. While the government recognizes the need to comply with EU climate goals, there is a persistent narrative that emphasizes energy sovereignty and the protection of domestic industries. This narrative is especially strong among conservative and nationalist factions, who argue that EU climate policies could undermine Poland's economic autonomy and burden its industries

Opposition parties, particularly Green parties, represent a stark contrast. They strongly advocate for a rapid transition away from fossil fuels and view renewables as the cornerstone of a sustainable future (Jänicke et al. 2020). They highlight the health benefits of cleaner air and the potential for job creation in the burgeoning renewable energy sector (Jänicke et al. 2020). However, their ambitious plans often clash with the economic concerns of PiS voters and the practical challenges of grid modernization and ensuring a smooth energy transition for coal-reliant regions (Ember Climate, 2024).

The geopolitical dimension also plays a role in Poland's energy policy. Concerns about dependence on Russian gas have made energy diversification a strategic priority. This has encouraged some degree of investment in renewables as a means of reducing reliance on external

energy sources. However, this geopolitical rationale often competes with domestic political concerns about the economic impact of moving away from coal (Jänicke et al. 2020).

In conclusion, the linkage between political perspectives and renewable energy transitions in Poland is shaped by a complex set of factors. These include economic dependencies, historical legacies, EU regulations, and geopolitical considerations. While there is growing recognition of the need for renewable energy development, the pace and extent of this transition are heavily influenced by political dynamics. Poland's future energy landscape will depend on how these political, economic, and environmental considerations are balanced in the coming years.

1.3 Alignment with the European Union's Green Deal

1.3.1 Germany's Alignment with the European Union's Green Deal: Opportunities, Challenges, and Impacts

The European Union's Green Deal, unveiled in 2019, is a transformative roadmap aiming to make the EU the world's first climate-neutral continent by 2050. This ambitious plan necessitates the concerted efforts of all member states, and Germany, as the EU's economic powerhouse, plays a crucial role in its success (Cifuentes-Faura, 2022). Germany has broadly aligned itself with the Green Deal's goals. It has committed to achieving climate neutrality by 2045, five years ahead of the EU's target. This ambition is reflected in its national climate action plan, which outlines strategies for decarbonizing various sectors like energy, transportation, and industry.

Germany is a leader in renewable energy, with ambitious targets to increase its share in the energy mix to 80% by 2030. The country invests heavily in wind, solar, and biomass power generation. Germany plans to phase out coal-fired power plants by 2038, accelerating the transition towards cleaner energy sources (Scholz, 2024). The German government is actively promoting electric vehicles (EVs) through financial incentives and investments in charging infrastructure. The aim is to have 15 million EVs on the road by 2030 (Scholz, 2024).

Germany has set ambitious targets for improving energy efficiency in buildings and industries, reducing energy consumption and saving costs. The transition to a green economy is expected to generate millions of new jobs in renewable energy, energy efficiency, and green technologies. Germany is well-positioned to become a global leader in developing and deploying clean technologies, strengthening its competitive edge. Reducing greenhouse gas emissions will lead to cleaner air, benefiting public health and reducing healthcare costs (Scholz, 2024).

Despite its alignment and ambitious goals, Germany faces challenges in implementing the Green Deal. The transition to a green economy requires significant investments, which can strain public finances and raise concerns about affordability for citizens and businesses.

The shift away from fossil fuels could lead to job losses in affected industries, necessitating effective reskilling and social safety net programs (Kenneth et. Al, 2019) Integrating large-scale renewable energy sources into the grid requires significant upgrades, which can be time-consuming and expensive. Not all sectors of the population are equally enthusiastic about the Green Deal, and concerns about potential negative impacts need to be addressed.

Germany's alignment with the European Union's Green Deal is a positive step towards a more sustainable future. The country's ambitious goals, policy initiatives, and focus on renewable energy and energy efficiency hold significant promise for economic growth, job creation, and environmental benefits. However, challenges related to costs, social impacts, and infrastructure need to be carefully addressed to ensure a just and equitable transition for all. By successfully navigating these challenges and capitalizing on the opportunities, Germany can solidify its position as a leader in the global green economy, inspiring other countries to follow suit.

1.3.2 Poland's Alignment with the European Union's Green Deal: Balancing Challenges and Opportunities

Poland's relationship with the European Union's Green Deal initiative is complex, marked by both alignment and divergence. While Poland acknowledges the urgency of climate action and has committed to achieving climate neutrality by 2050, its heavy reliance on coal-based energy and concerns about social and economic impacts present significant challenges. (Agnieszka, 2022).

Poland adopted its own National Energy and Climate Plan (NECP PL) in 2021, broadly aligned with the Green Deal's objectives. The NECP PL outlines plans to increase renewable energy use, modernize energy infrastructure, and improve energy efficiency.

There is a significant beneficiary of the EU's Just Transition Fund, established to support coal-dependent regions in adapting to a low-carbon economy. These funds can be used for diversification, retraining, and social safety nets (Pluta, 2019).

Poland remains heavily reliant on coal for electricity generation, accounting for over 70% of its energy mix. Phasing out coal will be a major challenge, requiring significant investments in

alternative energy sources and managing the social and economic consequences for coal-mining communities. There is some political resistance to the Green Deal within Poland, particularly from factions concerned about the potential economic impacts on jobs and energy affordability. This can hinder the implementation of ambitious climate policies. Ensuring a just transition that protects vulnerable communities and workers is crucial for public support of the Green Deal in Poland. Addressing concerns about job losses and energy security will be essential for building consensus (Poland And The European Green Deal - Publications Office Of The EU, 2022).

Transitioning to a green economy presents an opportunity for Poland to modernize its energy infrastructure, attract new investments, and create new jobs in sustainable sectors. By reducing its reliance on coal, Poland can improve air quality, reduce greenhouse gas emissions, and contribute to combating climate change.

Poland's path towards climate neutrality under the Green Deal will require careful planning, significant investments, and effective communication with stakeholders. Overcoming the challenges of coal dependence and ensuring a just transition will be crucial for success. However, the potential economic and environmental benefits, as well as the opportunities for international cooperation, make the Green Deal a worthwhile endeavor for Poland.

To conclude, Poland's alignment with the Green Deal is complex, with both areas of cooperation and challenges. The country's heavy reliance on coal and concerns about social and economic impacts present significant challenges. However, the Green Deal also offers opportunities for economic modernization, environmental benefits, and international cooperation. Successfully navigating this transition will require careful planning, significant investments, and effective communication with stakeholders.

The study employs a comparative case approach to investigate the degrees of feasibility for the transition of Germany and Poland from Fossil Fuels to Green Energy to comply with the EU's Green Deal Strategy. This study will extract information from various Political and Non-Government Reports to provide an understanding on how the two countries react towards the Green Deal and if it could be achievable.

2 Methodology

In this chapter, the methodology used to conduct a comparative analysis of Germany and Poland's transition from fossil fuels to renewable energy will be reviewed and detailed. It explores political, financial, and technological factors affecting the transition and projects the feasibility of both countries achieving their 2050 net-zero emissions targets based on current and historical data. The approach includes collecting data, examining potential biases in reports, and conducting a comparative study applying time frame analysis.

2.1 Research target

The research target is to assess the feasibility of Germany's and Poland's transition from fossil fuels to renewable energy within the context of the European Green Deal. The research addresses the following questions:

- What are the key political factors influencing the feasibility of Germany's and Poland's transitions from fossil fuels to renewable energy since 2000s? (Q1)
- How have financial conditions, including investment levels and funding sources, evolved in Germany and Poland regarding renewable energy adoption over the past two decades? (Q2)
- In what ways have technological advancements impacted the feasibility of transitioning to renewable energy in Germany and Poland from 2000s to the present? (Q3)

In terms of the first research question, we are primarily interested in investigating the key political factors influencing the feasibility of Germany's and Poland's transitions from fossil fuels to renewable energy. This analysis will be guided by theories of policy change and stakeholder theory. To gather relevant data, we will collect governmental and non-governmental reports that detail energy policies, legislative changes, and stakeholder involvement since the turn of the century. We will examine the roles of key stakeholders, including government bodies, industry representatives, and civil society organizations, applying stakeholder theory to assess how these actors have shaped policy development and impacted renewable energy initiatives. Lastly, we will evaluate political commitment and stability regarding energy transition initiatives in both countries.

To answer the second research question, we need to gather historical data on investment levels and funding sources from reliable sources. Next, analyze investment trends by comparing annual levels and noting significant changes. Identify and categorize funding sources and assess how policies and regulations have influenced investments. Investigate market developments and their impact on renewable energy investments. Compare the financial conditions and funding sources between Germany and Poland and summarize the key findings.

To answer the third research question, we will identify key technological advancements in renewable energy from the 2000s to the present. We will gather data on how these advancements have impacted feasibility, focusing on efficiency improvements and cost reductions. We will compare the effects in Germany and Poland by reviewing case studies and market trends. We will also assess how these technologies have influenced policies and investments and then we will summarize the key findings.

2.2 Dependent and Independent Variables

In the research questions posed above, we identify that the dependent variable is the progress in renewable energy transition. This is measured by indicators such as the renewable energy capacity derived from renewable sources, reduction in greenhouse gas emissions, and public support in renewable energy. These indicators provide a comprehensive picture of how each country is advancing towards its renewable energy targets, enabling a detailed comparative analysis.

The independent variables in this study are categorized into political factors, financial conditions, and technological advancements. Political factors play a crucial role in shaping the energy policies of a country. This includes government policies and regulations supporting renewable energy, which can either accelerate or slow-down progress. Political stability and government commitment to the energy transition are also critical, as consistent and long-term policies are necessary for substantial progress. Additionally, the influence of political parties and public opinion on energy policies can significantly affect the direction and speed of the transition.

Financial conditions include various aspects, such as diversification of funding sources and renewable energy investments. The availability and sources of funding, such as EU grants, national subsidies, and private investments, are essential for supporting these projects. The financial health and investment landscape of a country is directly impacted by its ability to pursue and sustain renewable energy projects.

Technological advancements refer to innovations in renewable energy technologies. This includes advancements in solar, wind, and storage technologies, which can significantly enhance the efficiency and effectiveness of renewable energy systems. The availability and adoption of new technologies in the energy sector are also crucial, as they can provide more sustainable and cost-effective solutions. Research and development expenditure in renewable energy technologies is another important factor, as it drives innovation and helps overcome technical challenges.

Social factors involve public perception and acceptance of renewable energy. The influence of traditional energy sectors and employment concerns can create resistance to change, as communities that rely on fossil fuel industries may oppose the transition. The role of social awareness can influence a push for policy changes.

Infrastructure and grid integration factors encompass the existing energy infrastructure and its capacity to integrate renewable energy. The technological readiness of the grid to handle intermittent renewable sources is crucial, as effective integration is necessary for a stable and reliable energy supply.

2.3 Methodological Approach

To conduct the comparative analysis, the framework involves several steps. First, the study will assess the dependent variable by measuring and comparing the progress in renewable energy transition in Germany and Poland. This involves a detailed examination of the indicators mentioned earlier, providing a clear picture of each country's advancements. Next, the study will analyze the independent variables to evaluate the impact of political factors, financial conditions, and technological advancements on the energy transition in both countries. This analysis will involve a thorough examination of the policies, financial landscapes, and technological innovations in each country, identifying the key drivers and barriers to progress. By examining these variables, the study will identify the specific challenges and opportunities faced by each country, providing a clear understanding of the factors influencing their progress.

By integrating this framework into the methodology, the study aims to provide a rigorous and systematic approach to understanding the multi-layered dynamics of Germany and Poland's transition to renewable energy. This structured analysis will highlight the different factors that influence the feasibility of achieving the 2050 targets and offer insights into the necessary policy adjustments and strategic initiatives. The goal is to provide a comprehensive and detailed

comparative analysis that can inform future policy decisions and support the successful transition to renewable energy in both countries.

2.4 Data Collection

The primary source of data for this thesis has been a combination of government reports, industry publications, and academic studies. These sources provide comprehensive insights into renewable energy investments, technological advancements, and policy impacts in Germany and Poland.

Government reports offer official statistics and policy updates, while industry publications deliver current trends and market analysis. Academic studies contribute theoretical perspectives and detailed case studies.

Data collection involved reviewing these sources for relevant information, focusing on investment levels, technological developments, and funding mechanisms. Special attention was given to cross-referencing data to ensure accuracy and address potential biases.

The collected data was then organized and analyzed to identify patterns and trends over time, facilitating a thorough comparison between the two countries.

Author + Year Published	Publication Summary	Category (Non-Government Report/Government Bodies Report)
Hansen, K., et al. (2019)	Complete Energy System Transition to 100% Renewable Energy in Germany by 2050	Non-Government Reports
Perez, M., et al. (2019)	Speeds of Energy Transition in Europe: Opportunities and Challenges for EU Energy Security	Non-Government Reports
Pluta, M., et al (2019).	An Analysis of Poland's Integrated National Energy and Climate Plan for 2021-2030	Non-Government Reports
Petri, F. (2020)	The Role of Diplomacy in EU's Climate and Energy Policies, with a Focus on the EU's Green Deal Strategy	Non-Government Report
Jałowiec, T., et al. (2021)	Green Energy Management in the EU, focusing on Poland and Germany	Non-Government Reports
The European Green Deal – An Analysis Of Key Aspects (2021)	An analysis of the European Green Deal, including its impact on energy policies and environmental strategies.	Government Bodies Report

Multi-Level Governance In (Climate) Action (2021)	Analysis of the importance of multi-level governance in the EU for addressing climate change at various administrative levels.	Government Bodies Report
Mazurek-Czarnecka, A., et al. (2022)	Explores the various support mechanisms for renewable energy in Poland	Non-Government Reports
Perissi, I., et al (2022).	EU decarbonization strategies and pathway to carbon neutrality by 2050	Non-Government Reports
Publications Office Of The European Union (2022)	Explores Poland's stance and initiatives in adopting the European Union's Green Deal strategy and its implications for energy transition.	Non-Government Report
Ślosarski, R. (2023)	Non Government report on the EU's track towards Renewable Energy.	Non-Government Reports
European Parliament. Energy Transition in the EU (2023)	Discusses the energy transition in the EU, including policies and strategies to shift toward a low-carbon economy.	Government Bodies Report
Multilevel Governance Is Key To Eu's Climate Ambitions (2023)	Discusses the importance of multilevel governance in achieving the European Union's climate ambitions.	Government Bodies Report
Mckinsey (2023)	Identifies crucial obstacles to Europe's energy transition, including policy implications and challenges.	Non-Government Report

Bundesnetzagentur and Bundeskartellamt (2023)	Annual monitoring report published by the the Federal Network Agency and the Federal Cartel Office (Bundesnetzagentur and Bundeskartellamt) for an overview of Germany’s energy transition, focusing on policy measures and future plans.	Government Report
Ministerstwo Klimatu i Środowiska (2023)	Poland’s National Energy and Climate Plan for the years 2021-2030 (NECP PL) which outlines the steps and measures Poland must take for its climate change policies set by the EU	Government Bodies Report
Wiertz, T., et al .(2023)	An academic paper focusing on the geopolitical impacts of Germany’s energy transition in light of the war against Ukraine.	Non-Government Report
Scholz, L. (2024)	Academic Paper focusing on Germany’s strategy between its EU targets and Economic Freedom.	Non-Government Report
Strum, C. (2020)	A history on Germany’s political path towards the Energiewende	Non-Government Report
Gawlikowska-Fyk, A. (2019).	Coping with the challenges of decarbonization and diversification in Poland	Non-Government Report

Table 1: Sources of Data

The data that was chosen is from both Non-Government Reports and Government Bodies Reports. The sources provided can provide vital detail and insight towards the feasibility of Germany and Poland towards the green deal. However, a concern that there may be a fact that the data could be biased. An example could be found in sources that come from specific governmental agencies or political entities. In particular, the sources that are heavily focused on policy advocacy that is aligned with the current governments agenda or national interest.

For example, Poland's National Energy and Climate Plan (NECP PL) outlines ambitious goals for renewable energy adoption and measures needed to be taken in order to fulfill the requirements set by the European Commission. However, the report „Challenges and Barriers to Renewable Energy Adoption in Poland“ explains that such policies highlighted by the Polish government will be challenging. Changes in legislation, such as feed-in tariffs for solar energy, have discouraged investment in Solar energy infrastructure (Agnieszka, 2022) which is not mentioned in the NECP PL. To add, the report mentions that the current grid in Poland cannot possibly handle the increase in renewable energy capacity as it is envisioned in the NECP PL, this may potentially slow down any progress. There may be a risk that the sources chosen may have a more favourable, or selective, viewpoint in regards to the policy positions. The NECP PL report may not fully address contrasting perspectives from other environmental, or political agencies. However, independent institutions (Academics, Non-Government Bodies) may offer a balanced assessment to the Polish approach to its climate policies and energy governance.

Another example is the government report by the Bundesnetzagentur and Bundeskartellamt (2023) discusses the progress and success of Germany's energy transition by detailing the steps implemented by the government to ensure a secure and environmentally friendly way of energy supply while also emphasizes the achievements and positive developments in its policy. However, a non-governmental source „A turn to geopolitics: Shifts in the German energy transition discourse in light of Russia's war against Ukraine (2023) by author Thilo Wertz offers a different perspective on Germany's energy transition. It argues that the impact of the war in Ukraine has exposed Germany's vulnerability in its energy policy – particularly in its dependency on Russian energy and has created challenges for its transition to renewable energy (Wiertz, 2023). The report showcases complications that are not fully addressed in the monitoring report by the Bundesnetzagentur and Bundeskartellamt

Government reports may be biased as energy policies change depending on the environmental and geopolitical events that are taking place. For example, in 2006, German Chancellor Angela Merkel had stressed it will be „absurd“ to shut down technologically safe nuclear power plants that do not emit Carbon-Dioxide (BIG THINK, 2021). However, in 2011, three days after the Fukushima Nuclear Power Plant disaster, Angela Merkel announced that Germany will be suspending its extension to operating live nuclear power-plants following the catastrophe that had taken place in Japan. Three months later, the German government voted to phase-out Nuclear Power by the end of 2022 (Stanford University, 2021). Another example, as mentioned above, is the war in Ukraine as it had exposed Germany’s vulnerability in its energy policy – particularly in its dependency on Russian gas (Wiertz, 2023). No matter how optimistic government reports may provide as a „future outlook“, current geopolitical events can challenge plans laid-out by governments and ultimately cause delays in achieving certain political and environmental targets.

3 Comparative Data Analysis:

The following section will discuss the results of the thesis by utilizing a comparative case study approach. The section will first define feasibility based on three main factors: political, financial, and technological feasibility. Secondly, I will dive into the key policy milestones, financial investments in the renewable energy sector, and the technological advancement of both Germany and Poland in the past 20 years.

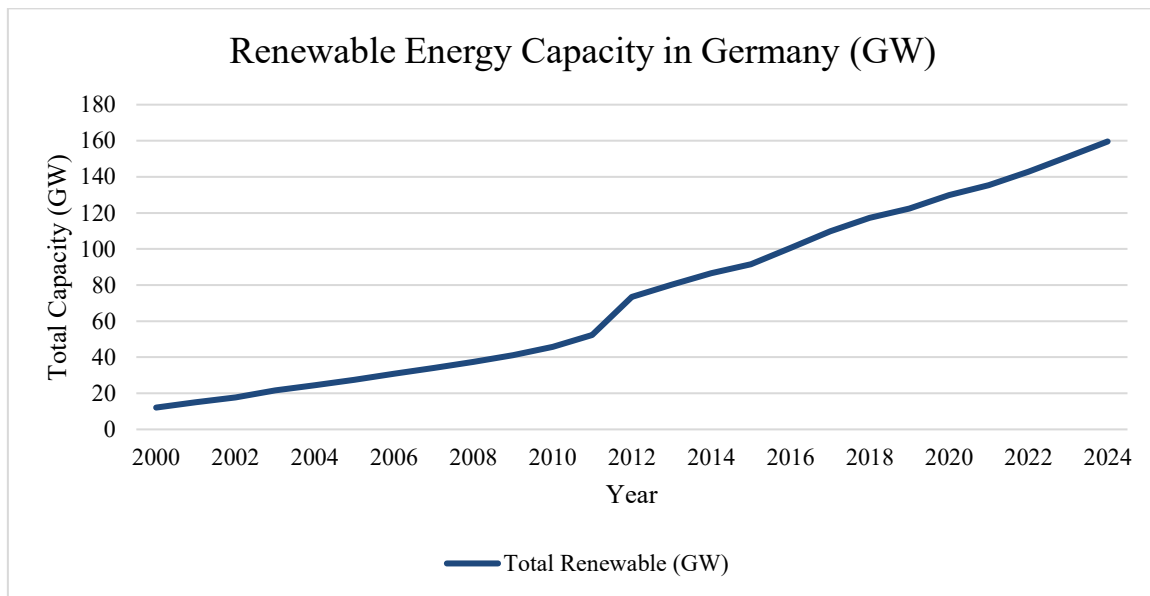
3.1 Political Feasibility for Germany and Poland

The transition from fossil fuels to green energy in Germany and Poland by 2050 is significantly influenced by several key political factors, including legislation, government alliances, and public opinion. These elements collectively shape the direction and efficacy of energy policies within both nations.

Germany has been at the forefront of the green energy transition, primarily driven by its *Energiewende*—a comprehensive policy framework aimed at transforming the country's energy system. Central to this transition was the Renewable Energy Sources Act (EEG) of 2000, which introduced feed-in tariffs that provided stable revenue streams for renewable energy producers. This legislative move stimulated significant investments in wind, solar, and biomass technologies, substantially increasing Germany's renewable energy capacity

and setting a global benchmark (Hansen, K., 2019). The EEG was pivotal in expanding Germany's renewable energy capacity.

The following table illustrates the growth in renewable energy capacity from 2000 to 2020:



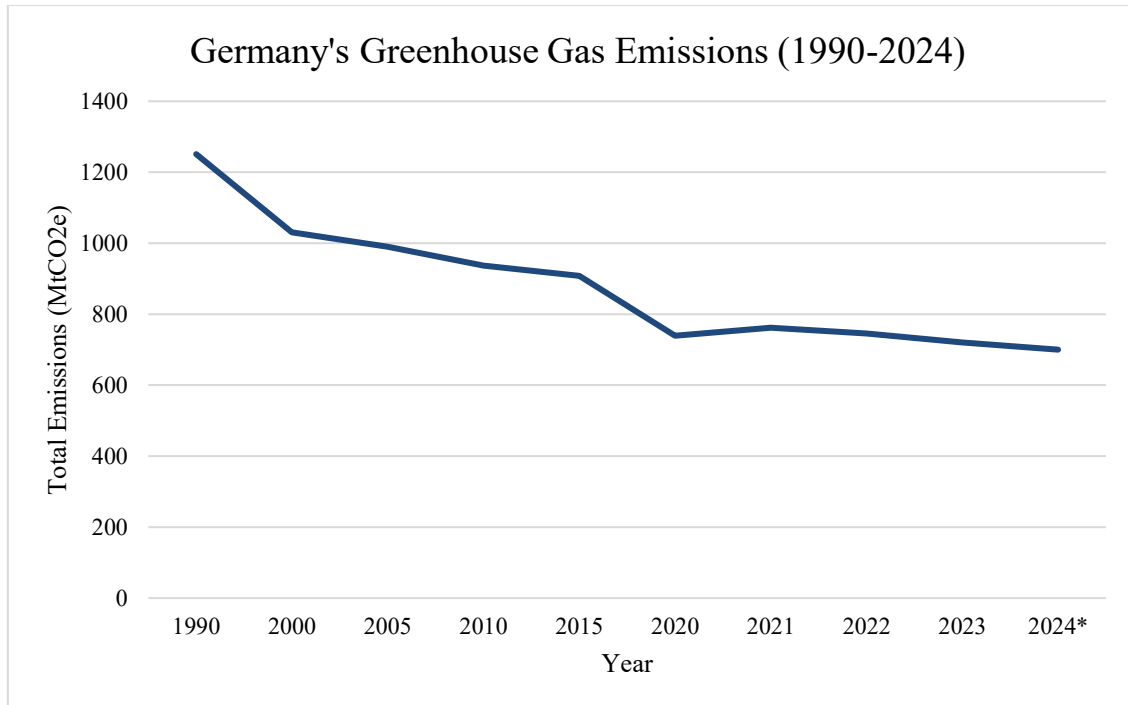
Source (BMWi, 2024)

Figure 1: Growth of Renewable Energy Capacity in Germany (2000-2024)

In 2002, Germany took a decisive step by committing to phase out nuclear power, planning to decommission all nuclear plants by 2022. This decision was a direct response to public opposition to nuclear energy, driven by environmental concerns, which necessitated redirecting efforts and resources towards developing alternative clean power sources (Bundesnetzagentur and Bundeskartellamt, 2023).

Germany's legislative efforts continued with the Climate Action Plan 2050, introduced in 2016. This comprehensive plan outlined strategies to reduce greenhouse gas emissions by 80-95% by 2050 compared to 1990 levels, setting sector-specific targets and measures for energy, industry, transportation, and buildings (Jałowiec, T, 2021). The Coal Phase-Out Law of 2020 mandated the closure of coal-fired power plants by 2038, accompanied by substantial funding to support coal-dependent regions, thereby balancing environmental objectives with social and economic stability (Bundesnetzagentur and Bundeskartellamt,

2023). The Climate Action Plan 2050 sets ambitious targets for reducing greenhouse gas emissions. The chart below illustrates Germany's progress in reducing emissions:



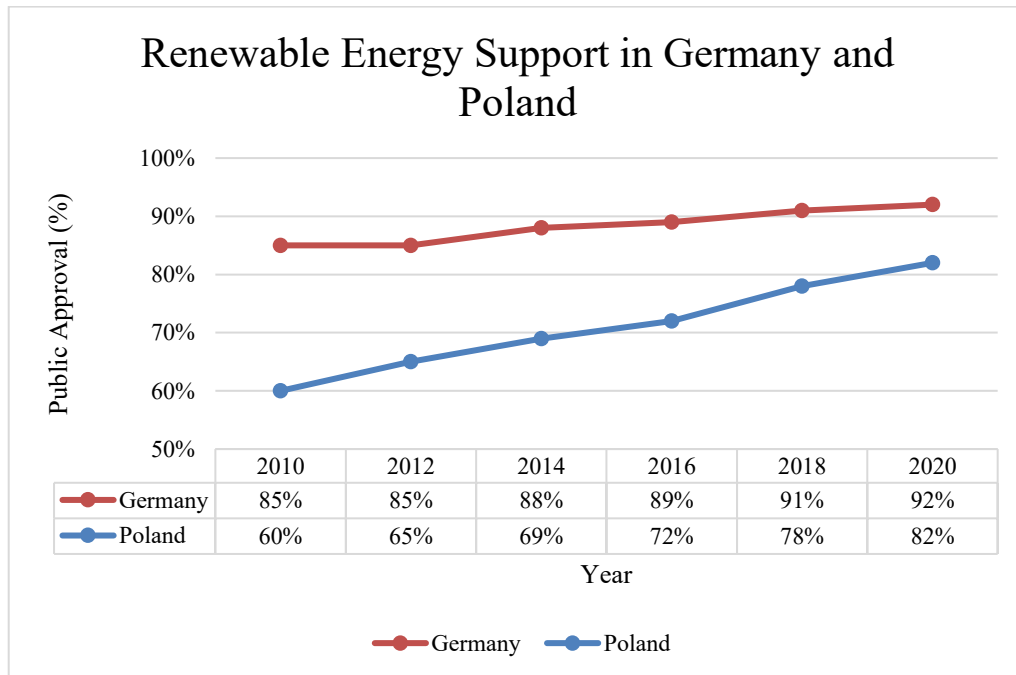
Source (BMWi, 2024)

Figure 2: Germany's Greenhouse Gas Emissions (1990-2024)

Government coalitions in Germany have consistently supported renewable energy policies. The SPD-Green coalition from 1998 to 2005 laid the groundwork for the Energiewende, enacting key legislation focused on renewable energy and environmental protection (Petri, F., 2020). This momentum continued under Chancellor Angela Merkel's leadership, with CDU/CSU-SPD coalitions maintaining political stability and facilitating gradual advancements in the energy transition amidst complex economic and social challenges. The current SPD-Green-FDP coalition, formed in 2021, has placed climate action at the forefront of its agenda, emphasizing renewable energy expansion and economic modernization (Strum, 2023).

Public opinion in Germany has consistently supported renewable energy, with surveys indicating widespread approval for policies promoting wind and solar energy. Environmental concerns and growing awareness of climate change have fueled this support, creating a conducive environment for ambitious energy policies (Jänicke, 2020). The

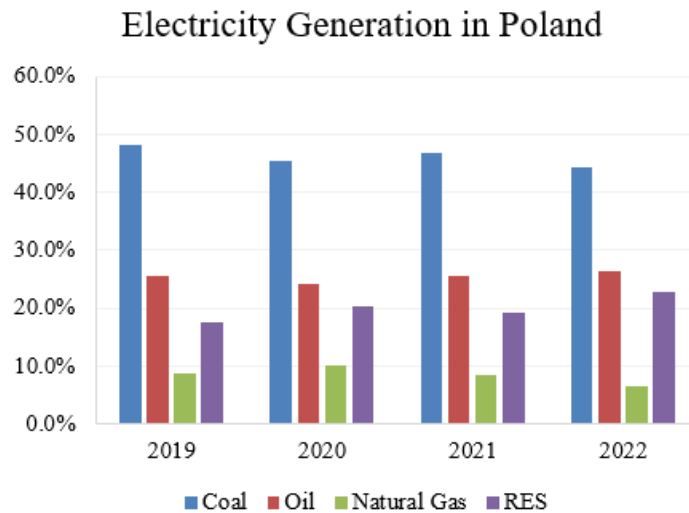
public's long-standing opposition to nuclear energy intensified following the Fukushima disaster in 2011, while increasing awareness of coal's environmental impact has accelerated the push for a rapid transition to renewable energy (Jänicke, 2020). Surveys below taken from various sources indicate strong public support for renewable energy in Germany:



Germany Sources (BMW, TNS, AEE, UBA, Kantar Emnid, EIB)
 Poland Sources (MoCE-Poland, CBOS, IEO, MoE-Poland)

Figure 3: Public Perception of Renewable Energy in Germany and Poland (2010-2020)

In contrast to Germany, Poland has faced significant challenges in its energy transition. The Renewable Energy Act of 2015 aimed to align with EU directives by introducing feed-in tariffs and auction systems to promote renewable energy development. However, implementation was hindered by political resistance and economic concerns, exacerbated by Poland's heavy reliance on coal and the powerful influence of the coal industry (Kuchler, 2015).



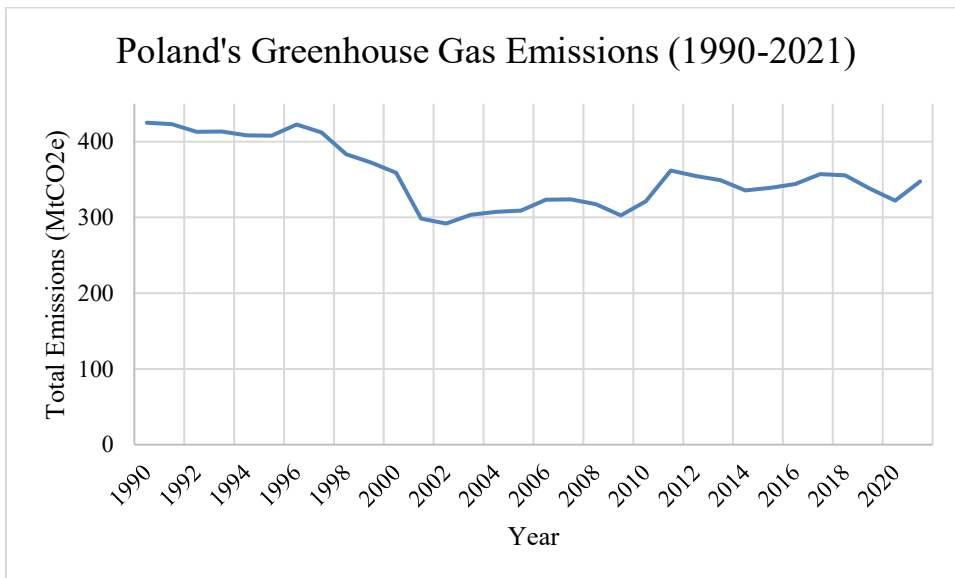
Source (Forum Energii)

Figure 4: Share of Electricity Generation in Poland (2019-2022)

Poland's Energy Policy until 2040 (PEP 2040), announced in 2021, outlines the country's strategy for reducing coal consumption, expanding renewable energy capacity, and ensuring energy security. This comprehensive plan marks a significant shift in Poland's approach to energy, recognizing the urgent need to transition from its long-standing dependence on coal to more sustainable energy sources.

PEP 2040 aims to reduce the share of coal in electricity generation from over 70% to as low as 11% by 2040, depending on various scenarios, while increasing the share of renewable energy in the energy mix to at least 23% by 2030. The plan includes substantial EU funding to support this transition, reflecting a compromise between economic, environmental, and social considerations (Ślosarski, 2023). Under the PEP 2040 framework, the Polish government is committed to expanding renewable energy sources such as offshore wind and solar power, while also exploring nuclear energy as a potential component of the future energy mix. The policy recognizes the importance of modernizing the energy infrastructure, enhancing energy efficiency, and investing in new technologies to achieve a sustainable and secure energy future. Additionally, the plan includes measures to support regions and communities affected by the coal transition, ensuring a just transition for workers and minimizing social disruption (Ślosarski, 2023).

Poland's role in decreasing greenhouse gas (GHG) emissions from 1990 to the present has been a crucial aspect of its climate strategy, particularly in alignment with the European Union's Green Deal. In the 1990's Poland's GHG emissions were around 473 MtCO₂e, this alarming number was mainly due to the country's heavy reliance on Coal (IEA, 2023). By the early 2000's we can see that Poland's emissions decreased to about 370 MtCO₂e, this was largely due tot the closures of several industrial facilities – not related to any environmental initiatives (IEA, 2023). However, last couple of years (from 2019) Poland has seen an increased invesetment in renewable energy resources, this had allowed the Greenhouse gas emissions to drop to approximately 380 MtCO₂e in 2021. This slow decline is promising, as it aligns to Poland's commitment to the EU's Green Deal strategy and its PEP 2040 vision (Ślosarski, 2023).



Source (ClimateWatchData)

Figure 5: Poland's Greenhouse Gas Emissions (1990-2021)

Overall, PEP 2040 represents a significant step forward in Poland's energy transition, aligning with EU climate objectives while addressing the country's unique economic and social challenges. The plan underscores the importance of a balanced approach that considers the needs of various stakeholders, paving the way for a more sustainable and resilient energy system in Poland.

Government coalitions in Poland have also played a significant role in shaping the country's energy policies. The Democratic Left Alliance (SLD) governments from 2000 to 2005

prioritized EU accession and economic stabilization, taking initial steps towards aligning with EU energy policies but facing challenges due to Poland's heavy reliance on coal. This period marked the beginning of Poland's efforts to diversify its energy sources and comply with EU regulations, though progress was slow due to economic constraints and the social importance of the coal industry (Gawlikowska-Fyk, 2019). The Civic Platform (PO) governments from 2007 to 2015 continued to support EU integration and climate policies, promoting renewable energy and environmental protection. However, they encountered significant obstacles in reducing coal dependency due to economic and social factors, including the strong influence of coal unions and the socio-economic implications of transitioning away from coal in coal-dependent regions. This era highlighted the complex interplay between environmental goals and economic realities, as the government sought to balance EU climate commitments with domestic priorities (Gawlikowska-Fyk, 2019)

The current Law and Justice (PiS) government, in power since 2015, has prioritized economic nationalism and energy security, adopting a more cautious approach towards the renewable energy transition. PiS's energy policies reflect a balance between meeting EU climate targets and safeguarding domestic economic interests, with a strong focus on energy security and the socio-economic impact of energy transitions. The PiS government has emphasized the need for a pragmatic approach that considers Poland's economic conditions and energy security requirements, leading to a more gradual shift towards renewable energy sources (Gawlikowska-Fyk, 2019).

Unlike Germany, the public opinion in Poland is heavily influenced by the economic significance of coal, particularly in regions heavily dependent on the industry. Concerns about job losses and economic stability have shaped attitudes towards renewable energy policies, making it difficult to garner widespread public support for a rapid energy transition (Szulecki, 2019). Nevertheless, growing public awareness of climate change and environmental degradation is gradually shifting opinions in favor of renewable energy as shown in Figure 3. Younger generations, in particular, exhibit stronger support for green energy policies, indicating a gradual evolution in public opinion toward greater acceptance of renewable energy as environmental concerns become more pressing (CIVICUS, 2020).

The political feasibility of transitioning from fossil fuels to green energy by 2050 in Germany and Poland is shaped by a complex interplay of legislative actions, government coalitions, and public opinion. Germany's consistent legislative framework, stable coalitions,

and strong public support have propelled its progress, making it a leader in renewable energy transition. In contrast, Poland's transition is hindered by economic dependence on coal, political resistance, and slower legislative implementation. However, the influence of the EU and growing environmental awareness offer potential pathways for change in Poland.

3.2 Financial Feasibility for Germany and Poland

The transition from fossil fuels to green energy by 2050 presents both significant challenges and opportunities for Germany and Poland. The financial feasibility of this transition is a critical aspect that involves analyzing investment requirements, potential economic benefits, funding sources, and financial incentives. While both countries have committed to reducing their carbon footprints, the pathways they are taking differ due to their unique economic contexts and energy landscapes.

Germany's ambitious *Energiewende*, or "energy transition," demands substantial investments across various sectors, including renewable energy infrastructure, energy efficiency, and grid modernization. According to the German Institute for Economic Research (2020), Germany will need approximately €1.1 trillion in investments between 2020 and 2050. This includes €550 billion for renewable energy, €400 billion for energy efficiency improvements, and €150 billion for modernizing the energy grid. The Renewable Energy Sources Act (EEG) of 2000 played a crucial role in promoting investments. It guaranteed feed-in tariffs (FiTs) for renewable energy producers, providing a stable and attractive return on investment. This policy led to a surge in investments from both domestic and international investors, with significant contributions from private equity, institutional investors, and state-owned enterprises – increasing the capital flow into the sector.

Year	Government & Public Funding (€ billion)	Private Sector (€ billion)	Bank Financing (€ billion)	EU & International Funding (€ billion)	Green Bonds & Capital Markets (€ billion)	Total Investment (€ billion)
2010	8.50	4.20	5.00	2.00	0.50	20.20
2011	8.90	4.60	5.40	2.20	0.60	21.70
2012	8.30	5.00	5.80	2.40	0.70	22.20
2013	7.80	5.50	6.10	2.50	1.00	22.90
2014	7.20	6.00	6.50	2.60	1.20	23.50
2015	6.90	6.80	7.00	2.80	1.60	25.10

2016	6.50	7.50	7.50	3.00	2.00	26.50
2017	6.20	8.10	8.00	3.10	2.40	27.80
2018	6.00	9.00	8.50	3.30	2.90	29.70
2019	5.80	10.00	9.00	3.50	3.50	31.80
2020	5.50	11.20	9.50	3.80	4.00	34.00

Source (BMW, BloombergNEF, IEA, KfW)

Table 1: Diversification of Funding Sources in Germany (2010-2020)

From 2010 to 2020, Germany witnessed a steady increase in investments, with contributions from a variety of sources – in accordance to Table 1. In 2010, the total investment in the energy transition was approximately €20.20 billion, with around €8.50 billion coming from government and public funding and €4.20 billion from the private sector. By 2020, the total investment had nearly doubled to €34.00 billion, with a notable increase in contributions from private sector investments (€11.20 billion) and green bonds and capital markets (€4.00 billion). This diversification of funding sources highlights the support for Germany's energy transition, involving both public and private stakeholders (BMW, 2024).

As of the early 2020s, Germany continues to lead in renewable energy investments, The financial landscape is characterized by increasing investments in innovative technologies such as offshore wind and hydrogen. Looking towards 2050, Germany is likely to continue its trajectory of high investment levels, driven by ambitious climate targets and the European Green Deal. The financial sector is expected to play a pivotal role, with green finance becoming mainstream and new funding mechanisms such as climate funds and impact investing gaining prominence (McKinsey, 2023).

Poland's energy transition requires around €490 billion during the same period, with €240 billion allocated to renewable energy, €150 billion for energy efficiency, and €100 billion for grid modernization (Ministerstwo Klimatu i Środowiska, 2021). These figures underscore the substantial financial commitments needed to shift away from coal dependency towards a more sustainable energy mix.

Despite the high initial costs, the transition to renewable energy offers substantial long-term economic benefits. In Germany, the renewable energy sector is projected to create approximately 500,000 new jobs by 2050, compensating for the decline in fossil fuel industries (McKinsey, 2023). Moreover, the transition is expected to result in annual energy

cost savings of about €60 billion by 2050, driven by the decreasing costs of wind and solar energy.

The period from 2010 to 2020 marked a turning turning point for Poland. The adoption of the Renewable Energy Act in 2015 introduced an auction system and new support schemes, leading to increased investments. EU funds continued to play a significant role, complemented by rising private sector participation and international financial institutions' involvement. Poland can expect economic gains from its energy transition. The renewable energy sector is projected to generate around 300,000 jobs by 2050, particularly in wind and solar industries (CIVICUS, 2020). Energy cost savings are estimated at €40 billion annually by 2050, as the country diversifies its energy mix and reduces reliance on expensive coal imports. Additionally, improved air quality from reduced coal use is expected to enhance public health and lower healthcare expenses.

Year	Government & Public Funding (€ billion)	Private Sector (€ billion)	Bank Financing (€ billion)	EU & International Funding (€ billion)	Green Bonds & Capital Markets (€ billion)	Total Investment (€ billion)
2010	1.20	0.50	0.80	0.50	0.10	3.10
2011	1.30	0.70	0.90	0.60	0.20	3.70
2012	1.50	0.90	1.00	0.70	0.20	4.30
2013	1.70	1.00	1.10	0.80	0.30	4.90
2014	1.80	1.20	1.20	0.90	0.40	5.50
2015	2.00	1.50	1.30	1.00	0.50	6.30
2016	2.20	1.80	1.50	1.20	0.70	7.40
2017	2.50	2.00	1.80	1.50	1.00	8.80
2018	2.80	2.30	2.00	1.80	1.50	10.40
2019	3.00	2.80	2.20	2.00	2.00	12.00
2020	3.50	3.50	2.50	2.30	2.50	14.30

Source (EIB, BloombergNEF, IEA, MoCE-Poland)

Table 2: Diversification of Funding Sources in Poland (2010-2020)

The success of the energy transition in both Germany and Poland hinges on their ability to secure adequate funding from various sources. Germany's transition is supported by a combination of public and private investments, along with substantial EU funding. Government subsidies, such as feed-in tariffs and tax credits, have played a crucial role in attracting private sector investments, which account for over 60% of total funding (German

Institute for Economic Research, 2020). Additionally, EU funding programs, including the European Green Deal, provide significant support for Germany's energy initiatives.

Poland relies heavily on EU funding, alongside domestic public and private investments. The EU's Just Transition Fund and Cohesion Fund are particularly important for supporting Poland's shift away from coal dependency (Ministerstwo Klimatu i Środowiska, 2021). Although the Polish government offers financial incentives for renewable energy projects, such as subsidies for energy efficiency, attracting private sector investment remains a critical challenge due to the perceived risks associated with the energy transition.

Germany's legislative framework provides strong financial incentives and policy support for the energy transition. The Renewable Energy Sources Act (EEG) introduced feed-in tariffs, which guarantee stable revenue streams for renewable energy producers and encourage investment in green projects (Agora Energiewende, 2019). Tax credits and subsidies for energy efficiency improvements further bolster the financial feasibility of the transition.

Poland has also implemented financial incentives to promote renewable energy, though to a lesser extent than Germany. The country's auction system for renewable energy projects fosters a competitive environment for investment, while EU support programs offer financial assistance for regions affected by the coal phase-out (Gawlikowska-Fyk, 2019). However, Poland's energy policies must address the economic significance of coal and the social implications of transitioning away from it to ensure broader public support and investment.

Germany and Poland have followed distinct paths in renewable energy adoption, shaped by their unique socio-economic and policy contexts. Germany's early and substantial investments, supported by a stable policy framework, have positioned it as a leader in the sector. Poland, while initially slower, has made significant strides, particularly in the last decade, supported by EU funds and new regulatory mechanisms.

By 2050, both countries are expected to see continued growth in renewable energy investments, driven by ambitious climate targets and evolving financial instruments. Germany will likely maintain its leadership with innovative technologies and a robust financial sector, while Poland is poised to reduce its coal dependency and expand its

renewable energy capacity, supported by domestic and international funding sources. The future outlook for both countries indicates a strong financial commitment to achieving sustainable energy transitions.

Year	Germany Renewable Energy Investments (€ billion)	Germany Renewable Energy Capacity (GW)	Poland Renewable Energy Investments (€ billion)	Poland Renewable Energy Capacity (GW)
2020	36.00	125.00	9.40	10.90
2025	45.00	150.00	12.50	15.00
2030	55.00	180.00	15.00	25.00
2035	65.00	210.00	18.00	30.00
2040	75.00	240.00	22.00	40.00
2045	85.00	270.00	26.00	45.00
2050	100.00	300.00	30.00	50.00

Source (Fraunhofer ISE, BMWi, IEA, MoCE-Poland, Polish Wind Energy Association)

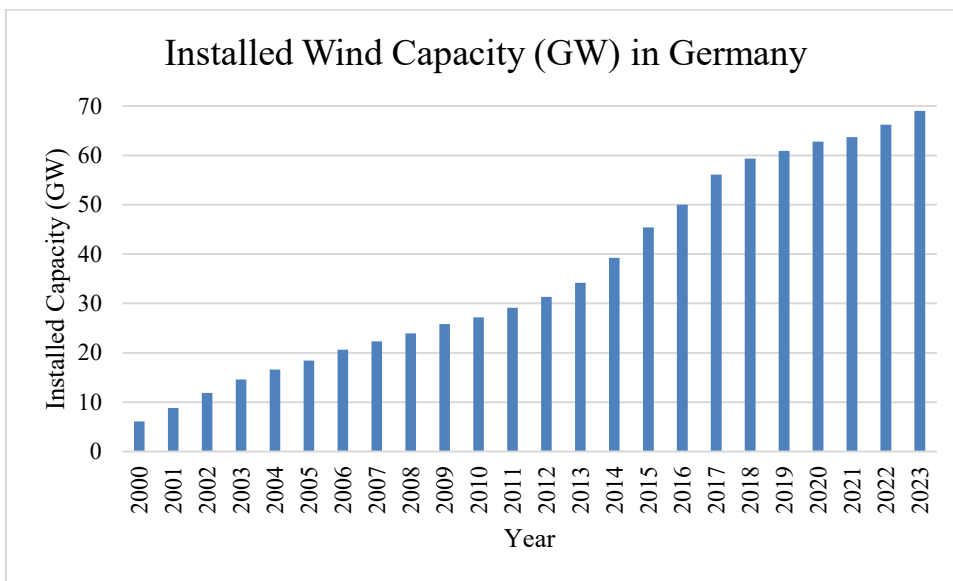
Table 3: Germany vs. Poland Renewable Energy Investments (2020-2050)

3.3 Technological Feasibility for Germany and Poland

The transition to renewable energy has become a critical objective for many countries seeking to reduce their carbon footprint and achieve sustainable energy systems. Germany and Poland, as part of the European Union, have made significant strides in this direction. Technological advancements have played a pivotal role in shaping the feasibility of this transition. This paper examines how technological developments have influenced the renewable energy landscape in Germany and Poland from the 2000s to the present.

Germany has been at the forefront of renewable energy innovation, particularly in wind and solar technologies. The period from the early 2000s witnessed substantial improvements in the efficiency and cost-effectiveness of photovoltaic (PV) cells and wind turbines. Technological innovations such as multi-junction solar cells and offshore wind turbines have significantly increased the energy output and reduced the cost per kilowatt-hour, making solar and wind energy more competitive with fossil fuels (Fraunhofer ISE, 2020). Germany's wind energy sector has benefited significantly from advancements in turbine technology. The development of larger turbines with higher hub heights and longer blades has increased the capacity factors of wind farms. Offshore wind technology has also advanced, with

floating wind turbines allowing for deployment in deeper waters, further expanding the potential for wind energy generation. In the early 2000s, Germany saw significant growth in wind energy capacity, driven by favorable policies and the introduction of the Renewable Energy Sources Act (EEG) in 2000. This period marked a transition from traditional energy sources to renewables, with an annual capacity addition averaging around 2 GW (BMW, 2023). The growth continued at a steady pace, with Germany adding approximately 1.5-2 GW annually.



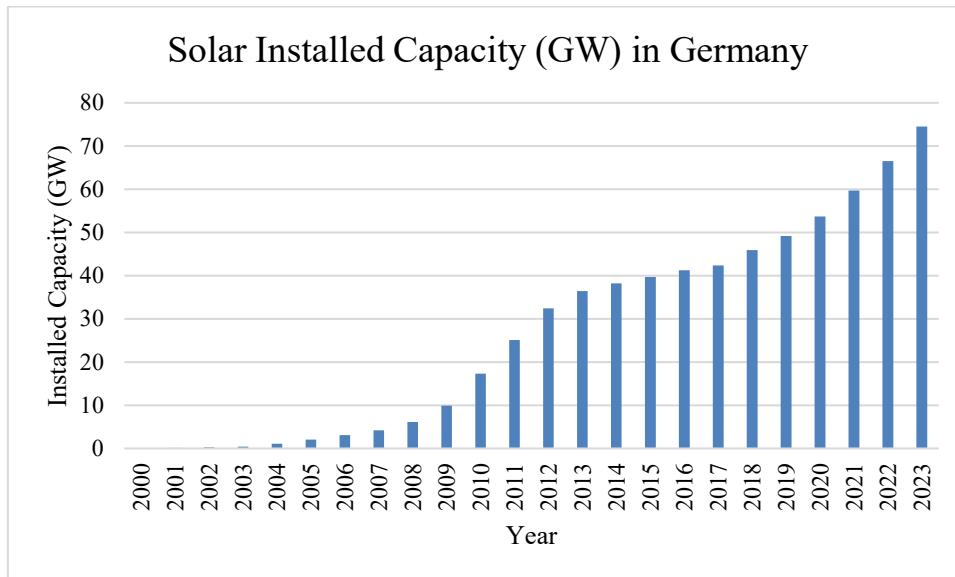
Source (BWE, AEE, WindEurope)

Figure 6: Growth of wind energy capacity in Germany (2000-2023)

Advancements in PV technology, such as the development of thin-film solar cells and multi-junction cells, have improved the efficiency and reduced the cost of solar panels. These technological improvements have made solar energy a more viable option, even in regions with less direct sunlight. Recent years have seen a resurgence in solar PV installations, driven by technological advancements, increased efficiency, and supportive policies aimed at meeting climate targets. In 2023, Germany added 8.00 GW, bringing the total capacity to 74.50 GW. The government’s commitment to achieving climate neutrality and the European Union's Green Deal has further incentivized solar energy investments.

Germany is expected to continue expanding its solar PV capacity, focusing on large-scale solar farms, rooftop installations, and innovations such as bifacial solar panels and floating

solar farms. The integration of solar energy with battery storage and smart grid technologies will play a crucial role in ensuring a stable and sustainable energy supply (IEA, 2023).



Source (Statista)

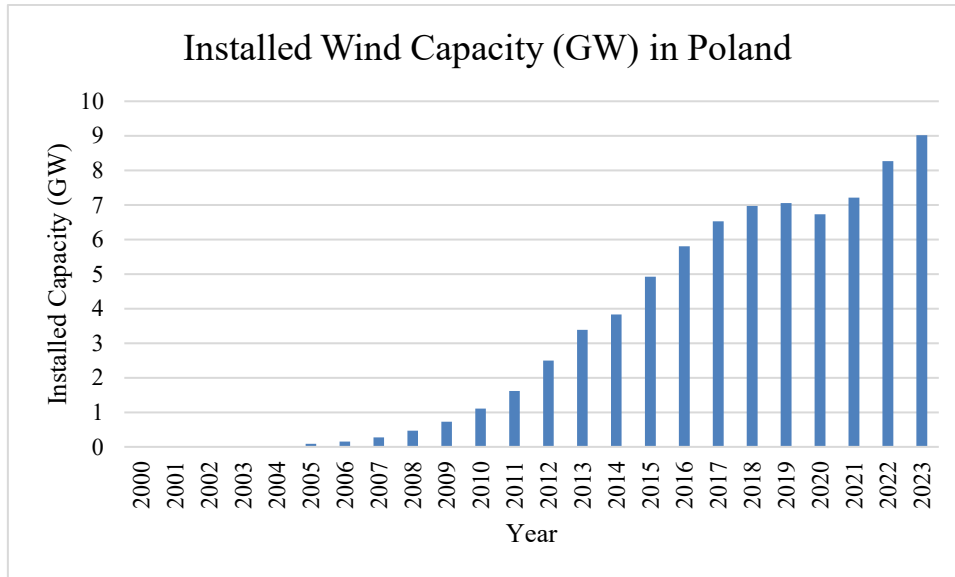
Figure 7: Growth of Solar PV Energy Capacity in Germany (2000-2023)

The development of smart grid technology and energy storage solutions, such as lithium-ion batteries, has further enhanced the feasibility of integrating renewable energy into the national grid. These advancements have addressed the intermittency issues associated with solar and wind energy, ensuring a more stable and reliable energy supply (Bundesverband Solarwirtschaft, 2019).

Poland's transition to renewable energy has been slower compared to Germany, primarily due to its heavy reliance on coal. However, technological advancements have begun to shift this trajectory. Improvements in wind turbine technology, particularly for onshore wind farms, have enabled Poland to harness its wind energy potential more effectively. The introduction of more efficient turbines with higher capacity factors has made wind energy a viable option for Poland (Polish Wind Energy Association, 2021).

Poland has seen significant improvements in wind energy technology, with modern turbines capable of operating efficiently even at lower wind speeds. The adoption of these advanced turbines has increased the viability of wind energy projects across the country. The early

2000s marked the beginning of wind energy development in Poland, with modest capacity additions due to limited investment and policy support. By 2005, Poland's installed wind energy capacity reached 0.085 GW, reflecting a growing interest in renewable energy (Ministerstwo Klimatu i Środowiska, 2023).

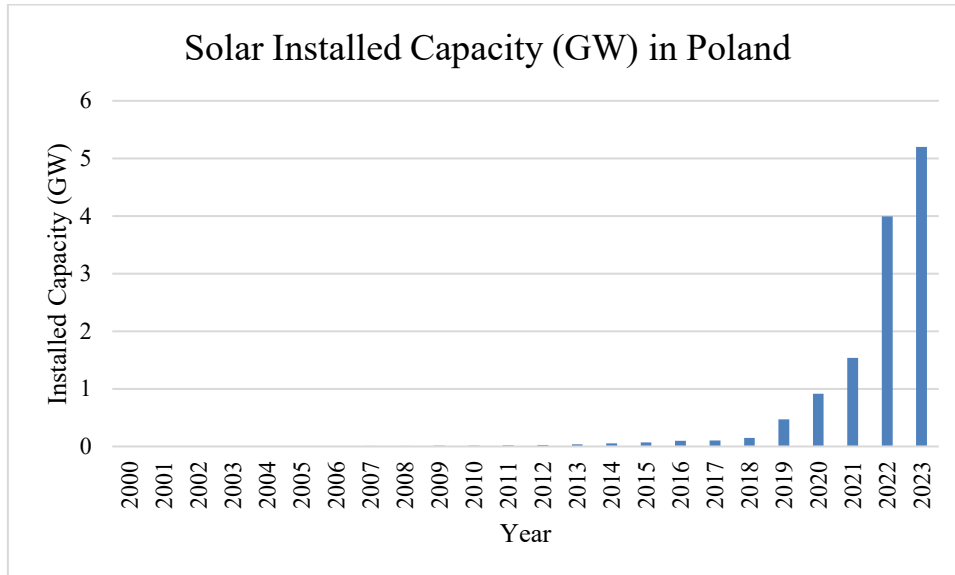


Source (Statista)

Figure 8: Growth of wind energy capacity in Poland from 2000 to 2023.

Solar energy technology has also seen significant advancements in Poland, with the adoption of more efficient PV panels and the growth of small-scale, decentralized solar installations. The falling costs of PV technology have made solar energy increasingly attractive, even in regions with less sunlight (Ministerstwo Klimatu i Środowiska, 2023). In the early 2000s, Poland's solar PV market was in its nascent stage, with very limited installations and low capacity. By 2005, the installed capacity was only 0.0032 GW, reflecting the early development phase and limited adoption (Igliński, B, 2023). With the introduction of the Renewable Energy Act and financial incentives, Poland began to witness more significant growth in solar PV capacity. By 2015, the installed capacity increased to 0.0699 GW, reflecting growing interest and investment in solar energy Poland is expected to continue its rapid expansion in solar PV capacity, focusing on large-scale projects, grid integration, and innovations such as energy storage and smart grid technologies. (Ministerstwo Klimatu i Środowiska, 2023). This attraction had continued throughout 2022 and 2023, with significant annual additions, particularly in utility-scale solar farms. By the end of 2023,

Poland's installed solar PV capacity had reached 5.200 GW, demonstrating strong growth and commitment to renewable energy (Statistica, 2024).



Source (Statista)

Figure 9: Growth of solar PV capacity in Poland (2000-2023)

While both Germany and Poland have benefited from technological advancements, the impact has been more pronounced in Germany due to its proactive policy framework and greater initial investment in research and development. Germany's Energiewende (Energy Transition) policy has facilitated large-scale deployment of renewable technologies, supported by substantial subsidies and incentives (BMW, 2021).

Germany's commitment to renewable energy is exemplified by its substantial investments in research and development, as well as its comprehensive policy measures designed to promote the adoption of renewable technologies. The Renewable Energy Sources Act (EEG) has been instrumental in providing feed-in tariffs and other financial incentives to support renewable energy projects. In contrast, Poland's energy policy has been more conservative, with slower adoption rates for renewable technologies. However, recent policy shifts, including the adoption of the Polish Energy Policy until 2040, indicate a growing recognition of the need to diversify energy sources and embrace renewable technologies (Ministerstwo Klimatu i Środowiska, 2021). The introduction of auction systems for renewable energy

projects and other financial incentives has begun to stimulate the growth of the renewable energy sector in Poland.

4 Discussion

This study examines the feasibility of transitioning from fossil fuels to renewable energy in Germany and Poland, within the framework of the European Green Deal. The analysis focuses on three main points. Our first point was in regards to the key political factors influencing the feasibility of Germany's and Poland's transitions from fossil fuels to renewable energy since 2000's.

As mentioned earlier, Germany's political feasibility for transitioning to renewable energy is strong, thanks to a robust legislative framework and supportive government coalitions. The Energiewende policy, enacted in 2000, established a stable revenue system for renewable energy producers through feed-in tariffs. This policy has driven substantial investments in wind, solar, and biomass energy, as illustrated in figure 1, the increase in renewable energy capacity from approximately 12.1 GW in 2000 to approximately 151.2 GW by 2023. Germany's decision to phase out nuclear power by 2022, driven by public opposition and environmental concerns, redirected focus towards clean energy sources. The Climate Action Plan 2050 and the Coal Phase-Out Law of 2020 further demonstrate Germany's commitment to reducing greenhouse gas emissions and transitioning away from coal. Government coalitions in Germany, including the SPD-Green and CDU/CSU-SPD, have generally supported renewable energy policies, creating a stable environment for the transition.

Public opinion in Germany also strongly favors renewable energy, with significant support for wind and solar power, particularly following the 2011 Fukushima disaster and growing awareness of coal's environmental impact. In contrast, Poland's political landscape has been less conducive to renewable energy growth. Despite being an EU member, Poland's reliance on coal, which accounted for 70% of its electricity generation in 2020, has slowed the transition. The Polish government's support for coal has led to fluctuating policies and limited incentives for renewable energy investment, reflecting a cautious approach influenced by energy security concerns and socio-economic factors, particularly in coal-dependent regions.

The second question we had asked was how have the financial conditions, including any investments and funding, evolved in Germany and Poland regarding renewable energy over the past two decades. To start with, Germany has seen robust investment in renewable energy, with an approximate €32 billion invested in 2019 alone – according to Table 1. This has been driven by a mix of public subsidies, favorable bank financing conditions, and private sector involvement. The country has also benefited from international funding mechanisms. Poland, however, has faced financial hurdles. In 2019, investments in renewables were significantly lower, at approximately €12 billion – according to table 2. This discrepancy is partly due to a lack of consistent policy incentives and the higher perceived risks associated with Poland’s energy sector. Although recent initiatives, like the Polish Energy Policy 2040, aim to increase the share of renewables, attracting sufficient investment remains a challenge. The EU's could play a critical role in bridging this gap, offering financial support for transitioning coal regions.

The third and final question that we had posed was the technological advancements of both Germany and Poland from the early 2000’s and how this impacts the feasibility. To start with, Germany has been a leader in technological advancements in renewable energy, particularly in wind and solar power. According to Figure 6 and Figure 7, the country installed over 60 GW of wind power capacity and around 53 GW of solar power in 2020. This was supported by strong R&D initiatives and a favorable regulatory environment. The technology in Germany has not only reduced costs but also improved the efficiency of renewable energy systems. Poland's technological progress has been slower. By 2020, Poland had installed around 6.5 GW of wind power capacity and less than 1 GW of solar power in accordance to Figure 8 and Figure 9. This limited adoption of advanced technologies can be attributed to lower R&D investment and less supportive regulatory frameworks. However, the recent introduction of policies (Renewable Energy Act) promoting offshore wind and solar PV indicates potential for future growth, which could be bolstered by EU funding and technology transfer from more advanced markets.

Ultimately, the study reflects on both the existing literature that underscores the importance of political stability, financial incentives, and technological innovation in facilitating energy transitions and the data extracted in Section 3 based on our comparison of Germany and Poland. The data adds depth to the understanding of how varying Germany and Poland

affect the success of transitioning to renewable energy in the context of the European Union's Green Deal Strategy.

Conclusion

The comparative analysis of Germany and Poland's transition from fossil fuel to renewable energy has shown that the feasibility is dependent on its political, financial, and technological advancements in order to achieve such a transition by 2050.

Germany's strong legislative efforts towards renewable energy, high financial investments, and continuous technological advancements has put the country as the lead of the renewable energy transition across the European Union. In contrast, Poland's more conservative approach is a representation of its challenging political landscape and its heavy reliance on coal, making the country fall behind in terms of progress in achieving the EU targets at an acceptable pace.

This study elaborates on the key achievements and yields a comprehensive understanding of the political commitment, financial investments, and technological innovations necessary for the energy transition in both countries. The results of the study conclude that Germany is on the right path into achieving the EU's target by 2050, in contrast, Poland is faced with challenges that require stronger legislative, financial, and technological planning in order to overcome this obstacle.

This thesis emphasizes on the necessity for strong policy frameworks that are sensitive to the specific political and economic situation of both countries. The comparison between Germany and Poland shows that even though both have the same common objective set by the European Union, their approaches towards achieving such goals vary and have to be adjusted to the particular challenge each country is facing.

Based on the comparative analysis presented in the thesis, it is clear that the 2050 target for achieving net-zero emissions, while ambitious and necessary, is exceptionally challenging for certain countries. Germany's advanced progress provides a path forward, but Poland's struggle underscores the need for flexible timelines and adaptive strategies. Financially, it is crucial for countries to engage major fossil fuel companies to transition towards renewable energy sources, or invest in renewable energy technology. By providing financial incentives, such as tax breaks, subsidies, and investments in renewable energy infrastructure, governments can encourage these companies to shift their focus and resources. Finally,

engaging a variety of stakeholders such as policymakers, industry leaders, and financial institutions, is essential for fostering a supportive environment.

Therefore, policy recommendations should include more coherent targets that allow for incremental progress and substantial financial incentives to drive industry participation. Ensuring that no country is left behind in the transition to sustainable energy not only acknowledges the diverse starting points of EU member states but also promotes a more inclusive and realistic pathway to achieving the overarching goals of the European Green Deal Strategy. Engaging a wide range of stakeholders will amplify public support and foster a collective effort towards a sustainable future.

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Summary

This thesis concerned itself with the factors that influenced the political feasibility of Germany's and Poland's transitions from fossil fuels to renewable energy, within the context of the European Green Deal. It examines the varying degrees of feasibility in achieving a sustainable energy transition in both countries, considering their distinct political, economic, and social contexts. Germany has been a pioneer in renewable energy adoption, driven by strong political will, public support, and substantial investments in green technologies. The country's Energiewende policy has set ambitious targets for reducing greenhouse gas emissions and increasing the share of renewable energy in the energy mix. However, challenges such as grid stability, economic costs, and political opposition from certain sectors remain significant obstacles.

In contrast, Poland's transition has been slower due to its heavy reliance on coal, economic dependency on fossil fuels, and political resistance. The Polish government has shown reluctance to fully commit to the European Green Deal's stringent targets, citing concerns over economic impacts and energy security. However, recent developments indicate a gradual shift towards renewable energy, influenced by EU funding and policy pressure.

The thesis argues that the feasibility of transitioning to renewable energy in Germany and Poland is highly dependent on political factors, including government policies, public opinion, and international obligations. It highlights the need for tailored approaches that consider each country's unique circumstances and the importance of political leadership in driving sustainable energy transitions. Overall, the thesis provides a comprehensive analysis of the political challenges and opportunities in the energy transitions of Germany and Poland, offering insights into how the European Green Deal can be effectively implemented across diverse national contexts.